LEARNing Landscapes

Teaching and Learning in the Digital World: Possibilities and Challenges

Spring 2013 Vol. 6 No. 2

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Statement of Purpose

LEARNing Landscapes™ is an open access, peer-reviewed, online education journal supported by LEARN (Leading English Education and Resource Network). Published in the autumn and spring of each year, it attempts to make links between theory and practice and is built upon the principles of partnership, collaboration, inclusion, and attention to multiple perspectives and voices. The material in each publication attempts to share and showcase leading educational ideas, research, and practices in Quebec, and beyond, by welcoming articles, interviews, visual representations, arts-informed work, and multimedia texts to inspire teachers, administrators, and other educators to reflect upon and develop innovative possibilities within their own practices.

Review Board

Editorial

There are three themes that permeate the education literature at the moment. One is the need for 21st century skills to equip youth with the necessary tools to succeed in the new millennium, which of course is well underway after 13 years. As currently articulated, this means knowing how to access content knowledge efficiently and effectively and to acquire inquiry/problem-solving skills that are meaningful, adaptable, and integrative. The second is the importance of developing creative, collaborative, communicative, and innovative learners who are culturally sensitive, globally aware, and who behave in ethically responsible ways. The third is the need for developing digital literacy to keep pace with the exponentially burgeoning digital world that offers vast promise, but at the same time demands a critical stance to ensure that the power of these tools is used responsibly in what Gardner (2012) terms "good work."

Technology is playing a critical role in how curricula are being developed and implemented. This is reflected in a huge movement in many countries to create STEM (science, technology, engineering, and mathematics) curricula to prepare students for lifelong learning and the demands of the future. Others have proposed that this acronym should be expanded to that of STEAM (science, technology, engineering, arts—language, visual and performing—and mathematics) if educators truly wish to embrace creativity and innovation in all its forms (Catchan, 2013).

In addition, pedagogies are being re-thought as learning how to learn becomes paramount in inquiry learning and problem solving. An example is the trend towards the "flipped classroom" where "fact learning" is relegated to independent work on the part of the learners and frequently accessed electronically, the lecture-style of transmission learning is eliminated, and classrooms become hives of activity, exploration, application, discussion, reflection, and collaboration. There is no doubt that technology has helped to facilitate this, and to widen the possibilities for teaching learning and connection. At the same time it has created new problems around issues of accessibility, safety, and accountability.

The wide range of contributions to this issue tackles all of these areas and much more. We are pleased that our LEARNing Landscapes digital capacity allows our authors to show and illuminate their extremely interesting work in both visual and auditory ways. As in the past, the issue begins with the commentary from invited authors. All other contributions are arranged alphabetically, but for the purposes of this editorial are clustered thematically.

Commentary

Once again we are extremely grateful for the positive and enthusiastic responses we received from luminaries in the field who we invited to submit commentaries for this issue. **Seymour Papert** is a Massachusetts Institute of Technology mathematician, computer scientist, and educator. He is particularly renowned for the digital revolution he inspired through his work on Logo computer programming, and for research that focuses on how new technologies can support learning. **George Markowsky** is well known and respected Professor of Computer Science at the University of Maine. Over the years, Papert and Markowsky have collaborated on numerous projects related to technology and education. In their commentary, these authors challenge educators to move away from the practice of placing new technology in existing, and sometimes outdated, approaches to teaching and learning. They share the work they are doing for a new book entitled "The State of Learning," and while remaining optimistic about the potential for learning that digital technologies offer, they argue that the whole structure of schooling—the age segregation, and the curriculum content—needs to be rethought and revamped. It is only when this happens that the full potential and benefits of the digital technologies will be reaped.

Tom Snyder is a former classroom teacher, an award-winning software product designer, and founder of Tom Snyder Productions. In an engaging audiotaped interview, he describes himself as one of North America's first true "computer geeks." He traces his early interest in computers in the 1960s and 70s when computers filled entire rooms, and recounts how his life with computers evolved and the milestones he encountered along the way. He describes the huge influence the work of Vygotsky and Bruner had on him and how, as a result, he began examining how computer software might accommodate the fundamental human propensity for narrative and storytelling. He leaves the reader/listener with the final and important message that there is no good substitute for a great teacher, but that "there is a need to get more of them out there digitally."

Michael Fullan is Professor Emeritus at the Ontario Institute for Studies in Education at the University of Toronto and a former dean of education there. He is an accomplished and award-winning authority on educational leadership and change. He argues that there is a "push-pull" phenomenon operating in schools. The push consists of increasingly bored student populations as they travel through the grades, while there is also an irresistibly strong pull of students to the accessible, seductive, and exploding world of digital technology with which students interact largely outside of schools. He suggests an extreme overhaul of schools is demanded, with particular attention to what he calls "the new pedagogy." This not only requires basic structural and policy changes, but also includes a fundamental need for teachers and students to be learning partners, for a shift in the role of teachers from facilitator to that of "change agent or activator," and for a much more dynamic and integrated use of technology. His final message is that while these changes may be both messy and daunting, they are mandatory if this new "learning agenda" is to be achieved.

Samuel Bradshaw-Truesdale is a grade-two student at Grenville Elementary School in Grenville, Quebec and truly a member of the digital age. His interview poignantly underscores just how naturally and easily the newest generation of school-aged children is able to use technology in engaging, enlightening, and novel ways. He is clearly ahead of some of his peers when it comes to technology, which is a credit to his school and family who have encouraged his inquiry and technological interests at home. Hopefully, the push-pull phenomenon that Fullan describes will not become a reality for Samuel as he proceeds in his schooling.

Fundamental Parameters of Our Digital World

Daiute's article can serve as an interesting introduction to this issue of LEARNing Landscapes. She postulates that the three fundamental dimensions of digital technologies are interactivity, symbolic flexibility, and the vast array of available information and illustrates these with interesting examples. She suggests that the development and implementation of these dimensions are critical if the global potential of technology is to be realized and matters of questionable use are to be eliminated. She argues that socio-constructivist pedagogies and democratic practices are the cornerstones for engaging students in interactions that are meaningful, as well as for promoting respect for diversity and both inter- and cross-cultural understanding. She underscores that much of the responsibility for doing this resides in the hands of educators.

Digital Possibilities in Classrooms and Schools

Tarchi, **Chuy**, **Donoahue**, **Stephenson**, **Messina**, and **Scardamalia** have developed a "knowledge building" and "knowledge forum" approach using technology in a senior kindergarten and grade one class. This process is comprised of observation, experiments, reading, reflections, and ongoing discussion. The students learn how ideas can be developed and refined collaboratively and then preserved, synthesized, and deepened by recording their thoughts and further reflections in a communal electronic database. Over time, the students learn how to access the technology, add to it, and develop and share their ideas. These authors show with examples how authentic and democratic learning can be scaffolded and developed effectively among very young children. **Strong-Wilson**, **Gilman-Smith**, and **Bonneville** describe how a grade six teacher who became committed to using technology during a four-year "learning with laptops" project sustained and expanded this commitment and transferred it effectively to a primary grade class with the help of her former grade six students who acted as mentors. These authors suggest that it is the intersection of learning networks, digital tools, and creative spaces that can produce teacher agency and sustained change. **Minnigerode** describes how two sixth-grade girls enhanced their interest in STEM curricula, became more involved and engaged, and developed self-efficacy while learning how to design and produce a video game entitled "Don't Give Up." The video was a culmination of their inquiry into the topic of school dropouts and how their game would make players aware of the barriers to high school graduation and success. **Myer**, **Wade**, and **Abrami** documented the work of 21 elementary school teachers and their students in nine urban and rural schools in Alberta and Quebec as they migrated from "pencil and paper" student portfolios to electronic ones. The software used in these classrooms, ePEARL, is free and bilingual and available through The Centre for the Study of Learning and Performance based at Concordia University in Montreal. They found that in addition to teaching media literacy, the portfolios helped students to develop ideas, and to store, share, reflect on, and edit their work, as well as to collaborate and provide feedback to each other electronically. This electronic form of assessment, which includes visual and auditory documentation, facilitated parent participation and enhanced the teaching of cross-curricular competencies. **Hughes** and **Thompson** studied a class of adolescents aged 12 and 13 who used a host of digital devices to critique a variety of texts and share digitally their reflections on a secure classroom network about issues related to the role of the new media in their lives. They created and shared their own digital magazines and poetry which increased the level of engagement and led to new understandings about media. I would suggest that the push-pull tension of technology described by Fullan was mitigated by bringing their adolescent world into the classroom. **Pitman**, a high school physics teacher, shares a very interesting and personal story of how with determination and ingenuity he was able to effectively engage and develop his students' knowledge of physics and problem solving. He shows with visuals how he did this by creating digital laboratories using computer video gaming software such as *Portal 2* and, by so doing, provided students with a "visual sandbox" for exploring physics. **Russell**, also a high school teacher, describes how his students studied the history of World War 1 by combining the traditional analysis of documents with the use of Google Earth. The technology allowed the students to plot the movement of Canadian soldiers during WW1, develop research skills, and understand more fully and empathetically the roles of soldiers and medical workers during this war. Using lenses of critical media literacy and critical pedagogy, **Garcia, Seglem**, and **Share** show with interesting examples how high school youth and pre-service teachers can become more critical consumers of texts by creating their own media texts using a variety of digital technologies. **Hicks**, **Turner**, and **Stratton** share the writing development of a pre-service teacher as she was encouraged and scaffolded into the world of digital storytelling. They suggest that digital storytelling increases the complexity of the writing task and the communicative propensity of the work and that technology cannot be divorced from the understanding of both craft and substance. This creates interesting avenues for yet additional demands on both teachers and learners that merit further study. **Foulger**, **Ewbank**, **Carter**, **Reicks**, and **Darby**, a team of varied educational stakeholders, tackle the issue that schools are facing as social media permeates classrooms everywhere. Rather than trying to eliminate social media from schools, they support the development of policies and practices in schools and school districts that promote innovation, safety, and accountability. They urge policy makers to check existing laws and legislation to avoid duplication and to ascertain the adequacy of these in the face of fast-changing technology. They add that another level of protection is frequently provided in social networking tools. If we are to truly attend to the danger of Fullan's push-pull phenomenon, then surely social media should be incorporated with forethought and care into school systems.

The Role of Technology in Differentiating Instruction and Meeting Special Needs

It is not surprising that the adaptability inherent in various forms of technology can be used to enhance the nuances of differentiated learning and the responses of educators to the special needs of students. **Parr** describes her eight-month study of 28 grade five students who were using text-to-speech technology (TTST) to facilitate their reading, decoding, and comprehension. She shows with poignant examples how important it is to match technology with the needs of each student and the ways each learns best. She argues that TTST is never a substitute for a skilled reader;

it is simply a tool that can be used effectively for some learners and discarded at the appropriate moment. **Golos** and **Moses** discuss how deaf and hard of hearing preschoolers increase their literacy behaviours and skills when exposed to educational videos that are presented in American Sign Language and incorporate visual strategies. They share interesting suggestions on how teachers can enhance the viewing time and integrate effective follow-up activities.

Contexts Using Digital Technology for Locally Relevant Topics and Issues

Walker and **Arrighi** share how participatory video (PV) was used in Ethiopia and Uganda in a "train-the-trainers" model. This experience fostered empowerment among the participants because they were creating and taking ownership of knowledge and information. Also, it encouraged critical thought and civic engagement. The mastery of this technology and process of production provide participants with tangible and accessible ways to communicate among themselves as well as with those in other contexts. They suggest that PV has utility in all learning contexts, and in a development setting it has excellent potential for producing narratives that will target and reach key stakeholders and help to effect change. **Malmberg** and **Maull** describe their very interesting work with 75 teachers and their 5,500 students from 22 US states and Puerto Rico who participated in the Global Learning and Observations to Benefit the Environment (Globe) Program. This initiative was designed to support educators, students, and scientists in inquiry-based Earth system investigations with support from the From Learning To Research (L2R) program. L2R provided the necessary professional development for teachers via webinars so that their students could engage effectively in the scientific process and develop their understandings by networking and sharing with other classrooms both locally and more distantly, as well as by communicating globally with scientists using Skype. The project culminated in the L2R Virtual Conference for which students uploaded videos of their projects and shared their reports. The lessons learned have now been incorporated into the second iteration of this program.

The Virtual Classroom: Potential and Issues in Online Teaching

Ferrario, **Hyde**, **Martinez**, and **Sundt** describe their involvement in online, synchronous university courses using Adobe Connect, Blackboard Collaborate, or Cisco WebEx that permitted individual, visual broadcasting via a webcam, audio connection through a Voice over Internet Protocol, and a chat box for texting/typing during discussions. Their work suggests that online time works differently—sometimes slower, sometimes faster. Moreover, online teaching requires as much, if not more, preparation and familiarity with the tools, and more structure than they initially anticipated. They found that by front-loading, or "flipping" much of the fact-based learning via digital tools such as Voicethread, they were able to change more traditional lectures into "lecturettes" augmented with visuals and animation which heightened and sustained engagement. The students were able to view the asynchronous materials ahead of time, which enabled them to spend the majority of their time in breakout or plenary sessions. These authors were able to put to rest the idea that online teaching is static and impersonal. Their results demonstrated that the online learning under these kinds of conditions equals and can even surpass that of face-to-face instruction. **Graham** discusses her experience of an online, 12-week reading course that she conducted with eight elementary and middle school teachers using Elluminate and Blackboard systems. She uses the ebb and flow of the tides as a metaphor for how she adapted and changed during this experience and relates how sharing personal histories, negotiating assignments, and having weekly discussion threads contributed to the efficacy of the course. **Passmore** and **Morrison-Beedy** examined the experiences of 16 nursing faculty members from four major state universities while developing online courses for their students. They discovered that in addition to knowing how to use the technology, it is very important for course planners to understand and incorporate the fundamentals of adult learning theory as a basis for developing courses. **Imholz** and **Goldman** suggest that designers of online curricula are committing the same kinds of mistakes that have been made historically in curricula designed for school settings. They explore the advantages of several design methods and propose a four-step design process and an evaluation rubric to increase the effectiveness of online courses. Finally **Cho**, **Ro**, and **Littenberg-Tobias** explore thoughtfully the potential in using Twitter and Web 2.0 as mechanisms for building professional learning communities (PLCs), which increasingly have been shown to be a very powerful type of professional development. They suggest that these technologies can increase and extend the potential for dialogue among educators and provide tools for teacher peer-coaching. As well, they can increase educators' access to information sources and expand and diversify their networks. These authors articulate systematically the various features and functions of the tools themselves—tweets, hashtags, mentions, retweeting—and the access and interface capabilities. They suggest, however, that focusing only on the materiality of these tools is too narrow a perspective. Instead, the focus should be on the sociomateriality of technologies by directing attention to values, contexts and relationships that shape use in order to get a better grasp of how online PLCs can grow professionally, be sustained, and effect change.

Invited Article

It seems fitting to conclude with **Robert Lawler**'s invited article. Longtime friend and colleague of Seymour Papert and Marvin Minsky, Lawler graduated from MIT with a PhD in Artificial Intelligence and Education, a combination that suggests why his interests focus on natural learning and constructed personal knowledge. He shares in great detail the strategy learning that occurs in a game of tic-tac-toe and how learning occurs when the relationships among the elements of the game interface with cognitive change. In a second detailed analysis he shows the process involved in mastering the solution for a Rubik's Cube. It is by trying to look inside mental processes that he is able to argue for the need to consider very carefully what role representation plays in problem solving. In the current world of burgeoning technology that can support many forms of representation, this need merits further attention.

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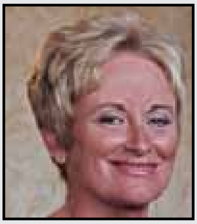

Lynn Butler-Kisber (B. Ed., M. Ed., McGill University; Ed. D., Harvard University), a former elementary school teacher, is Professor in the Department of Integrated Studies in Education in the Faculty of Education at McGill where she is Director of the Office of Leadership in Community and International Initiatives and the McGill Graduate Certificate in Educational Leadership Programs I & II. She has served as Director of Undergraduate Education Programs, Director of Graduate Studies and Research in Educational Studies, Associate Dean in Education, and Associate Dean and Dean of Students, and on numerous committees inside the University and in the educational milieu. In 2007 she was appointed to the Board of Directors of St. George's Schools. She teaches courses on language arts, qualitative research, and teacher education. She has a particular interest in feminist/equity and social justice issues, and the role of arts-based analysis and representation in qualitative research. Her current research and development activities include the McGill/Champlain College Mentoring Project, the Quebec/Vermont International Professional Learning Community Project, and other work with teachers and school leaders in Dominican Republic, France, and Bhutan. The focus of this work includes leadership, literacy, student engagement, professional development, and qualitative methodologies and she has published and presented extensively in these areas. Most recent is her book entitled, *Qualitative Inquiry: Thematic, Narrative and Arts-Informed Perspectives*, published by Sage.

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Commentary

Technology Talk With a Grade Two Student

Samuel Bradshaw-Truesdale

ABSTRACT

In this interview, elementary grade level student Samuel Bradshaw-Truesdale discusses how he uses technology—ranging from Smart tables and Smart boards to computers and the Internet—both at home and in the classroom. He talks about how technology helps him solve word and mathematic problems as well as build LEGO robots.

What kind of technology do you use in your school?

Mostly, I'd say, touch screen.

Can you say a little bit about that?

We sometimes do math with it. We do games and we use the markers sometimes. We use it as a calendar in French class… I like the interactive games on the Smart table. I haven't used it a lot… All I can say is that those games have a lot to do with clothing for some reason. There's somewhere you have to subtract numbers and say which one is bigger—that's what I remember. And there was this one where you had to put socks in a washing machine. If you had the most points you'd win but there's also another way you have to win by doing this. You have to add up your numbers, and if you get it wrong, the person with the second does it until one person gets them right.

What's the favourite technology in school for you?

The Smart board. We look up pictures of things when we don't know what they look like and need to draw them or something. We use it to learn lessons…math worksheets, things that we've already done in math but keep practising them, sometimes very rare but ELA once or twice.

I've heard some really interesting things about robotics that you've done. Can you talk about that?

I'm really good at building them. I built robots, machines, and machines that actually work—ones with wheels that work. I've been trying to make one that can fly…I've stopped doing that for a long time. But I think because of this conversation I'm going to try to do that again!

Tell us how you go about making a robot?

I'd say it is fun, and the programming part for the robots we did in class last year in grade one, was, they really just let you on your own. They didn't give you instructions on how to program it. There was no words to program it, but pictures that I couldn't really understand, but it worked after. You can also do cool stuff on your own. They come with sensors…you can program it for when it senses a thing that you made it sense. It will do something that you made it do, that you programmed it to do, and it senses it. I made a crumpled paper ball—this is actually a game you can play based on something else from the instructions. You make two posts out of anything…you make a person, it can be anything, then you play in the goals—it's like soccer! I made it so that when it senses the ball it will kick it.

You talked about games systems. Can you talk about Pixel People?

I have it!

If you're a really good player, how do you win?

What do you mean, "win"?

Do you create people? Is that the idea?

Yes, except you don't get people every single second—you have to wait. Sometimes you need to build more houses to get more genes. Do you know what I'm stuck with now? I need more houses to make genes—this is a program I used to be stuck with—but, and this is another part of the game, in order to have enough land to make them, there is this land law that whenever you build something, let's say I'm a house that's one square or land long, it would take up one land. And then you can expand with a certain amount of money. Then you get 10 more lands plus one new token. And now I haven't gotten into *utopium* yet!

It sounds like it's not a game you can play in one day

And there's no finishing the game.

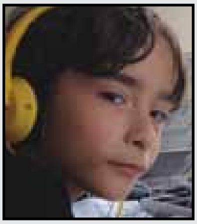
Fig. 1: Samuel's LEGO robot

When you want to create something, come up with something really exciting, what is the best learning environment for you?

There are two or three ways I do that. First, it's kind of like staring at the wall and playing with LEGO, this and browsing at the computer. First, when I want to make something up—sometimes I do this, sometimes I don't—sometimes I look at the Internet for things that are similar. Then, I draw what it's supposed to look like and what it does. Usually it's made of LEGO so I take my LEGO and I build it. But then, I take it apart and make the actual thing. I take the LEGO that does stuff; I don't actually always use the robotic one…I usually use the LEGO that moves.

I heard something about a dinosaur project that you did when you were a little bit younger.

It was just filming with flip cameras. I haven't used them in so long that…all I know is that you stop motion animation on them, that's all I remember. That was in kindergarten!



Sam Bradshaw-Truesdale is a Grade 2 student at a rural Elementary school in Quebec. He enjoys playing video games, reading, building, playing on the computer, and badminton. He is looking forward to being in Grade 3 next year.

Commentary

The New Pedagogy: Students and Teachers as Learning Partners

Michael Fullan, University of Toronto

ABSTRACT

There is currently a powerful push-pull factor in schooling. The push factor is that school is increasingly boring for students and alienating for teachers. The pull factor is that the exploding and alluring digital world is irresistible, but not necessarily productive in its raw form. The push-pull dynamic makes it inevitable that disruptive changes will occur. I have been part of a group that has been developing innovative responses to the current challenges. This response consists of integrating three components: deep learning goals, new pedagogies, and technology. The result will be more radical change in the next five years than has occurred in the past 50 years.

There is currently a volatile push-pull dynamic intensifying in public schools. The push factor is that students are increasingly bored in school and ever more so as they go from grade to grade. My colleague, Lee Jenkins, has been asking thousands of teachers across grade levels how enthusiastic their students are about school. In kindergarten the figure is about 95% satisfaction; and then it goes steadily down until it bottoms out in grade nine at 37%. This represents a tremendous amount of bored students. For teachers one could say that there is only one thing worse than being bored and that is "having to teach the bored." Moreover, the last two Met-Life surveys (2008 and 2010) have shown a dramatic decline in teacher satisfaction, plummeting from some 54% to 40% or less. Thus, school, as it is currently organized and experienced, is psychologically and literally "pushing" students and teachers out of school.

At the same time the digital world of learning and entertainment is exploding, most of it outside schooling. Explosion is the word. What is becoming available is enormous, and easy to access. The pull here is incredibly irresistible, but not necessarily productive in the sense that it is largely ungoverned. Given the push-pull tension we need to avoid either of two extreme reactions. One counterproductive move is to try to rein in students—not a chance against the allure of technology. Another is to marginalize teachers on the grounds that technology can replace them. This too would be a mistake, as mere immersion in the land of information does not make one smarter.

So we are left with a fundamental problem: the dynamic push-pull phenomenon is rapidly reaching a breaking point. Enter the "new pedagogy." In my book, *Stratosphere* I suggested that the learning solution would have to meet four criteria. They must be:

i) Irresistibly engaging for both students and teachers
ii) Elegantly efficient and easy to access and use
iii) Technologically ubiquitous 24/7
iv) Steeped in real-life problem solving (Fullan, 2013a)

This new engagement is in pursuit of "deep learning goals," which we have referred to as the 6cs: critical thinking and problem solving; communication; collaboration; creative thinking and imagination; character education; and citizenship (Fullan, 2013b). It is clear that schooling would have to be radically overhauled to meet the four criteria above and to enable learning to flourish.

The New Pedagogy

There are fundamental structural and policy matters to be considered in relation to standards, assessment, governance, and organization of schooling. In this brief paper I want to indicate the starting point—what we call "the new pedagogy." By definition we only have a preliminary directional notion of what it might look like. In fact I am working with a group of partners to help map out this task.[1] Here we just see the beginning point that can be stated in the following paragraphs.

The basic notion is teachers and students as learning partners. We get an inkling of this in one of the clusters that John Hattie (2012) compared from his meta-analysis of over 1000 research studies. At one point he combines certain instructional practices as "teacher as facilitator," and as "teacher as activator," and shows their "effect sizes." He suggests that effect sizes less than .40 are not worth considering, and those above .40 are of increasing interest. This is what he found:

Teacher as Facilitator (.17 effect): simulations and gaming; inquiry based; smaller class sizes; individualized instruction; problem-based learning; web-bases; inductive teaching

Teacher as Activator (.60 effect size): reciprocal teaching; feedback; teacher-student self-verbalization; meta-cognition; goals challenging; frequent checks on effects of teaching

These findings are provocative and raise several critical questions concerning the new pedagogy. First, they say to me that the reason that the first cluster had such a weak impact is that they were used so to speak "poorly pedagogically." Put another way, the guide on the side is a poor pedagogue; or we don't want "a guide on the side" anymore than we need a "sage on the stage." More proactive partnership will be required.

Second, it is not clear exactly what the new pedagogy would look like. In general terms I would take it as teacher as "change agent or activator," and student as proactive partner in learning. Not only would this require radically new learning relationships between students and teachers, but also *among* them. The next step, and that is what we are working on, is to map out what this new learning relationship would look like—what it is, and why it would be good for learning.

Third, how can this new learning relationship be developed in a way that it positively affects deep learning goals, such as the 6Cs cited above.

Fourth, Hattie did not even examine the possible role of technology. Two items on his list are simulations/gaming and web-based. They were both in the weak impact category. I would surmise that the main reason is that they were used passively as the teacher as guide on the side. The new question by contrast is, with a strong teacher-learner partnership, how could technology be used to deepen and accelerate learning.

Fifth, and finally, what about the implications for costs. The per-pupil cost of education in the current model is breaking the bank; and when you look closely it is inefficient as well as ineffective. I had a throwaway line in my book that said, "welcome to the stratosphere where you get twice the learning for half the cost." This now seems to be an underestimation of the cost of running the new pedagogy. Take three obvious time and cost savers that could come together. One, to put it crassly, is *student labor*—in the new system students help teachers with technology; they help other students as tutors and co-learners; and they help themselves through taking on a greater share of learning as partners. None of this costs a single penny. Also, because the new pedagogy harnesses learning resources 24/7, the *learning day* is effectively doubled or more. Lastly, technology can achieve new efficiencies as it reaches more learners, more easily just as the MOOCs[2] are doing in higher education. All in all the new system will be cheaper, easier, deeper, and more engaging.

Taken together these five implications represent a new learning agenda that is as exciting as it is daunting. This work will draw new energy that will expand geometrically as it feeds on itself. This is what Clayton Christensen means by "disruptive innovations."[3] The scenario is this: the status quo is beginning to reach the limits of its yield (the push factor above); people still are committed to continuous improvement of the existing system (albeit with marginal results); along comes disruptive innovations (e.g., digital product); these early versions, to use Christensen's critical observation, are "inferior products" (compared at this early stage to existing versions); and what ensues is a "rapid learning cycle" where innovations are tried, discarded, refined, and ever improving.

Future Directions and Considerations

The question for the field of education is how it can best participate in this rapid learning cycle while working in an otherwise less and less functional system. The general conclusion for me is that this will be a messy period in which the best stance is to become a reflective doer and learner. One way of cutting this is to think of working simultaneously on continuous improvement and on innovation. In the "Great to Excellent" paper (Fullan, 2013b), I recommended that Ontario "continue" to go deeper in improving literacy, mathematics, and high school graduation, while it simultaneously engaged in "focused innovation" in relation to the 6Cs, and to early learning.

Relative to the 6Cs we need to shift from the perennial superficial homage to the 21st century learning skills, that has been going on for at least a quarter of a century, to the development of what it means to actually implement them in practice. This will entail the hard operational work of defining what each of the skills actually means (and their interrelationships), identifying and developing what learning would actually look like, and assessing the learning outcomes therein. This is of course the new pedagogy agenda.

Similar detailed work will have to be carried out relative to early learning. The critical importance of early learning—prenatal to age five—has also been known for a long time. For more than a quarter of century we have known that careful attention to the early years will pay off economically at least seven times the investment, not to mention the myriad benefits for individuals and society that will accrue. In Ontario we are implementing full-day kindergarten (FDK) for all four and five year olds in the province. There are some 250,000 children in question. Half of them are being currently served with the remaining 50% to be incorporated in 2013 and 2014. Focused innovation does not just pertain to structure and capital, or to getting the education force in place (early childhood staff and teachers), but also to the everyday learning curriculum and assessment. In operational terms, what does "play-based inquiry look like," what does it accomplish, and how does it feed forward to grades one and beyond. This is of course part and parcel of the evolution of the 6Cs curriculum.

From a change perspective we have to work at both the micro and macro levels and their interconnections. At the micro level the watchwords for the new pedagogy are precision, specificity, and clarity. We have to develop in practice what this new work looks like, not in order to prescribe it, but to know what it means and to be clearer about how to do it, assess it, and learn from it.

The macro level involves what we have been working on since 1997—what can be called "whole system change" (WSC). The content of WSC is beyond the terms of reference of this paper. Two things can be said briefly here. One is that we know a good deal about how to improve the whole system in terms of raising the bar and reducing the gap for *all* students, which includes factors such as: a relentless focus on a small number of ambitious goals; a positive non-punitive stance toward the sector that places accountability more in the position of being a motivator; transparency of results and practice including the use of data for improvement, and for public accountability; ongoing investment in capacity building (professional learning); learning from implementation across the system; the development of an infrastructure and related fostering of leadership on all levels; and a general sense of vertical and horizontal partnership committed to immediate and continuous improvement.

The second thing that can be said is that no system in the world has developed such an infrastructure as we have just described that was developed to stimulate and serve the kind of innovative teaching and learning that I am portraying in this paper.

In short, we have our work cut out for ourselves. At the same time the direction and nature of the change is reasonably clear, while the development and implementation of solutions is as exciting as it is daunting. What could be a better learning proposition—high risk, high yield in the context of an unavoidable challenge.

Notes

1. See *Partnership for New Pedagogies for Deep Learning*, including the M. Fullan and M. Langworthy White Paper, http://www.newpedagogies.org/, as well as M. Fullan and K. Donnelly, *Alive in the Swamp, Assessing Digital Innovations in Education*. London: NESTA; and Oakland, CA: NewSchools Venture Fund.

2. Massive Open Online Courses

3. Please see: http://www.claytonchristensen.com/key-concepts/

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Michael Fullan is Professor Emeritus of the Ontario Institute for Studies in Education at the University of Toronto Recognized as a worldwide authority on educational reform, he advises policymakers and local leaders around the world in helping to achieve the moral purpose of all children learning. He is a prolific, award-winning author whose books have been published in many languages. His latest books are *Stratosphere: Integrating Technology, Pedagogy, and Change Knowledge* (2012), *Motion Leadership in Action: More Skinny on Becoming Change Savvy* (2012), and *Professional Capital: Transforming Teaching in Every School* (with Andy Hargreaves) (2012). Michael Fullan received the Order of Canada in December 2012.

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Commentary
The State of Learning: A Preview

Seymour Papert, Massachusetts Institute of Technology
George Markowsky, University of Maine

ABSTRACT
This article gives some background information on the authors' forthcoming book, *The State of Learning*. There are many challenges facing educators who want to bring education into the 21st century. At the same time, the explosion of technology has the potential to make education more available and influential than ever before. Education is taking place on a large stage and is not just confined to schools. We must rethink the foundations of education so it can truly benefit from new technology.

Learning has moved into center stage of public debate and private concern. Never has there been such concern about education, so much worry about its problems, so much excitement about new prospects, so many ideas generated, so much money spent, and so many developments that dramatically demonstrate that learning is on the move. Yet, at the same time, never has there been such a tangle of confusion in public and private discussion about where it is going and about why so many schools and so many students are having so many difficulties.

We are writing a book called *The State of Learning*. This book focuses on the problems associated with reforming education and bringing it into the 21st century. There has been a lot of talk about reforming education that has seemingly had little effect on the educational establishment. Yet change is coming. It is being driven by many factors and facilitated by technology. Change is coming because it is no longer possible to do things the way we used to do them, because a student in Bangladesh can freely access an online course from MIT,[1] because an ever-growing number of people carry computers in their pockets, because computing and communication are challenging traditional methods of knowledge collection and dissemination, and because we simply can't afford to do business as usual. Big change really is inevitable. What is not inevitable is the way the big change will play out. Our book is about the megachange that is happening in the way the world thinks about education.

The State of Learning presents a unified approach to a wide range of aspects of learning. Although the book's primary emphasis will be on issues directly related to schools, it will devote chapters to the learning that takes place in the home, in the workplace, and in the virtual space of the Internet. The thesis of the book is that problems and opportunities in all these areas are profoundly misunderstood by being treated separately from one another and from large developments in society. The fragmentation of issues allows narrow specialists and interest groups to apply incompatible "remedies" that in the end aggravate the problems they seek to solve.

Our book gives the reader a bold and rigorously realistic vision of where learning might be going in the next decades and offer concrete strategies for dealing with immediate problems faced by schools, by families, and by the "knowledge society" at large. Many factors hold out the promise that ours could be the best of times for a flourishing of learning at all levels from early childhood through formal schooling to lifelong learning for work, for fun, or for a richer quality of life. With startling rapidity, every year sees the emergence of new forms of learning made possible by powerful new technologies. The past half-century has seen a burgeoning of theories capable of guiding further developments. Many futurists looking at these developments declare the arrival of the learning millennium.

But the bright picture is only one side—the best side—of a complex story. The worst side is represented by drugs[2,3] and violence[4,5] in schools, by epidemics of "learning disabilities," by growing disparities of opportunity, and by a growing abandonment of public education for home and privatized schooling.[6,7]

A narrow concept of "special ed" is strangling the budgets of many school districts, causing intense worry to many parents and contributing to the flight from public schooling. Dysfunctional responses currently favored by the Education Establishment hide the problems by the shocking practice of drugging millions of children labeled on the basis of flimsy research as organically hyperactive and by redefining learning as learning to score on superficial tests. The consequences go far beyond the unconscionable harm being done to children who are doomed for life to regard themselves as learning disabled. The disruptions of classrooms and the perversion of educational values affect all children, drive away many of our best teachers, and undermine the originality and intellectual spirit that is necessary for greatness.

In the midst of these grave problems there is profligate waste of resources and opportunities. *The State of Learning* focuses special attention on understanding why the vast majority of schools seem to be unable to use digital technologies,[8] which in principle hold the key to an unprecedented liberation of human learning potential for purposes that go beyond the trivial.

Our diagnosis of the principal cause of School's problems is a deep and ever-widening gap between school and society. Society is changing at an accelerating pace. School remains lethargically stuck with structures that took form in the 19th century with the result being that school now teaches obsolete skills that are not what is needed to make the best of life and learning in our new century. Far more serious is the social disaffection that comes in the wake of the growing perception among children that school is out of touch and grotesquely out of sync with the modern world that they experience every day. Increasing numbers of children are resisting learning what their parents learned not because they are learning disabled but because they do not see the point and find school boring and irrelevant.[9]

Yet our view of learning is optimistic. Understanding the gravity of the problems opens new ways to handling them. A central theme of our book is that the same failure of understanding that has blinded us to the causes of the malaise in learning also blinds education policy makers and the general public to the powerful means we can bring to bear on curing it. In particular it has led to a profound misunderstanding of the potential role of digital technology.

School's mishandling of technology is typical of a larger tendency. We examine the current responses to many problems facing schools and find that most actually aggravate the condition they seek to remedy. For example, if the problems facing School stem from the fact that it has changed so little, then the conservative "back to basics" solution of blaming and trying to reverse the little change that has taken place is an egregious example of a remedy that aggravates the disease. Less obviously but more invidiously, packing large numbers of computers into fundamentally unchanged schools falls into the same category. We argue that the entire structure of School, including its age segregation by grades and the content of its curriculum, is determined by outgrown characteristics of pre-digital age knowledge technologies. The attempted use of the computer to improve the obsolete system is akin to using the jet engine to improve transportation by attaching it to a stagecoach.

The State of Learning offers concrete visions of what it might be like to invent the educational jet plane: new forms of learning that would effectively use our powerful technologies to meet the needs of our evolving society. These visions of what education will have to be like in a near future serve as a compass for realistic steps that can be taken now by policy makers, educators, and parents to prepare for that future. In short the question is: What can we do on Monday that will be a step towards "some day"?

Notes

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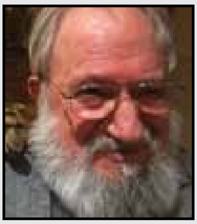


Seymour Papert is considered one of the world's foremost experts on how technology can provide new ways to learn. He has carried out educational projects on every continent, some of them in remote villages in developing countries. He participated in developing the most influential cutting-edge opportunities for children to participate in the digital world. His book, *Mindstorms* has been widely read and has influenced much thinking about education. Papert was instrumental in the One Laptop Per Child Project in convincing Maine to distribute laptops to all middle school children.

George Markowsky earned his PhD in Mathematics from Harvard University after which he spent 10 years working at the IBM T. J. Watson Research Center. Since leaving IBM, he has been a Professor of Computer Science at the University of Maine where he specializes in the development of algorithms, cybersecurity, and understanding the impact of technology on education. He has collaborated with Seymour Papert on a variety of projects related to technology and education, including the First Laptops, Learners and Powerful Ideas Conference at the University of Maine in 2002.

LINK TO:
http://DrGM.us

Commentary

At the Evolving Intersection of Teaching and Technology

Tom Snyder

ABSTRACT

In this interview, Tom Snyder recounts how his technological curiosity led him to build computers at a very young age. He describes how later, as a fifth grade science teacher, he started writing big group simulations on a RadioShack TRS80 computer, which served as the launching point for his future and ongoing career as an educational software developer. He talks about the key changes and trends he has witnessed over the past 40 years in the realms of technology, business, and education. In addition, he critically discusses the works of Vygotsky and Piaget as well as the "huge influence" that Jerome Bruner's educational path had on his life.

CLICK ON QUESTION TO LISTEN TO INTERVIEW

You've been in the technology business for a long time. Can you tell us how you got started and what kinds of things you were doing in the early days in the late 1970s?

I was born in 1950 and by 1962 I was perhaps North America's first true personal computer geek. A phone company went out of business near our house because they were converting over to touch-tone phones in '62. They had all these relays which were electromagnetic devices that when you turned one on, it closed another switch. I picked them up by the bushel and noticed that you could hook them up in a series... You'd turn on the first one, which would then the turn on the second one and the third, and so on. But with time I realized you could do different combinations of things with "off and on." I started creating, without really realizing it, a computer and I didn't know anything about computers. I really cut my teeth on the logic of these things. I built a little device that could count. My parents were… I said to them, "I want to not go to school," I think I was in the seventh grade, eighth grade, by this time. "I want to stay at home and build these things," and they said, "okay," just incredible [laughter]. (Neither one of them had done well in school.) But I built it. And then they said, "You really ought to send it to IBM." I knew that what I had was cute at best but I sent a paper description of it to IBM. I came home one day and there were crates on the front lawn of computer components that they didn't use anymore because they were doing more electronics. There were these 1950s, vintage '40s, vintage relays, and I built a bigger computer and a bigger computer still, not knowing what the hell I was doing, no training.

Then one day I was passing RadioShack—by the way I was teaching, I was teaching fifth grade, fifth grade science—but I saw a computer in the window and I thought, "You can't sell computers. These things fill gymnasiums." I bought the TRS80, which was a really early hobbyist computer—it was about six hundred bucks, which was also a lot of money. I think my take-home pay at that point was $6,900 a year, so it was substantial. I brought it into my classroom and started messing around with it—with no intention of writing what would be called educational software, because I was not a believer… well of course!

I started making tools for myself, just record-keeping tools, things like that on this TRS80; programming in the Basic computer language you learn when you buy the computer. Then I slowly started writing tools for myself to run the big group simulations that I did in my classroom. I've always loved teaching. I had two sisters who both had some learning disabilities, an older and a younger one; it was always my task to teach them and I needed to be really gentle and careful and personal and charming and everything I could to bring them around. I was not interested in the computer as a way to teach, but as I said, it began to creep into my teaching. Before I had my computer I would run simulations and have the kids pretend to be sailing across the ocean, or to be running a factory, group simulations to get the kids talking to one another, and role-playing these fun science simulations. I realized the computer could in fact, sort of administrate that for me, so instead of me with my ice cream carton-full of paper strips with random kids' names on them and dice and a calculator…sort of me playing the role of a simulator, I could have the computer keep track of the simulation and make appropriate guesses as to what might happen next. I was free to wander among the kids and find out how their different groups were doing; each group of five kids might be a crew on a ship, or a shift in a factory, and as a group they would come up to the computer and input their decisions for the day and they'd all get some information back. The whole thing was just spectacular. After a year I had written five programs for group simulations: even one for a social studies teacher about African tribes migrating, looking for better farmlands, safer lands, etcetera. Then I put on a rented suit—and I mean rented—like ten bucks rent for the day, and went down to New York to McGraw-Hill. I took the day off teaching, which you didn't do, but I went down and said, "Got these things." And they said, "Oh, it's educational software." I had seen some before, which was this atrocious drone practice stuff, which is not that different from a lot of the stuff that's done today. They gave me a contract. They said, "We will buy all your five simulations and give you some real money for it." I came back and did that for a year and then finally I quit teaching and started a company. I was off and to the games, writing this group-based software.

Can you trace for us the software evolution that you have experienced in your career to date? What are some of the milestones along the way?

Some of it was business driven. I had a company: at first it was me in the classroom and then I hired somebody and then I hired somebody else. It eventually grew to about 175 people and along the way, like any artist I suppose, you not only have your ups and downs, but you realize you have to do the kind of work you don't really want to do just to make money to pay the employees. I had a lot of young hot-shot programmers from MIT and Harvard working for me. This is all out of my apartment and then I moved to another apartment. It wasn't [a] formal environment but they were real employees. I continued to make these educational group products, but there was more and more demand. Young business guys came to me; they were older than me, they were 32 or 33 and they had just graduated from Boston Consulting Group or Bain—yes the very same Bain that Mitt Romney ran. These highly prestigious consulting firms and all these young guys were coming up saying, "Educational software is going to be huge," and they had millions of dollars of venture capital. They sort of descended and said, "Could you take some of your school group simulations and make them work as home games?" I had a group simulation that I was doing for my girlfriend's classroom, even though I had finally left teaching to work full time. It was kind of a detective mystery where the kids would work in teams and go up to the computer and get information on how to solve this crime and all the different teams had different information and had to compare it. I sort of said no to the venture capitalists and they said, "That's too bad…you might make a million dollars on one of these games." And I said, "Well let me put Mr. Snyder on the phone." And I came back on the phone said, "Yes, of course I'll do that."

It really was never my intention…I'm not a big fan of kids playing games alone on computers. I actually have some theories which make me almost sound like an old Republican but I do believe that a massive amount of the disorders (kids and young people in their 20s and 30s even now who are still taking Ritalin) are not just based on watching television or reading too many comic books—they're rooted in the very strange experience of playing computer games. Syncing a young brain up to the clock speed of a computer has mischievous effects. But, alas, I picked up on computer games and that was an evolution for me. Our first game was a hit. There was something that was the functional equivalent of Billboard Magazine, sort of a top-40 of software and we shot right up to the top of that and started making serious money as opposed to the kind of ministry money that you would make producing at our boutique level for schools. And so the company grew and we made more games.

Then, by 1985, I said to my partner, "I want to get back to the school games. I don't want to work with these retail publishers, the Broderbunds, all these big game companies, Atari. I want to make big group simulations again. I wanted to cut all of our ties." We had Black Tuesday; we were at that point about 30 employees and we went down to seven employees. We invested all of our money in a little warehouse, and we became a publisher in our own right I believe in 1985, instead of just an author making games for what the game companies thought the public needed. We went back and became a serious educational software publisher again.

I did have milestones that came and went. You had mentioned in our last phone call that you had spoken to Jerome Bruner and he was an absolute key thinker. Watching his changes in his career really had a huge influence on the directions I went.

Can you say how?

I went to Swarthmore College, which is a very sort of intellectual place. I was a fish out of water because I was mostly interested by age 14 in girls and rock and roll, and spent a lot of my time in college recording in L.A., taking some time off college. By the end of [my] sophomore [year] I was surrounded by geniuses who knew how to talk about Karl Marx and Rosa Luxemburg, Freud and Émile Durkheim. And I didn't know anything except I had this passion for teaching. I have to mention as an aside: I read a book called "How to Survive in Your Native Land" by James Herndon, it was a book about teaching. That was what convinced me to go into teaching. My intellectual background about teaching was always self-hewn based on this one book, which is one of the neatest books I have ever read. It was honest and vulgar and told many truths about the relationship between teachers and kids, and that was how I cut my teeth in the classroom.

But then I started trying to catch up to all I had missed at Swarthmore. Every day at lunch I would go out for two hours and start reading, and read in a dendritic format where I'd read one book and it would mention something I didn't know about, and it could be either technology or Thomas Aquinas…it didn't matter, I just read and read and read, and I've been doing it ever since, trying to become sort of an auto-didact.

I started reading a lot about education because it was my business, and I read this fellow named Jerome Bruner that everyone talked about. First I had read Piaget, which I thought was such drivel, I couldn't believe it—he was so beloved by everyone I knew or was teaching with me in schools. You could tell he was a social scientist who wished everything were more quantifiable and would surrender more gracefully to metrics somehow. He came up with cognitive stages, because at least you can count stages, stages of cognitive development. As long as you can test things and hire armies of graduate students to perform experiments identically over and over again, you can begin to mathematically define stages of learning. And I "smelled a rat" because there was something bloodless about this, that didn't seem to have much to do with what actually took place in the space between the teacher and the learner. Everyone then told me, "If you love Piaget," which I didn't, "you'll have to read Jerome Bruner," who took up the mantle for Piaget. I read Bruner who held up Piaget as the go-to pedagogical thinker, and I was astounded because Bruner seemed like such a decent and deeply intellectual soul and so gifted and so prone to questioning things. At the time I was doing one keynote a week because it was very profitable for our company. I was always on the road, so my reading took huge leaps because I was flying to every country and state I could think of, staying in a cheap hotel, giving a keynote and flying home the next day. I was reading along the way and I remember on a plane flying out to Fairbanks, it was a long flight, reading Jerome Bruner about the gifts from Piaget. I was thinking: how could Bruner, who was so gifted, so fully support this very mechanistic view of how individual kids created their own path through learning and that it all can be tracked so beautifully with math. This view was, of course, fitting in so perfectly with the computer world because to a hammer everything looks like a nail, and to a computer everything looks like data if possible. I got off the plane, and gave my usual keynote which was about what could happen with groups and what could happen with conversations between kids and between teachers and keeping that conversation alive and finding teachers who enjoy the conversation and enjoyed being with kids in many different ways, in all the different sort of intellectual ways that one can both love and be amazed by kids. Then I got back on the plane and was finishing off Bruner's book and there it was at 35,000 feet, I came to this paragraph where Jerome Bruner did what I love, when scientists or philosophers say, “I was wrong.” He said it gingerly and carefully so as not to let down the hordes, the millions of people who adored him. He said something to the effect of, “…I might have been a bit too enthusiastic about the notions of Piaget, especially as I read Vygostky more.” [And I thought]: “Oh good, I’ll finish Bruner and read Vygotsky.”

But Bruner did me a favour—he translated Vygotsky, and I don’t mean he translated it from Russian—but from the Stalinist version of writing that Vygotsky had to do being a Russian in the 1930s, to try to figure out Vygotsky’s very exciting notions about the social nature of education. And then Bruner began noticing young acolytes of his—there was a woman, I think her name was Margaret Donaldson—who began doing Piagetian experiments that began to really take apart this Piagetian notion that, yes, if you construct the experiment perfectly, you can prove that kids can’t conserve volume with water until a certain age.” However, she introduced a story and narrative into the mix, wondering if there were parts of the brain that were being excluded from the Piagetian experimentation in order to make it more scientific, in order to delay any sort of false noise from the data. Instead of an experiment where water was poured into a beaker that was thinner and wider but the same amount of water and it rose to a different level and the kids would all agree that it was a different amount of water up until a magical age at which they had made a cognitive sort of quantum leap, she did the study, observing all of Piaget’s exactitude and carefulness but she had a puppet involved—a naughty puppet, I believe it was her first take on this thing. I forget exactly how she structured it but it didn’t break any of the rules that graduate students had been following for 30 years to make the testing accurate, but it did introduce a little bit of fiction in the background about the puppet. When the puppet would suggest that the water amount was the same amount as the other water, the kids would go, “No, it isn’t!” This was a very exciting moment because it was bringing back from 10,000 years ago the notion that narrative has an incredibly powerful neurological story to tell, and social story to tell, and that we might have been draining the blood out of an understanding of how learning takes place in order to accommodate this need for science to be physics-based.

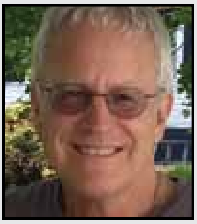
There are so many people who are thrilled that the computer could fit into this world of one-on-one classrooms where you’re getting kids from one stage to the next and then they actually began convincing people that there was enough artificial intelligence available to make this one-on-one computer tutoring feasible… because, they hoped, the computer could actually be making rational judgments about whether the kids were ready to leap to the next cognitive place. I thought that was all nonsense then—I do now. Thank you Jerome Bruner and your path, and then my subsequent path to understanding the power of other things other than total rational deconstruction of how the child learns. It's that space that Vygotsky actually defines as ZPD [zone of proximal development], the space between the learner and the teacher. I'm sorry if I'm being a bit long-winded but I might say that the Piagetian/computer view fit in perfectly with deconstructionists and the post-modernists who were very excited by the computers that were coming out, who were trying to dethrone authority and take the author out of the light, or the teacher out of the mix, and put the teacher back in now as only a guide on the side. They were saying it's not really about that space between what the teacher does and the students know, but it's about everybody creating their own singular path through knowledge, and no sort of leadership or as I would say, master story-teller. Sadly though, the promise of tutorial computing continues on to where we are today.

Where is the digital world going when it comes to education and what kind of challenges do we really have to attend to?

I believe firmly that there are going to be accidental discoveries, which is the only way it can ever really be done in technology as it becomes more and more ubiquitous...it's an unending parade of ubiquity. Since the beginning, there was no way we were going to discover what worked with computers in a classroom through a scientific process. I don't think Seymour Papert could do it with Logo or any of the other geniuses that came along. If I had to guess where the discoveries are going to be, there's going to be a return in technology to powerful human teaching. I think that's despite all of the money that's being spent today. There is another ed-technology bubble right now—even with ed incubator start-ups. There is so much money out there for educational technology right now, but it is no different…zero lessons have been learned as far as I'm concerned. It reminds me of all the days from the 70s when there were big companies trying to take over educational software and had systems where all the student data would be kept in Omaha. Every 10 years there is an attempt to consolidate and say, "We finally know on a megalithic scale how to monitor and guide the learning of students electronically." That's happening again and a lot of money is going into it—Rupert Murdoch throwing money into educational technology in the millions, in the tens and perhaps hundreds. The big publishers, like Pearson and others, are rushing into that vacuum and everyone's trying to figure out how to cash in.

But meanwhile, there's this strange and wonderful thing going on: everything from the very low-tech thing of "Khan academy" where there's a guy who basically hides himself in a closet and is a polymath himself and etches out instruction for students, but he's a gifted teacher in that he moves at the right pace and you can hear him thinking out loud, in a way that is very intuitive. Or MIT and Harvard and other universities investing a lot of money in infrastructure to get their best teachers out there in the ether. There is an interesting confluence, which is, on the one hand, there's still this misguided belief that, "Finally, we can solve the problem of bad teachers by having software," then at the same time, with bigger broader networks, there's the idea that, "There is no substitute for a great teacher and how can we get more of them out there digitally."

Ultimately, the solution to the problem of bad teachers or not enough teachers or not enough good teachers, will not be not great software—it will be more great teachers. That is going to creep back in. That has to be solved. I think the "accidental discovery" is going to be that despite Wireless Generation…despite the educational tracking and training…despite that money, we're going to keep on collapsing back into the great teachers, the great storytellers, and what it takes to understand that space between teachers and students. And how technology might promote that.



Tom Snyder is a creative and energetic teacher who began using a computer in his classroom 30 years ago to help him do what he loved to do most: teach. Tom began designing computer programs in the 1970s to enhance the collaborative learning environment in his classes. In 1980, Tom united his passion for teaching with his vision for education to establish Tom Snyder Productions. As founder and former chairman and head designer, Tom designed numerous award-winning software products including Timeliner; Fizz & Martina's Math Adventures; Geography Search; and Decisions, Decisions, a 1997 winner of the prestigious Codie Award for excellence in technology.

What Twitter Will and Will Not Do: Theorizing About Teachers' Online Professional Communities

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ABSTRACT

A growing hope is that Twitter and similar technologies will enhance teachers' professional growth by allowing them to collaborate and support each other online. In this conceptual paper, we evaluate the potential of such claims, theorizing about the relationships among technologies, practice, and communities of practice. Specifically, we demonstrate how the concepts of materiality and sociomateriality can be applied toward understanding and researching teachers' professional communities on Twitter. Materiality refers to the physical or digital components of a technology. Sociomateriality refers the social practices and contexts shaping one's sense of a technology.

Many educators are hopeful that Web 2.0 technologies have the potential to reshape schooling. Web 2.0 technologies (e.g., wikis, blogs, social networking sites) offer unprecedented ways for people to interact collaboratively, to create new content, and to leverage a diversity of media (e.g., text, audio, video). Such interactions can occur at any time and from anywhere around the world. Not surprisingly, educational scholars have initially sought to understand the potential of Web 2.0 by focusing on its potential contributions to instructional practices (Greenhow, Robelia, & Hughes, 2009; Hughes & Narayan, 2009; Nash, 2011).

However, suggestions have also emerged that Web 2.0 could also serve as a catalyst for collaboration and professional growth among teachers (Burden, 2010). Although plausible, this possibility yet deserves additional, deliberate examination. Certainly, this argument has gained popularity among professionals in the field. In the trade literature, this enthusiasm has been exemplified by arguments about the power of "personal learning networks" (PLNs) (Richardson & Mancabelli, 2011) and of being a "connected educator" (Nussbaum-Beach & Hall, 2012). Proponents of personal learning networks argue that Web 2.0 technologies provide educators with robust knowledge resources. Information streams can be tailored toward one's interests. Networks of professional relationships can be accessed for support. The imagined result is not only teacher professional growth, but also fundamental changes to the nature of schooling.

Indeed, the rhetoric around Twitter (a microblogging service) seems to exemplify such hopes. Launched in 2006, Twitter characterized itself as a way to "Find out what's happening, right now, with the people and organizations you care about" (twitter.com). Since then, Twitter has been especially touted for its information-sharing capacities. For example, Howard et al. (2011) describe Twitter's role in shaping and coordinating political engagement throughout the Arab Spring uprisings. What's more, Kwak, Lee, Park, and Moon (2010) describe the remarkable speed with which news on Twitter can travel among millions of users around the world. This optimism has been extended toward the sharing of professional knowledge. Couros and Jarret (2012) describe how Twitter helps educators connect with:

> Professionals with common interests who use Twitter to trade information, share resources, ask and answer questions, and debate and discuss education issues of the day... Educators are able to assemble a collection of literally "the best and the brightest" practitioners from around the world, individuals with whom the average teacher usually would never have the chance to interact with or learn from. (p. 149)

Although such accounts are encouraging, the promises around Twitter, PLNs, and the role of Web 2.0 technologies have yet to be studied empirically. While scholars have long acknowledged the importance of professional communities and relationships in the growth of educators (Barth, 1990; Fullan, 2002; McDaniel & Weick, 1989; Talbert, 2010), it is yet unclear what happens when educators attempt to translate those relationships into online interactions. Of additional concern, educational scholars and practitioners have too often assumed that simply adopting a technology is enough to "result" in changes to practice (Brooks, 2011; Cho & Wayman, in press). Thus, scholars and practitioners alike could benefit from more accurate ways to understand what Twitter will and will not do for teachers' professional communities online. In order to develop such understandings, however, stronger theorizing about such issues is in order.

We aim to support such theorizing by introducing education circles to concepts from information systems (IS) research. We first describe some of the hopes around teachers' professional communities online. Next, we illustrate how the concepts of materiality and sociomateriality can be used to illuminate different dimensions to Twitter and to its use. Subsequently, we discuss the implications that these dimensions may have for teachers' professional growth. Overall, these concepts serve as important reminders that educational change is not determined by the material presence of technologies per se, but rather by the values, motivations, and understandings of the people that use them. Applied to Twitter, this interpretivist approach sheds light on how the service's unique limitations could also be a source of strength and innovation among teacher communities online.

Hopes Around Teachers' Communities Online

In order to understand the proposed contributions of technologies to teachers' online professional communities, we first review conventional views regarding those communities. We follow this discussion by describing some of the hopes for how technologies like Twitter might support the development of professional communities.

Traditional Views of Teacher Professional Communities

Centered on the school, conventional teacher professional communities have been portrayed as venues in which teachers learn from one another, collaboratively improving their teaching practices (McLaughlin & Talbert, 2006). These communities are often seen as a way to address the decontextualized nature of formal professional development. Because such resources are often developed by outside experts and geared toward schools generally, they may be perceived by teachers as falling short of the unique needs of their settings (Lieberman, 2000; McLaughlin & Talbert, 2006). Schools differ in many ways that include sense of mission, levels of funding, and student population. Without connections to context and to practices in situ, professional development risks coming across as haphazard, fragmented, or irrelevant.

In contrast, professional communities provide a sphere for collective reflection and problem solving where people can not only process and apply formal training, but also share the unwritten insights that derive from experience (Brown

& Duguid, 1991; Nonaka, 1994). Teacher communities are characterized by teachers' active participation and collaboration in problem solving and decision making, a strong focus on teaching and learning, and an emphasis on developing evidence-based practice (Dufour, 2004; Hargreaves & Fink, 2006). Thus, professional communities can be enriching both at the level of formally articulated knowledge, as well as at the level of craft knowledge. Together, these can improve practice.

Conventionally, teacher professional communities are bound by geography. In school-based communities, teachers will often gather in the same room or hall to discuss matters. Professional communities can also develop in workshop settings. For example, the National Writing Project is one notable example of such a teacher professional community in the United States. In both school and workshop settings, sharing space and having face-to-face interactions are the primary vehicles of building teacher professional communities.

Hopes Around Web 2.0 and Twitter

In contrast to traditional teacher professional communities, professional communities online may be geographically dispersed and interact asynchronously (Kozinets, 2009). To some, increased flexibility might be seen as increased time and capacity to connect with others. Indeed, proponents have argued that technological advancements will catalyze teachers' professional growth by providing a virtual space for professional communities to evolve (Lieberman, 2000; Li, Li, & Sun, 2012; Schlager, Farooq, Fusco, Schank, & Dwyer, 2009).

There are two major sets of arguments in favor of leveraging technologies in teacher professional communities. One set of arguments holds that online professional communities will increase the potential for dialogue among educators, thereby improving schooling (Burden, 2010). For instance, Li et al. (2012) describe how different dimensions of teacher peer coaching can be enhanced by Web 2.0 technologies. They argue that Web 2.0 technologies are supporting tools for teacher peer-coaching and should be selected carefully according to the objectives of peer coaching. For example, microblogging services such as Twitter can enhance interactions among teachers by allowing them to have more dialogue.

Another set of arguments claim that teachers will be able to access knowledge that is better tailored and more relevant to their everyday work. For example, Hew and Hara (2007) describe how teachers can leverage electronic mailing lists (listservs) to share opinions, suggestions, and practices. Similarly, Forte, Humphreys, and Park (2012) found that teachers used Twitter to develop new professional ties, leveraging those ties to increase their access to information and passing on that new information to others. By connecting teachers to teachers, scholars, and experts, such technologies have been portrayed as giving teachers access to more knowledge resources.

Together, both sets of arguments call attention toward the potential of technologies like Twitter. We now describe some ways to begin unraveling how much of this potential for teacher professional growth might be attributable to the technology itself.

Materiality: Looking at Twitter

One lens for understanding the potential of a technology is to examine its material characteristics. Indeed, this is the everyday way of understanding technology: To understand Twitter use, look at Twitter. Materiality involves the components of a technology, including how physical and/or digital materials are arranged into particular forms (Leonardi, 2012). Materiality includes the features and other "stuff" available to all users in the same way. Below, we attempt to demonstrate the concept of materiality by describing Twitter. Specifically, we describe the features and functions, as well as the access and interface that characterize some of Twitter's materiality.

Features and Functions

Twitter comes along with unique terminology. These terms can help to shed light on the material characteristics that are unique to the system.

Tweets.

Microblogging involves the rapid broadcast of short messages. With Twitter, each message or "tweet" is limited to 140 characters. These messages may contain hyperlinks to websites. One image that helps to describe how Twitter works is that of a series of radio towers, where each user serves as an individual beacon, sending out tweets. Other users can choose to listen in on tweets from other towers, gaining information or even retransmitting it to others. One chooses to listen to other users by "following" them. The default is for tweets not only to be broadcast to all of one's "followers," but also to be available publicly. Unlike other Web 2.0 technologies such as Facebook, being "followed" does not necessarily mean that one must follow back. In fact, the majority of Twitter relationships are one-way, with only 22% being reciprocal (Kwak et al., 2010).

Hashtags.

Hashtags are a way to span boundaries across Twitter users and their sets of followers. Twitter hashtags are created by including the "#" symbol before a word or phrase (e.g., #edtech, #StarTrek, #AERA2014). These can serve as search terms or subject markers, reaching users who search for or monitor the hashtag in question. Hashtags allow one to reach a larger audience than one's standard network set of followers by cross-cutting according to a topic of interest. For example, Barkley (2012) describes how the hashtag #cpchat served as a forum for administrators to connect to each other via Twitter.

Mentions.

Tweets may also "mention" other users by preceding a username with the "@" symbol (e.g., @DianeRavitch, @MCButtons). Not only does Twitter notify the user that he or she has been mentioned, but it also makes the tweet visible to that user's set of followers. Honeycutt and Herring (2009) describe how the @username function can shape information sharing on Twitter. For example, it can serve as a way to address or call upon a particular user, to direct others to take action, or to broadcast information to the other users' followers. This may also serve as way to increase one's own visibility and following (boyd, Golder, & Lotan, 2010).

Retweeting.

Retweeting is a way to post to one's followers a tweet originating from another user. Because retweets can themselves be retweeted, information can cascade throughout Twitter to a large audience rapidly (Kwak et al., 2010). boyd et al. (2010) describe the ways in which users may modify messages before retweeting, as well as their purposes for retweeting. Retweets might add new content, or be intended to demonstrate agreement with, or to provide validation to, another user. Retweets may serve as triggers for social action by prompting users to rally and connect around a topic.

Access and Interface

Another dimension of Twitter's materiality is access and interface. Twitter can be accessed via its website, www.twitter.com. There also exist a host of third-party clients (e.g., TweetDeck, Hootsuite), mobile apps, and browser plug-ins. Thus, access is possible almost anywhere there is Internet access. It would seem that all one would need is a computer or mobile devices (e.g., smart phones, tablets).

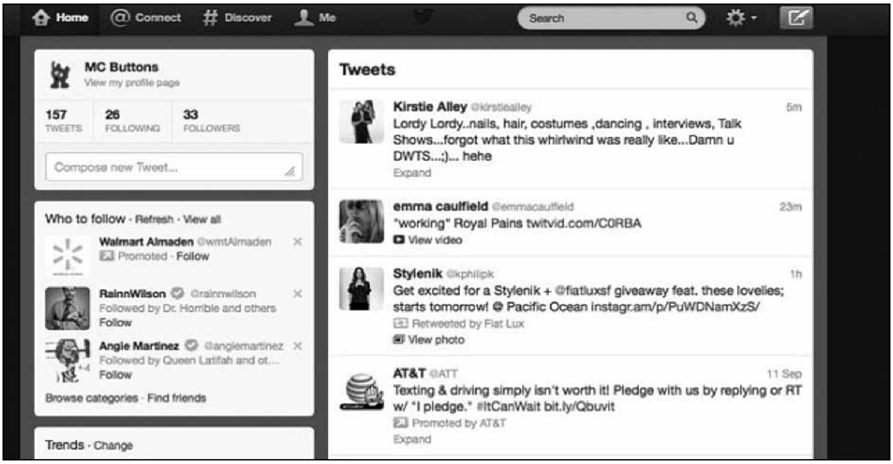

Fig. 1: Twitter screenshot. This figure illustrates the Twitter website interface.

Figure 1 provides a screenshot of the standard Twitter website interface (Twitter, 2012). Running across the top is a navigation bar that includes various icons, as well as a search box. Keywords, usernames, and Twitter hashtags are examples of information that might be queried using this function. At the top-left quadrant of the screen is publicly available profile information for the user, "MC Buttons." This includes a profile picture, number of tweets, number of users followed by MC Buttons, and MC Buttons's number of followers. Along the right-hand side of the screen are tweets from the users followed by MC Buttons. This stream of tweets is updated instantly and constantly, with the most recent tweet appearing at the top of the list. Clicking on a tweet expands the tweet so the user can see videos, pictures, or any information related to that tweet. Users can also interact with these tweets by hovering the mouse cursor over a tweet to reply, retweet, or mark as a favorite.

Can Materiality Teach Us?

Focusing on simply the materiality of a technology is not uncommon, but it can lead analysts to blind spots around the use and "effects" of a technology. Even among researchers, it can be difficult to think of a technology as more than just a "tool" (Orlikowski & Barley, 2001; Orlikowski & Iacono, 2001). Focusing on the material characteristics of a tool draws one's attention to the espoused aims of a technology and its engineering (e.g., reducing burden, strengthening productivity; enhancing collaboration). Focusing on materiality alone assumes that the presence of a feature is sufficient to result in benefits. As a result, the problem of improvement might be envisioned as simply a problem of access to the tool.

Thus, Twitter's material characteristics suggest great potential benefits. For example, several features of Twitter's design would seem to afford quick communication and wide-reaching connections with other professionals. Character limits, hashtags, and the ability to follow just about anyone are just a few of the features that bolster the vision of teachers connecting with other teachers rapidly, easily, and around mutual interests.

Indeed, much of the existing literature on teachers' professional communities online focuses only on the materiality and espoused intents of technologies, portraying Twitter and other systems simply as means toward more learning. Burden (2010) describes properties of Web 2.0 technologies that might contribute to teacher development. For example, he suggests that critical reflection might be served by teachers generating and publicly sharing their thoughts, such as via blogging. Similarly, Li et al. (2012) suggest that video chat technologies could open up opportunities for communication among teacher peer coaches. The question of whether, why, and how such potential is met, however, will not be easily answered by focusing on Twitter's or any other system's materiality.

Narrowly focusing on the material features of a technology has two main problems. First, it places materiality in the driver's seat for changes in practice, obscuring the role of human agency. Brooks (2011) observes that this kind of technological determinism is evident when district policy makers assume simply purchasing technology is sufficient to create "educational progress." Merely relying on material explanations for change fails to account for how technologies might be rejected or modified askew to their intended purposes. In other words, while the materials and design of a hammer may make it ideal for driving nails, this does not necessarily prevent it from being used as a paperweight (Leonardi, 2012). Twitter's benefits might not be about looking at Twitter. After all, just as Twitter has been cast as a professional development tool (Couros & Jarrett, 2012; Richardson & Mancabelli, 2011), it is also widely used for following celebrities (Kwak et al., 2010) and supporting political uprising (Howard et al., 2011). Twitter's material features may make all these things possible, but they do not explain how, why, or how effectively these different uses occur.

Second, a singular focus on materiality leads to assumptions that utility and practicality drive technology use. For example, educational scholars have promoted the notion that putting the "right data" in "better systems" will improve teachers' use of computer data systems (Hamilton et al., 2009; Means, Padilla, DeBarger, & Bakia, 2009; Wayman, Stringfield, & Yakimowski, 2004). This view of technology assumes that people will embrace the "best" tool for the job, because it is rational to do so. People, however, can act in non-rational ways. Leonardi (2009) describes how engineers can reject technologies, despite their potential benefits. Similarly, Wayman, Cho, and Johnston (2007) report about how teachers maintained traditional paper gradebooks *simultaneously* with online gradebooks, despite the burdens of the former. The same report also described how some schools doubled up on student information systems, implementing their own *and* the district's systems (despite the human and financial costs).

We propose that theorizing about teachers' professional communities online might be improved by considering Twitter and similar systems to be part of the context for where teacher learning communities could form. Materiality provides a starting point for understanding what might be possible, but it is the community that determines how, why, and to what degrees that materials are used.

Sociomateriality: Looking at the People Side

Twitter's material features are only one way to begin to understand its potential. The term "sociomateriality" refers to how social practices and context are inextricable from how a technology is used or understood (Leonardi, 2012). This goes beyond the intents espoused about a tool. Values, narratives, and relationships with others shape what people see in a technology, and consequently, what gets done in practice (Leonardi, 2009; Orlikowski, 1996; Cho & Wayman, in press). This can happen in subtle and unexpected ways. If attention to materiality centers on the technical aspects of Twitter, attention to sociomateriality reveals many of the people issues that shape what happens with those characteristics and features.

In this section, we describe how the concepts of interpretive flexibility and structure help to illustrate the sociomaterial aspects of Twitter. After describing these two concepts, we apply each toward exploring the ways in which sociomaterial practices might affect teachers' professional learning via Twitter.

Interpretive Flexibility

One concept that is foundational to understanding sociomateriality is interpretive flexibility. As exemplified by studies about the Social Construction of Technology (SCOT), the same technology can mean different things to people in different social groups (Pinch & Weibe, 1984). This emphasis on sensemaking underlines the influences of values, context, shared narratives, and social relations on technology use. For example, Cho and Wayman (in press) found that differences in teachers' use of the same computer data system could be attributed to differences in what they understood "data use" to be about. The same system could be used in one district as a tool for individualizing attention to student needs, while in another district it might be rejected as being irrelevant to student needs.

In ways that would not be predicted by focusing on Twitter's material features, the notion of interpretive flexibility allows the analyst to examine whether and how Twitter can mean different things to different people. There might not be one "Twitter" or one "best way" to use Twitter. How Twitter is defined (and used) might depend upon the goals, interests, and social context shared by the particular group or community in question. For teachers, those purposes could include sharing instructional wisdom, using Twitter as an instructional tool, or engaging in dialogue around educational politics and reform. These purposes might lead teachers to define Twitter as something that might not even occur to other users (e.g., students, administrators) or those with other interests (e.g., sports, investment, cooking). Below, we describe how this dynamic could shape practices online.

Structure

Structuration theory has been applied widely in studies of information systems and technologies (DeSanctis & Poole, 1994; Jones & Karston, 2008; Orlikowski, 1992). Structures are rules and resources that organize social systems. These rules and resources enable some activities while constraining others. Building upon the notion of interpretive flexibility, these structures might be associated with how people have made sense of their technologies. This sensemaking, however, is not just about the material features of a technology. Structures are part of the larger social fabric that includes institutions, policies, routines, and contexts around technology use (Bailey & Barley, 2011; Davidson & Chismar, 2007; Leonardi, 2009). Thus, some have asserted that structures have only a "virtual" existence, inextricable from the perceptions of the people engaged with them (Jones & Karston, 2008; Orlikowski, 2000). Thus, socially constructed notions about a particular technology (e.g., what it does, doesn't do, or is good for) constitute structures that may influence users' practices.

For example, a person seeking to draw cash from an automatic teller machine (ATM) might incorrectly perceive that the machine is activated via touch screen, tapping it accordingly. However, it might also be that the material characteristics of the

ATM do not afford touch screen use. Not realizing this, the person might even mash one's finger to the glass more strenuously or repeatedly—to no avail. These activities are not dependent on the technology's materiality, but rather on one's perception of an enabling structure in the material.

Equally important, another example of a structure is users' perceptions of community norms and rules. For example, an organization may have different social norms about when it is appropriate to ask a question by e-mail or by phone (Watson-Manheim & Bélanger, 2007). Orlikowski (1996) describes how the realization that a new electronic note-taking system had implications for problem solving and for one's status in the organization led to a host of changes in workers' practices. What people do with a technology is not just about whether the technology is capable of performing a specific action (its material characteristics). It is also about what activities people sense are enabled or constrained by perceived structures like norms and rules. One person might talk on her mobile phone outside of a library because of problems with reception, while another might do so in order to be (or seem) polite to others. The first might be responding to a perceived material constraint, while the second might be responding to both enabling and constraining social factors.

Indeed, Twitter may also be associated with certain social pressures. For example, the public nature of Twitter has been found to lead people to develop rules and routines around what types of content and information they post (Litt, 2012; Marwick & boyd, 2010). Although adapting one's behavior to a context has been well documented in face-to-face conversations (Goffman, 1959; Schlenker, 1980), on Twitter this becomes more complicated. Communities and social contexts can easily overlap; multiple audiences might need to be imagined. As a result, Twitter users must balance the expectations of different potential audiences when making decisions about what information to share (Marwick & boyd, 2010). Understanding teachers' uses of Twitter, therefore, requires an understanding of how teachers create and respond to structures about what types of content and information should be shared on the medium. Applied to Twitter, this view on structure raises questions that a narrow focus on materiality is unable to answer.

What Can Sociomateriality Teach Us?

Recognizing the sociomateriality of a technology involves directing attention to the values, contexts, and relationships that shape use. Accordingly, the sociomateriality of Twitter raises three kinds of questions that might influence the nature of teacher professional communities online. What these questions have in common is the recognition that the perception of both enabling *and* constraining structures drive innovations in practice.

The first question relates to what kinds of adaptations that teachers might make when using Twitter. Assuming that achieving meaningful or robust sense of professional community is the goal, how do teachers get Twitter to deliver what they want? After all, Twitter might be seen as rather limited. One hundred and forty characters is short: the present sentence is 141 characters and it does not incorporate hashtags or other conventions. What's more, a single, constantly streaming screen of information might come across as disorganized or overwhelming.

In other words, technologies can introduce cognitive burdens that make some information more difficult to understand (Ferran & Watts, 2008), and users must make decisions about how particular technologies fit their communication goals (Daft, Lengel, & Trevino, 1987). Teachers who prioritize a richer channel of information (Daft et al., 1987) or who have multiple communication goals (Watson-Manheim & Bélanger, 2007) might not perceive Twitter's basic features to be sufficient. If social connection or sharing the craft of teaching are among the goals of teachers on Twitter, then 140-character tweets seem to be shallow vessels. Some other mechanism might be needed to boost one's satisfaction with the information at hand.

Thus, the motivation to create a meaningful sense of professional community on Twitter might "spill over" into activities beyond the realm of Twitter. Such activities might include blogging out their thoughts, conducting school visits with other Twitter users, or chatting via phone or video. Teachers' online professional communities might not simply be about being online.

The second question relates to what kinds of topics teachers will be willing to address on Twitter. Are some topics "safer" than others? Some teachers might feel that certain topics are socially taboo, while others might not want to risk negative reactions from supervisors or colleagues. As a result, there could be implicit limitations on the professional development topics that can be addressed through Twitter. Additionally, the interactivity of the Twitter audience and its ability to both suggest and enforce social norms could also be leading to a "herding" effect where individuals only ask questions or express opinions that they feel will be validated by other users (Kietzmann, Silvestre, McCarthy, & Pitt, 2012). Indeed, Twitter users are more likely to retweet information or articles that match the expectations of their imagined audience (boyd et al., 2010). Although these are "people issues" that do not negate the possibility for teachers to learn from each other online, they do elevate the importance of examining what is and is not communicated among people in these communities.

Finally, the third question relates to the structure of ties among educators. Does it matter that ties aren't reciprocal? Proponents for Twitter argue that it provides teachers with access to an almost unlimited pool of colleagues (Burden, 2010). However, such ties are typically only "one-way" (Kwak et al., 2010; Holmes, 2011) and feedback about who is listening or benefiting might be difficult to discern. Some users might prefer to "lurk" in communities, perusing communications without posting anything themselves (Kozinets, 2009). In other words, if professional communities benefit from dialogue, then concerns remain about whether and how such dialogue actually occurs. What's more, concerns might also be raised about what kinds of tweets get prioritized in such a system. Marwick and boyd (2010) describe how a sense of "micro-celebrity" led users to tailor their tweets in order to maximize their potential reach and popularity among followers. As a result, relationships between teachers on Twitter may not have the same characteristics that they would in offline professional learning communities.

Discussion and Conclusion

In the preceding passages we have described different ways to think about and to understand Twitter's potential contributions to teacher professional communities online. We argued that simply focusing on the material characteristics of a technology only provides a portion of the picture about how a technology might be used. Accordingly, we suggest that it may be time for educational scholars and practitioners to think bigger. We attempted to provide theoretical contributions toward this end by describing how the sociomaterial and "people issues" around Twitter might refine one's understanding about its potential role in teachers' professional growth. Although Twitter serves as an important venue for such thinking, the lessons around sociomateriality could apply to broader discussions of how educational change occurs.

For example, we suggested teachers' drive to develop a meaningful sense of professional learning might lead teachers to innovate new routines and practices beyond the realm of Twitter (e.g., face-to-face interactions, blogs, video chats). This idea of developing a repertoire is worth examining, not only as it relates to Web 2.0 technologies, but also other school activities. For example, teachers often have a repertoire of technologies for delivering assessment and student information (Wayman, Cho, & Richards, 2010). It's plausible that the introduction of new data and new systems might present educators with new demands around how to interpret students' needs. In turn, these might spill over into new routines and advice networks around data or computer data systems.

We also suggested that social factors may influence the overall marketplace of ideas shared by Twitter users. If the content and dialogue in a professional community online is advertently narrowed, what does this mean for its quality? While the potential for celebrity and status might be possible in traditional school-based learning communities, the online context increases the likelihood that teachers might make decisions about the quality of a contributor without the benefit of direct observation or interaction. Future research might compare knowledge sharing within online professional communities with knowledge sharing in conventional communities. What is really being learned? How do teachers make decisions about who to collaborate with and who to learn from? Do the relationships developed online endure meaningfully? While technologies might enhance some forms of learning, for others they might only serve as a quick and shallow fix.

Just as scholars may need to evaluate what knowledge is being shared online, it may also be important to examine what actually happens with that knowledge in everyday practice. Do technologies really support changes in what teachers do or see in the world? If so, how do teachers decide what knowledge online is meaningful and practical? It is not uncommon for people to orient only toward "evidence" that confirms pre-existing biases (Coburn, Honig, & Stein, 2009; Pfeffer & Sutton, 2000). If this confirmation bias holds true in online communities, then practitioners might not even realize that their sense of reward and benefit is not necessarily based in "learning." Future research needs to look beyond the potential of Twitter toward whether its promises are actually being fulfilled.

Recognizing the sociomaterial dimensions of technologies, researchers may be better able to account for what contributions are best attributed to the technology itself. Equally important, this perspective may provide scholars with more nuanced ways to understand educational change and progress. Rather than focusing on broad stroke measures, like policy or technology, they might be better served by attending to how people come to perceive affordances or constraints around those resources. These issues may be at the heart of how and why policies and technologies are rejected or adapted (Cho & Wayman, in press; Davidson & Chismar, 2007; Spillane, Reiser, & Reimer, 2002)—people, and not simply technologies, are the real agents of change.

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Educational Uses of the Digital World for Human Development

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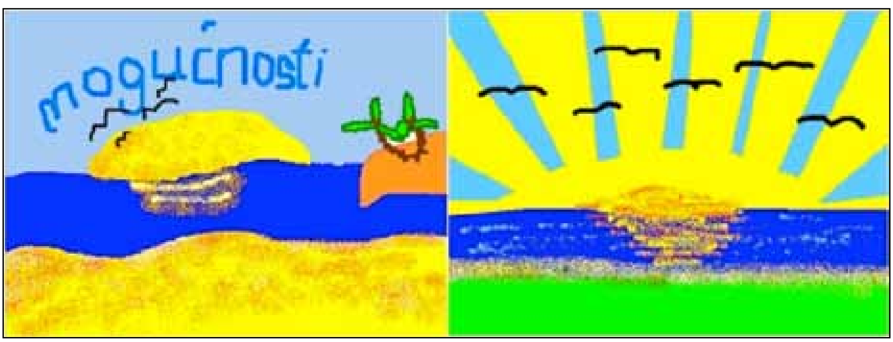
ABSTRACT

This article discusses several enduring features of the digital world in relation to the dramatically changing global context and visibility of the human condition. Based on the author's experience as an educator and researcher, she explains that interactivity, multi-modality, and information storage are ripe for advancing students' creative and critical interactions with diverse others and themselves. With the digital world as a focal point, although by no means the only communication medium, educators are in unique positions to guide contemporary human development, which is increasingly an interdependent individual-societal process, thereby requiring knowledge of realities beyond one's own.



"Future prospects" – Are they on the horizon?

This image of two horizons expresses an ongoing dilemma for teaching and learning in the digital world: Are prospects for teaching and learning in the digital world rising or setting? Does the seemingly limitless access to information and other peoples, at least by those in some parts of the world, increase or decrease educators' roles? What is the best use of precious education time when pre-school through college aged students spend so much of their time in digital worlds: texting, playing multi-user games, using wikis, blogs, or YouTube for term paper resources, learning foreign languages on computer-based programs or apps, and augmenting skills with word-processing and related tools? Guiding students to find meaningful purposes, interactions, and follow-up is more important than ever. How might educators think about the digital world to guide the development of horizons?

In this article, I focus on the capacities of the digital world in relation to challenges and possibilities for individuals and societies in the contemporary global context. Based on my experience as an educator and researcher, I explain that specific capacities of the digital world are ripe for advancing students' creative and critical interactions with diverse others and themselves. With the digital world as a focal point, although by no means the only communication medium, educators can address contemporary human development needs, which are increasingly interdependent, thereby requiring knowledge of realities beyond one's own.

The above image "Mogucnosti"—meaning "Prospects" in Croatian—was created in a research workshop for young people using myriad digital and non-digital tools to support mutual understandings among a generation growing up in countries separated by violent wars during their childhood. The activity culminating in the "Prospects" image was for the 12 to 27 year-old participants to use a digital survey template to create their own online interview with peers in the formerly adversarial countries. The text accompanying the "prospects" image read:

> YOUTH OF THE WORLD, WE ARE ASKING YOU TO FILL OUT OUR SURVEY AND ALLOW US TO FIND OUT WHAT YOU WOULD LIKE TO CHANGE IN YOUR COMMUNITY. WHAT ARE THE POSSIBILITIES FOR CHANGE, AND DOES YOUR COMMUNITY HELP YOU IN ACHIEVING THOSE GOALS?
> (Daiute, 2010, p. 148)

The digital work young people did in community education centers across the former Yugoslavia was purposeful, relational, and sensitive to each local situation. One hundred thirty seven youth in Bosnia and Herzegovina, Croatia, Serbia, and the United States participated in several activities to create local newsletter entries about problems and possibilities in daily life from the youth perspective. These young people created, implemented, responded to, and interpreted the "By and For Youth" survey, as well as writing letters to public officials, narrating personal experiences of conflict, reflecting on adults' interactions in public, reading narratives by peers across the region, and interpreting recent news stories about tensions in their locale. The activities were designed for implementation in the digital world, but not all the centers had such resources, so accommodations for offline participation worked of necessity and well.

Regardless of the specific tools available for creating, exchanging, and responding to the survey, these youth whose lives had been defined by war explained that sharing experiences and opinions with diverse others was a highlight. This comment by one teenager was typical: "I feel powerful thinking about others' responses to a survey I completed a little while ago" (p. 169). While participating in such a global imaginary—thinking about geographically and culturally distant others—the participants' hypothetical thinking, such as considering future education or employment, flourished in conversation with peers, community members, and educators. Activities that involved reviewing the responses of other youth to the same survey one had just completed, as noted by the teen cited above, and to surveys one had created, engage young people's reflection and agency.

Lest an example of a youth workshop with digital and non-digital tools seem limited to one region struggling to overcome war, consider the fact that the digital world makes conflicts, inequalities, and abuses worldwide visible to all with access not only to personal computers but also to public digital displays, news, and conversation. In addition, with the current extensive migration across the globe, people who do not have access to digital technologies are likely to have access to other people on the move. At the time of this writing, for example, millions of children are growing up in societies affected by armed conflict, resulting in unstable living situations, and displacement, often with no access to schooling (www.unhcr.org). As refugees flee to safer ground, they interact with residents, aid workers, and, most prominently, media like radio, newspapers, and billboards, all the while sharing experiences. These technologically enhanced mobilities create what many refer to as a shrinking world.

Diverse global human conditions are exposed in the digital world. Educators can seize the opportunity to use the web to expand students' interactions with situations beyond their own. There is, for example, no excuse for not knowing the story of a child living in a refugee camp in Syria or a martyred Egyptian idealist in the stalled "Arab Spring" that sparked the overthrow of dictators in several countries in 2011. Knowing that those situations occurred and why no one is exempt from them have become educational basics.

Global Potential, Questionable Use

Children and youth in many countries are passing increasing amounts of time in digital worlds, yet evidence is scant that this time is expanding knowledge or communication skills. Digital worlds create the potential for interactions from the most remote places and by the youngest people to major urban centers and the most powerful leaders. The reach of email, social media, wikis, computer-assisted language learning, simulated science environments, tweets, and other digital communication tools via web 2.0 and cell technologies has tremendous potential for teaching and learning about the world from within its chatter. For educators and students of literacy and the human sciences, applications of digital technologies remain potentially useful, albeit not yet fully realized. (Applications in the physical sciences and arts are, of course, also extensive and addressed elsewhere.) Education can make a priority to use digital worlds to close gaps in human relations and human development, if not materially then symbolically with activities that expand students' understandings. The "By and For Youth" survey is but one example of such an application.

Given the presence of others visually, aurally, and textually on screens in our homes, schools, libraries, phones in our hands, and public displays, the educational challenge is to learn how to read, interpret, respond to, and develop with others, especially those who might be difficult to understand. For their own personal, societal, and global benefits, American school children and youth, in particular, stand to benefit from becoming individuals who can communicate, identify problems, and imagine with diverse others. Research has begun to show, for example, that U.S. born youth exhibit less ability to narrate breaches in social interaction from the perspectives of those who differ in origin and experience (Lucić, 2012). Immigrant youth who have experience with people whose histories, language, and knowledge differ from their own, demonstrated an ability to explain others' approaches to solving a problem, while the U.S. born youth offered the same explanation for everyone (Lucić, 2012). Students in a country with the most access to the digital world could be especially good at imagining, empathizing, and interacting with diverse others. Therefore, a challenge for teaching and learning in the digital world is to develop and employ symbolic capacities for mutual awareness across divides of national borders, inequalities, stabilities, and geographies. Students who may understandably be drawn to friends' Facebook pages benefit from teachers' guidance in semi-structured activities toward interaction with diverse others, beyond their own standpoints, ideally with understanding and compassion. Building on the view that it's desirable to have many "friends" and "likes," educators can employ features of the digital world to help students consider those who "friend" and "like" something different. The goal is not to agree but to be able to know and to discuss.

Features of Digital Worlds

Three enduring processes of digital worlds are interactivity, symbolic flexibility, and vast sources of information. These capacities are especially ripe for expanding imagination, knowledge, thought, and action.

Interactivity

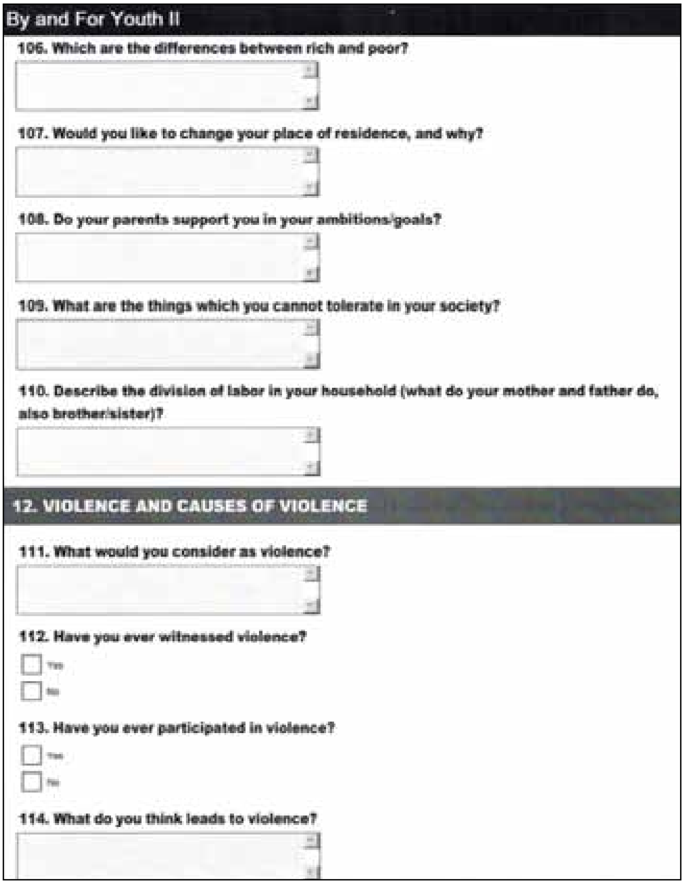
Interactivity of myriad kinds defines the digital world. Direct interaction in the digital world can augment face-to-face interaction. Asking questions and receiving feedback is immediate and fast, for creating seamlessly merged narratives, reports, emails, blogs postings, or social media connections. When tools are not uniformly available, hybrid forms of interactivity can work, as long as there is interactive purpose.

The digital world for the "Dynamic Storytelling by Youth" workshop was, for example, defined as a space for meeting up with others who before the war might have been neighbors, fellow vacationers at the seaside or lake, passers-by, or sweethearts, when, almost a decade after the war, cross-national contact remained problematic if not dangerous. Although these young people living in rural and urban contexts did not all have access to the latest technologies, they did the same activities, supported by several goals of teaching and learning that integrated human and technological capacities and needs. Some community centers had computers donated by international aid organizations, and others welcomed even low-cost tools like markers, pens, and recycled paper. Thus, for some participants in this practice-based study, interaction occurred via the web and instantaneously; for others interaction occurred via borrowed email addresses or post, which took weeks.[1]

Participants across the hybrid digital and face-to-face workshops used available tools to reflect on conflicts in their everyday lives, from the perspectives of others, and their own desires for the future. They used word-processing software collaboratively and individually, digital survey tools resident on computers and connected to others on the web, digital drawing tools, printers, publishing software, and peace games. In the absence of digital tools, the young people participated with printed copies of the surveys, shared via borrowed email accounts. Kinds of interaction included face-to-face small group work to generate survey questions, to discuss how participants imagined those who might take their survey, to enter the survey items in an interactive survey tool, and to examine results of a brief test.

Working in self-selected groups of four or five, participants across six international workshops wrote surveys to discover what peers in the other contexts felt about their positions in their newly formed countries. Instructions suggested that participants write a draft survey on paper, following guidelines to "Create a Title for the Survey," "Write questions," and "Decide on a format for each question" (reminding them of formats such as multiple-choice, Likert scales, and open-ended questions-responses in the survey they had completed at the beginning of the workshop). After writing a draft on paper, participants entered it into the online survey-maker application program if computers and the Internet were available, and if not, they handwrote or dictated to a volunteer scribe. To interest potential respondents, the groups designed ads for their surveys, like the one at the beginning of this article.

After entering their ad and questions in the digital survey tool, participants responded to a test version and then made any changes they deemed necessary. The research team compiled the surveys, maintaining every question and merging similar questions. This compiled "By and For Youth" survey resulted in 148 questions in 15 categories, including "Basic Facts; Cultural Life and Media; Society/The Company You Keep; Substance Use and Abuse; Education (including subsections on Relationships with Professors, Skipping School and Favorite Subject, Abuse); Health; Politics; Work; Social Relations and Life in Your Town; Violence and Causes of Violence; Philosophy of Life and Religion; Migration-Moving Across the World; Approaching Marriage.


By and For Youth II

106. Which are the differences between rich and poor?

107. Would you like to change your place of residence, and why?

108. Do your parents support you in your ambitions/goals?

109. What are the things which you cannot tolerate in your society?

110. Describe the division of labor in your household (what do your mother and father do, also brother/sister)?

12. VIOLENCE AND CAUSES OF VIOLENCE

111. What would you consider as violence?

112. Have you ever witnessed violence?

113. Have you ever participated in violence?

114. What do you think leads to violence?

Fig. 1: Youth-designed survey example

Interestingly, issues that emerged in the survey, like war, violence, abuse by professors, homosexuality, and prostitution, remained silent in other genres, suggesting the specific value of the interactive survey for addressing certain complex and controversial issues. Participants wanted to know how the children of their parents' and teachers' adversaries thought, felt, feared, and dreamed about life in the aftermath of war and thereby used the activity—in and out of the digital world—to begin a conversation otherwise silenced. When entering the hypothetical space with their intended survey audiences across borders, participants realized that they did not know about their peers' experiences, nor their news or worries about emigration, for example. After asking about possible emigration to peers who left during the war (many forcibly), survey writers inquired, for example, with questions like, "What's it like?" leading to a list of questions that become increasingly skeptical, such as, "Is it really worth leaving your home, family, loved one?" even if you're destined to remain poor? Such a questioning process itself prompted and expanded reflection, even before getting responses.

In summary, in the process of creating surveys that would actually go through the web to different sites, with responses compiled digitally, a goal emerged to learn about the "other side." Such new horizons could eventually continue with ongoing educational support.

Symbolic Flexibility

Multi-modality—images (moving and still), words, and sounds available for flexible use—is another important feature of the digital world. As stated by researchers, "multimodality can afford, not just a new way to make meaning, but a different kind of meaning" (Hull & Nelson, 2005, p. 225).

Research with verbal and non-verbal media shows how diverse tools may complement one another to "create new synergies" (Hull & Nelson, 2005). Hull and Nelson (2005) studied the use of digital storytelling by college students and community groups, illustrating

> how (a) the visual pictorial mode can repurpose the written, linguistic mode; (b) iconic and indexical images can be rendered as symbols; (c) titles, iconic, and indexical images and thematic movement can animate each other cooperatively; and (d) modes can progressively become imbued with the associative meanings of each other. (p. 239)

A classroom-based example of multi-media composing drew on capacities of multi-modality (and interactivity) to support writing development of 4th and 5th grade students with learning disabilities (Daiute, 1992; Daiute & Morse, 1993). The research-practice intervention guided students to write a book about their communities via the use of a multi-media composing environment. Students used disposable cameras and cassette audio recorders to collect images and sounds of places, people, or objects they thought depicted the culture of their neighborhoods. Together in the classroom, the students digitized their photos and sounds into a collective database, discussing each one and creating a basic organization of a cultural database. This database included images as diverse as photos of storefronts, t-shirts, clips of favorite music, photos of friends, and bedroom walls. The activity was then for students to write individual entries for a neighborhood culture book, drawing on multi-media resources as they wished. In addition to the image and sound database, which all students had access to, resources included digital drawing tools, word processing, and basic formatting for arranging words, images, and a sound icon digital printable pages, like the one below.

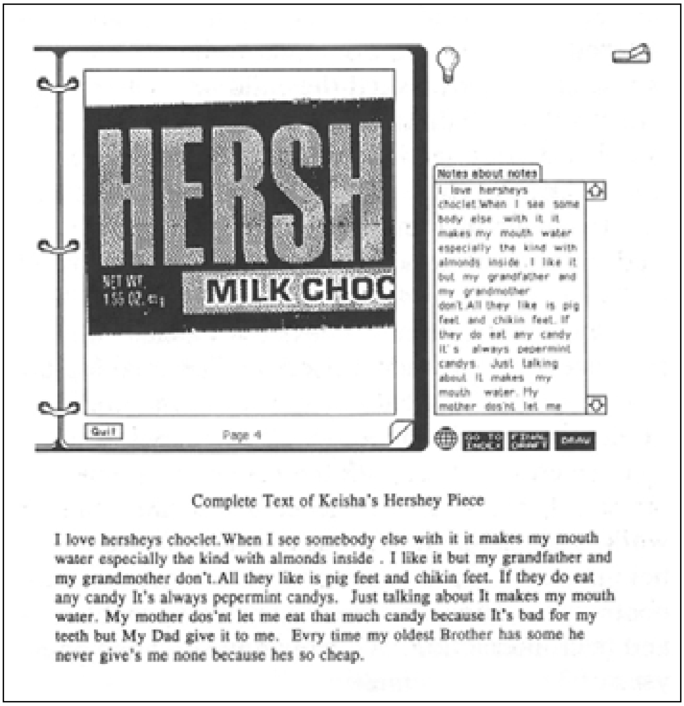


Fig. 2: Keisha's story

Analyses of the students' composing processes and texts revealed flexible and productive uses of the diverse digital tools. As shown in Figure 2, Keisha used the image of a candy wrapper (entered into the database by someone else) as a springboard for a story not about candy alone but about her relationship with a beloved grandfather. The visual mode, thus, served as a prompt, in large part via what appears to be a sensual connection from one kind of candy to another and beyond, eliciting another kind of affective memory. Keisha's teacher and analyses from the study indicated that this narrative was the most fluent and coherent that this student had written all year. Another student used multi-modality in a different way, shifting in real time from a digitized image of a music idol, drawing tools to add features to the musician's album cover, digitized snippets of a song by the artist, and the young author's writing about listening to this music in his neighborhood. This educationally directed activity—writing a book about contemporary culture—with a range of symbolic modes in the digital world is an example of an integration of tools and purposes to expand students' local horizons.

Another major digital feature is the storage and search capacity of the digital world.

Vast Sources of Knowledge and Experience

Given the constant and increasing amount of information in the digital world, students need to develop skills for accessing it. Creating databases, as Keisha and her classmates did, can provide a foundation for defining digital databases, their design, issues related to their development, and processes for accessing information—archived and live. Searching wikis and doing collaborative projects to stretch students' spontaneous realms of interest can guide their knowledge that those resources exist and can serve purposes beyond staying in touch with friends. Using digital tools for student research projects may not seem as appealing as using social media, but engaging students' activities and imaginations has scholarly and ethical value, as well as educational value. Because using digital tools to expand beyond one's personal concerns and milieu is not so easy, defining search purposes and processes requires educational guidance. Also benefitting from discussion in educational contexts is the fact that while the Internet provides recourses beyond a close circle of friends and family, there are dangers and supports. Like parents, teachers, librarians, and other professionals in educational contexts should be resources students can turn to about such issues.

Especially limited has been research on children's digital searching strategies. Search strategies require learning goals, not the closed-ended kinds for specific answers, but expansive goals that offer ongoing guidance and inspiration. With the general goal I have proposed of interacting with diverse others about their plights, a first step must be to have a framework, such as a project to learn about how those on the other side of a conflict divide feel about it. The next goal is for students to work interactively in their local contexts to discuss ideas for questions about what they would like to find out, need to find out, cautions, and ultimate uses of the information they gather. Available research indicates that this process has been, for the most part, the province of media specialists and librarians (Gray, 1994; Mendrinos, 1995). The spate of research interest in this topic in the 1990s seems to have subsided, perhaps because search skills are taken for granted, given the apparent ubiquity of the digital world or the relative transparency of the student research process. Nevertheless, that many young people spend time in the digital world does not mean they are using search processes to expand their knowledge.

Augmenting databases like books, journals, newspapers, YouTube resources, and wikis, students can interact with others who have knowledge, experience, and insights likely to be comparable to their own. Compelling social purposes can, with some guidance, be extended to serve scholarly and community development purposes. Some young people may, of course, do so spontaneously, but even they could benefit from ideas and structure for research projects. Young people across the region where we did the online peer survey-interview activity knew, for example, of certain events that led to the wars, albeit from the perspectives of their own country and certain impressions that others had about their country. Information in the media, from migrants across the region provided such insights, but direct and diverse interactions were needed to break the local rigid scripts on any single side of the war. Given the opportunity to inquire about the lives of youth in other areas, about whom they had some knowledge, some assumptions, and, no doubt, some prejudices, sparked participants' curiosity and empathy. Inquiries of peers living in different political positions brought contradictory ideas together, for example whether adolescents across sites of political conflict experience ongoing discrimination because of ethnicities that, in part, fueled the war. Asking rather than only answering questions shifted agent-audience relationships, thus prompting some participants to realize they had actually never considered their peers' plights. Asking questions is, moreover, foundational to navigating the enormous digital world. As question askers, young people can expand their receptivity to diverse ways of knowing and knowledge.

Because of the vast sources online, educators can help students figure out the best digital tools for increasing knowledge and social relations—tools for connecting with others and one's self, critically and creatively. Using digital environments and tools in these ways is not only instrumental for creating knowledge products, but also useful for purposes of human development. Research and practice must continue to explore how students use the digital world and what they gain from using specific features, such as interactivity, multi-modality, and information.

Relational Projects in Digital Worlds

Still needed are educational designs to guide students' and society's prosocial development. Educational projects in digital worlds can implement collective purposes among face-to-face and distant groups building from local and global issues, like immigration, displacement, unemployment, social media miscommunications, and other problems worthy of the energy of students across upper elementary through high school. This focus on using digital affordances along with others in relation to cultural realities like the roles of diverse institutional actors is consistent with other socio-cultural approaches (Cole, 2010; Gee, 2013; Kress, 2003; Hull & Nelson, 2005). A brief review of theory about the role of education in the digital world is a reminder of the need for a renewed educational agenda.

Epistemological assumptions guiding research and practice with learning technologies have shifted from behaviorist to constructivist to socio-cultural. Explanations of relationships among the computer, teaching, and learning have, for the most part, changed since the 1980s when microcomputers entered public K through 12 schooling. An early focus was on computers as teaching devices, with the attendant excitement, doubts, and fears. Educators then applied constructivist theory to explain that children would, at different ages, interact with the capacities of technological tools based on their own developing capacities. This shift was represented by an emphasis on computer-aided instruction for teaching specific skills (Skinner, 1961; Taylor, 1980) to uses of computers to facilitate early writing development (Daiute, 1985), geometry with child-friendly programming languages (Papert, 1993), problem finding and problem solving with diverse symbolic media (Bamberger & Schon, 1991), and visually rich environments integrated with symbolic media for simulations (Cognition and Technology Group, 1992). Contemporary theorists of learning and development have explained that digital technologies serve as mediators of human activity—useful tools for figuring out what is going on in the world and how one fits.

Scholars are increasingly interpreting digital systems as they do other uniquely human symbol systems like speech (Vygotsky, 1978). Words are cultural technologies (Ong, 1982), and novels are like utterances offered in chains of communication across time and place (Bakhtin, 1986). From the perspective of socio-cultural and activity theories, educational researchers have emphasized the use of technologies to mediate interactions (Cole, 1998; Daiute, 1985; 1993; Hull & Nelson, 2005; Stone & Guitierrez, 2007). The interactive qualities linking diverse audiences for real purposes include, for example, university students participating in community development (Cole, 2010), children of formerly warring groups communicating (Daiute, 2010), multimedia student writers using diverse symbolic modes (Hull & Nelson, 2005), and children expanding their perspectives through on-screen role models (Richert, Robb, & Smith, 2011). Consistent approaches for teaching and learning in the digital world have focused on the digital world as a "scaffold," in one strand of research explaining that "the growing prevalence of screen media in young children's lives suggests technology itself may function as a more advanced partner scaffolding children's developing abilities and facilitating learning" (Richert et al., 2011, p. 82), relating to and learning from characters on the screen (Calvert, Strong, Jacobs, & Conger, 2007; Hoffner, 2008).

In spite of such theoretical advances, few consistent lines of inquiry have survived, in part because research tends to be defined in terms of specific hardware and software rather than features (like those discussed above). Moreover, recently published research indicates that the pendulum sometimes swings back to suggest a one-way process from technology to student, as suggested by numerous research articles reporting the "impact," "effects," or "learning from" technology, rather than explaining the mediational uses of technologies in the midst of a range of collaborative purposeful activities. What insights are especially relevant for educators wanting to employ this theory of technology use to mediate global contexts for human developmental purposes?

Interacting With Diverse Others

The digital world and digital tools for communication, knowledge acquisition, and goal-making have become increasingly easy to use, flexible, ubiquitous, and immediate, although not in all places. What has also changed dramatically is the world in which the digital world is embedded. These capacities stand, for the most part, in parallel to contemporary needs of human civilization. As the digital world has expanded across the 20th to the 21st century, scholarly and popular writing about human social interaction has also increased dramatically. One reason for the increased attention to interactive abilities and purposes—in the digital world and around it—is that environments where children are growing up are changing rapidly. We should, thus, be exploring developmental concepts that 21st century children are using as they interact in unstable contexts. The more young people encounter others with diverse experiences, ways of knowing, and interacting in the world, the more they have to develop skills for negotiating differences—not as neutral processes but as fraught with issues of inequality, prejudice, and conflict. This argument for "pro-social" (Higgins-D'Alessandro, 2012) and "non-cognitive" capacities is increasing in developmental literature (Boyden & Dercon, 2012). Cognition—language and thought—are inextricably integrated with social and affective processes. While any teaching and learning agenda cannot address all needs for human development, educators can better define the teaching/learning process as interacting in the complex social, cultural, and material world, using digital tools to mediate knowledge and experience rather than merely transmitting them. An important question for educators to consider in this process is whether and how their students use the digital world to steer increasingly toward people who think and look like them or to do the more difficult task of considering difference.

A socio-cognitive skill that seems especially relevant to contemporary circumstances is something like perspective-taking. Interestingly, scholarly writing about perspective-taking has risen increasingly over the 2000s, after a drop in citations from the 1970s through the 1980s and 1990s. In addition to "perspective-taking," concepts like "diversity management" and "social inclusion" have increased, adding cross-cultural and institutional dimensions to mutual understanding. Consistent with those expansions is the concept "relational complexity." Beyond interpersonal perspective-taking, relational complexity involves multi-dimensional interactions across individual (child), group (ethnic history and affiliation), generation (as historical circumstances change) and institution (such as school) positions by those in different societal roles, such as student, teacher, administrator. These roles embed diverse resources, influences (power), and goals in the communication process and resulting meanings. Relational complexity, thus, accounts for structural relations, reflecting the increasing need globally for individuals across the life span to relate to others who live, believe, think, and know differently because of language, culture, religion, and politics.

Children as young as 3rd grade in U.S. public schools and young adults in politically and economically unstable contexts in countries elsewhere use diverse genres for relational complexity—connecting in intra-personally sensitive ways to diverse knowledge in diverse situations and with diverse audiences. Paying attention to relational complexity as a process and goal is likely to shift educators' perspectives, as well. For example, we often value autobiographical genres as means of bringing students' personal perspectives into the classroom; nevertheless, there is evidence that autobiographical genres are most useful for conforming to expected mores, while fictional narratives are useful for questioning expectations or expressing less-than-ideal mores (Daiute, 2010). For example, Moira in Croatia used autobiographical writing about a conflict she observed to conform to expected values of moving beyond the conflict by means of compromise for a greater good:

Misunderstandings always begin when people love each other. If people didn't care about each other, all the problems would be forgotten without any effort spent in trying to solve them. People would simply go their way. My aunt has a boyfriend who is a biker. At the parties he goes to, men always have to be the first in everything and have the best bike and the prettiest woman sitting in their lap. The conflict between my aunt and his boyfriend began because of a striper who was seeing my aunt's boyfriend. They usually tried to solve their conflicts with loud and long lasting conversations. … They annulled their marriage but their relationship had many revivals. In the end they were happy because they insisted on preserving their relationship. In their age it isn't easy to find someone who suits you completely, so they decided to accept their flaws and find a common language. Now the story has a happy ending because my aunt is pregnant. (Daiute, database)

Moira organized that conflict as a "misunderstanding" among people who "love each other" and, ultimately, "preserving their relationship."

In contrast, when writing a fictional account positioning her as outside the narrative actions, this same author expressed values related to her country's justification for war and their righteous victory. An allegory with the "Greens" and "Blues" as antagonists (thinly veiled as Serbs and Croats), the following narrative elicited as a fictional story expresses a political ideology that would be less acceptable, especially among many future-oriented youth in present-day Croatia.

The Greens and The Blues created this center in order for it to be the main place for social development of our town. The Greens were ready to do everything. They didn't mind the fact that the Blues participated in some other community centers in other towns. The Blues were loyal to the Greens as much as they were to the other partners. They had enough time and will to be active in many places. The news they told the Greens destroyed everything. With time, the Greens showed they weren't open for cooperation with others. They wanted their capital and their success only for themselves. They didn't realize that it was possible to be even more successful through cooperation with others. The Blues weren't able to explain them how they weren't the traitors and that they didn't operate behind the Greens' backs. In the end, the Blues, cooperating with others became even more successful, while the Greens failed completely. The projects the Blues and others were writing helped the development of many towns. Few years later, they called the Greens to join them. (Daiute, 2010, p. 114)

The ultimate contribution of the relational complexity concept to be explored further is the use of cultural tools in this technological age—to mediate a variety of one's relations from peers to powers, parental and political. Education can serve to direct and connect people as they search the massive content and Babel that's on the Internet. Although interaction abounds, it is likely that engaging in challenging communications may require guidance, not to challenge for its own sake but to provoke synergistic thinking, among, for example, people on opposite sides of wars; participants in different educational contexts (university, school, and community institutions) (Cole & the Distributed Literacy Consortium, 2006), users of MUDDS (Turkle, 1995), and pro-social gamers (Gee, 2007).

Relational complexity is increasingly possible to provoke and support with educational designs in digital worlds, where multiple diverse audiences are available. Interaction with those diverse others to find and/or pursue common purpose can expose students to diverse audiences, responses to their writing, and responses to others' writing. The plethora of other interlocutors in digital worlds also provides opportunities to learn about responses from those who are similar and different in a variety of ways—such as an age-mate growing up in a very different culture, a person of a different age growing up in the same religion, an institutional representative (such as a governmental head) in a very different role from the student. Crafting these interactional experiences is an educator's job, in part because the principled diverse interactions are not likely to occur spontaneously.

Using Hyper-imaginaries

Considered together, the features of the digital world allow for hyper-imaginaries. Imagination employing cultural tools remains the mediator of life, while blogs, wikis, social media, writing, radio, and other technological tools fuel imagination. In research to understand how poor migrants made decisions to embark on perilous journeys, such as across oceans in small ill-equipped boats, in spite of media evidence that odds are greatly stacked against their successful arrival, one scholar wrote the following:

> Our social imaginary oscillates between *presentia* and *potentia* thereby prolonging *being* into possible *becoming*, and when looking at the way people envision themselves as agents and social categories – as groups of people within and among others in time and space – this imagined community often gains a holistic character, simply because people see themselves as wholes and parts of wholes in relation to their historical becoming. (Vigh, 2009, p. 99)

Complex uses of symbolic thought to act in the world and on one's self is a uniquely human capacity. From the beginning of life, babies put these capacities to work, understanding, for example, that a parent's pointing finger means "Look there" and that repeated sounds like "Mama" refer to a specific person, and so on. As educators teaching with digital tools know, children and youth participate with technologies in their realm spontaneously. The work for us is to understand the important features and activities in the digital world that young people do not use spontaneously, do not use for developmental ends, or use for counter-developmental ends. Recognizing those uses, we can create projects that would otherwise probably not occur. Expanding the imaginary—knowledge, thought, conceptual strategies, and communicative genres—is one of the major goals of education. Teaching the tools of science (physics), math (geometry), literacy, literature, analysis of civilization, prior uses of those tools, and the attendant purposes of those tools, is for example, much of what we do in education. Consistent with that view, supporting the best uses of hyper-imaginaries could be a major focus of teaching and learning in the digital world.

Reading books about the lives of children in distant countries is essential; communicating with those children via the Internet advances learning about other children to experiencing their thinking verbally or visually. Guided projects to address cultural and other differences in rational ways are currently possible in the digital world, albeit still for the most part a frontier in practice. The digital youth survey is an example with the multiple means of interaction, multiple-symbol systems, and engagement of knowledge bases in a way that brings age-mates who experienced a war on the opposite side of reason into the room as potential audiences to consider. Inevitably, when responses are entered, which could be during a class session, by the next meeting of a class, or within a week, there will be differences that are off-putting, foreign, or even abhorrent. Here again is where the organizational structure of teaching and learning is crucial for engaging students with diversity, rather than allowing them to turn away or to retreat to only familiar ways of knowing. How to understand diverse perspectives, analyze and learn from them, or agree to disagree is still on the horizon of educational practice and research with hyper-imaginaries. The digital world is not absolutely necessary for such practice, but with enlightened educational projects building on interactivity, multi-modality, archived and live information sources, digital tools can greatly enhance imagination. While many make the distinction between on-line and off-line life as a distinction between not real and real, imagination is the basis of the real. The most brilliant scholars across time have explained that it is social culture that creates mind, mind that creates activity, and this meaningful activity that organizes everyday life.

Learning for Self- and Societal-determination

One expectation of the digital world is that it would increase democratic processes. Although recent socio-political innovations like the Occupy Movement and the Arab Spring, which involved masses of people, many of them young students, expressing their opinions, intentions for political change, and ideas for how that would occur, the Internet has not proved the magical tool for democratic change (Sitrin & Azzinelli, 2012). Blocks to such change have to do with the concentrations of power and inequality in the material worlds where virtual worlds reside. That said, the interactive, multi-modal, and storage qualities of the digital world can be mined for authoritative uses by individuals and groups with developmental goals. The intentions and plans for such educational initiatives are in need of guidance—the kind of guidance possible in educational contexts.

Having designed and implemented the "Wizard" project to involve cross-generational communication for community problem solving, Cole (2010) summarized

> …it is important to recognize that we provide the kinds of education our social ecologies permit and promote, failures and all. It is changes in the modes of human life, including the role of education in promoting human adaptation, that will ultimately shape the forms that educational activity takes… (p. 804)

Another scholar explained how, with some structure in place, the developmental process occurs.

> [An] intergenerational interaction between a child and undergraduate as they engage in activities that represent two varieties of the imaginary situation proposed by Vygotsky: Playing a game and orienting to the 'mythical figurehead,' a fantasy figure common to all Fifth Dimension sites. … As the interaction unfolds, child and undergraduate are seen to engage creatively with both game and [face-to-face] site rules as they create a collaborative and increasingly complex representation of the mythical figurehead. The participants' engagement with rules … provides the child with multiple opportunities, together with those prompted by the site artifacts, to affect and negotiate the Fifth Dimension experience. (Poole, 2011, p. 216)

In conclusion, engaging students in important purposeful interactions with diverse others is a way to expand the horizons of education by expanding interpersonal and inter-cultural understanding. While digital worlds continue to transform in many ways, educational projects must mobilize interactivity, multi-modality, and vast databases of information, which endure along with welcomed changes in portability, flexibility and, for some, accessibility. These digital capacities serve teaching and learning to mediate students' symbolic control, knowledge, and participation in critical and creative thinking about and with others and one's self. Considered together these capacities are most useful for provoking students' interactions with diverse others to expand their horizons, not only to acquire information about other places and other peoples, but also with the affective and intentional goals to understand the world around them and how they fit. Given the ubiquity of digital tools and the vast range of all kinds of information and chatter therein, it takes education to guide and nurture that process.

Note

1. The efficiency of different tools—immediacy and speed of interaction—makes a difference but whether and how remains an empirical question.

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An Honest Account of the Humbling Experience of Learning to Teach Online

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ABSTRACT

The focus of this article is on lessons learned about teaching through the online environment from the experience of 120+ instructors who transitioned from teaching in a traditional face-to-face environment to a blended synchronous and asynchronous online world. We admit that we entered the synchronous virtual world with faulty assumptions and misplaced confidence, believing that what worked in the brick-and-mortar world should also work, with little adaptation, in the virtual world. There continues to be so little literature about teaching in the synchronous virtual environment that we had to rely on our ability to learn quickly by trial and error.

Introduction

Online instruction is gaining momentum. As of 2008, more than 1 million K-12 students were estimated to be enrolled in at least one online course, a 47% increase from two years earlier (Picciano & Seaman, 2008). We see similar momentum in higher education: the 2011 Babson Survey (Allen & Seaman, 2011) found that 6 million students—one third of all students enrolled in higher education—took at least one course online, an enrollment increase of 10% over the previous year, well above the 1% increase in higher education enrollments overall for the same period.

Teachers and administrators could perhaps have ignored these trends until the U.S. Department of Education (2010) reported that “students in online learning conditions performed modestly better, on average, than those learning the same material through traditional face-to-face instruction," (*Evaluation of Evidence-Based Practices in Online Learning*, p. ix). Along with this finding, the USDOE reported, "Instruction combining online and face-to-face elements had a larger advantage relative to purely face-to-face instruction than did purely online instruction" (p. xv).

Given the growth of online learning environments, we focus in this article on lessons learned about teaching through the online environment from the experience of 120+ instructors who transitioned from teaching in a traditional face-to-face environment to a blended synchronous and asynchronous online world. We admit that we entered the synchronous virtual world with faulty assumptions and misplaced confidence, believing that what worked in the brick-and-mortar world should also work, with little adaptation, in the virtual world. There was so little (and there continues to be so little) literature about teaching in the synchronous virtual environment that we had to rely on our ability to learn quickly, as we did not want our students to suffer because of our ignorance. The purpose of this article is to share where we "skinned our knees" as we learned to ride this bicycle of the virtual world, in the hopes of assisting other teachers, and in the hopes of expanding our collective understanding of what it means to teach effectively.

What Is a Virtual Classroom Like?

Often the discussion of online versus face-to-face learning gets positioned as "asynchronous" versus "synchronous," as if online learning had no synchronous elements to it. Typically, "asynchronous" describes students accessing a website and completing assignments on their own time (Anderson, Rourke, Garrison, & Archer, 2001). Our faculty has spent the past four years teaching more than 750 courses in an online environment that does both—provides virtual (i.e., online) face-to-face classes and supplements that learning with asynchronous experiences and resources. We are pleased to note that comparisons of student work produced in our online and our traditional brick-and-mortar programs have found no difference in overall student performance. The one big difference between the two groups is that the online students leave our program feeling more confident about using technology in their own instruction (Chong, 2012).

In this virtual classroom, video conferencing software (such as Adobe Connect, Blackboard Collaborate, or Cisco WebEx) is used as the means through which instructors and students can participate in live class discussions. The staple features of these programs are: (a) they allow for instructors and students to broadcast themselves, individually, via a webcam wherein they can see themselves and the other participants; (b) they connect the audio of participants through either an integrated phone bridge or through the use of Voice over Internet Protocol (VOIP); and (c) they provide a chat box or texting tool where participants can read and type text during a discussion (see Figure 1).

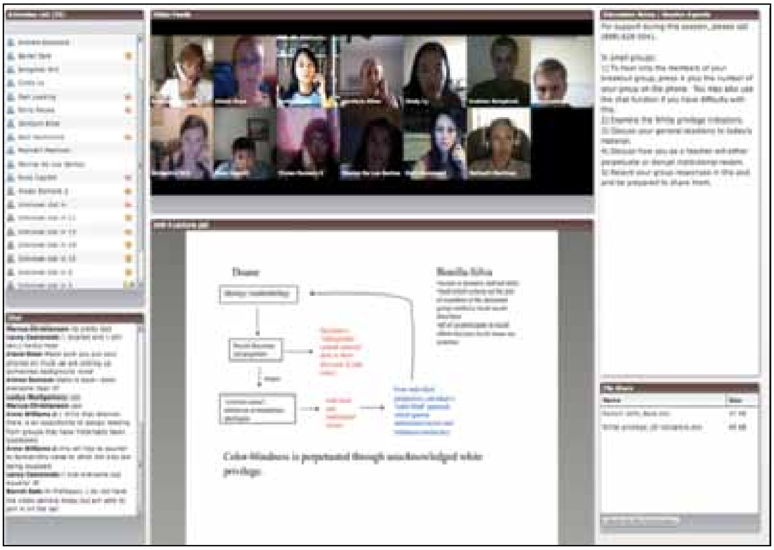

Fig. 1: Screenshot of a synchronous virtual classroom

In this environment, instructors and students exploit the distinct features of the virtual classroom much as in a brick-and-mortar classroom. They discuss readings and case studies, answer questions, respond to polls, share a desktop to demonstrate a procedure or use of other software, and engage in other traditional learning activities such as sharing experiences, and co-constructing knowledge, all within a group of 12-15 participants.

We began teaching in this environment with some technical training, and quickly figured out that our (naive) assumption that "it would be just like teaching face to face" was incorrect in at least these five significant ways:

What We Learned

1. Time Feels Different Online; It Can Move Too Slowly and Too Quickly

The first thing we all noticed was that time takes on a different life in the online world; it can seem both too short (i.e., there is so much to discuss!) and too long (the wait time after a question can seem interminable). We began with very little structure in our class sessions; sessions were brief (1 hour), and generally consisted of a few discussion questions worked in the whole group setting. We found that this short class time was not sufficient for students to interact with the content, and they simply did not have the requisite prior knowledge to be able to engage with the material with so little structure.

Our reaction to this initial attempt, however, resulted in class sessions that felt far too long. We lengthened class time, and used "pushed out" information through PowerPoint lectures. This approach, too, was lacking, in that while students had more structure, the class sessions were not engaging. Long stretches of lecture, no matter how interesting, just did not work, and it was difficult to tell, using traditional strategies, if students were engaged with the content. A student staring intently at her monitor, after all, may just as easily be staring at Facebook as at a class session.

We found a happy medium by combining short, focused "lecturettes" with structured discussions, and small group work. As Palloff and Pratt (2000) note, the online instructor must be trained "not only to use technology, but also to shift the way in which they organize and deliver material" (p. 3). Most content that might ordinarily be presented in a lecture has been filmed, intercut with video examples, edited down to about 20-minute segments at their longest, and front loaded into the asynchronous portion of the course—see tip 3 for how we now use asynchronous time. Additionally, instructors introduced short multimedia tools, like images, videos, and interactive polls. Our synchronous virtual classrooms became student centered instead of teacher centered, leaving little room for students to "check out."

2. We Underestimated the "Cognitive Overload" of Learning to Teach Online and Its Impact on Instructor Self-confidence

Earlier research has flagged the use of the technology as a stumbling block for instructors (Berge, 1998; Palloff & Pratt, 2000; Valentine, 2002); much of the technology being shopped around to teachers is not as easy to use as it looks. Surveys and interviews with our instructors before and after a semester of teaching confirmed this well-documented anxiety about becoming adroit with the tools. As in a traditional classroom, any tool an instructor wants to use needs to be prepped ahead of time, including the technology that brings the tool into the room. If the instructor begins a virtual class session without having adequately prepared all of her tools and the classroom itself, or if the instructor has not spent an appropriate amount of time familiarizing herself with the technology, then a significant amount of class time can become "dead air," which can decrease engagement and result in missed content. Instructors who are not comfortable with the technology will also choose to use fewer of the available resources that can enhance their students' learning (Akdemir, 2008).

The instructor of the virtual classroom also becomes reliant on the technological preparation of her students. Particularly in the early days of a course, students may have trouble navigating the technology. The addition of "invisible" tech support in the virtual room can help triage problems but over the long term is a costly addition. Finally, while the likelihood of a traditional class having to abandon its classroom due to some catastrophe is rare, that likelihood is far greater in the virtual classroom. Servers go down, and upgrades knock out key room functions. There are "workarounds" for almost any type of technological issue that may arise; being prepared for these issues can prevent lost or poorly utilized class time.

To help us master these "workarounds," we practiced with our technology experts who came into our virtual rooms and "sabotaged" them, making tools disappear or break down so that we had to learn to fix them, but with their coaching at first—a bit like using training wheels when learning to ride a bicycle. That kind of simulation training dramatically increased our confidence in our ability to handle most snafus. To build our pedagogical skills, we watched each other teach, and practiced with each other, trying different approaches to see what captured interest. The result has been not only acceleration in our pedagogical skills but also the emergence of a collaborative, open-door culture around our own instruction.

3. Engaging Students Requires Far More Structure Than We Expected

Student engagement has been defined as the observable actions, positive emotions, and the critical thinking that a learner demonstrates during a learning event (Fredricks, Blumenfeld, Friedel, & Paris, 2005). As well, Kuh (2009) suggests that engagement occurs both *in-class* and *out-of-class*, with *in-class* described as the academic activities in which a student participates, usually facilitated by an instructor.

Online instructors are often asked *what is the difference between engaging students in a brick-and-mortar classroom and a virtual video conferencing classroom?* Fundamentally, there is no difference. Instructors still utilize direct instruction, whole class and small group discussions, student-led presentations, and the use of multimedia such as presentation tools, video, and audio. However, because all participants in the synchronous virtual classroom are portrayed from the shoulders up, reading body language, watching students take notes, or being able to converse with a student one on one as a teacher would in a brick-and-mortar setting were not easily transferable to the virtual classroom. Therefore, *how* instructors engage students and the *type of engagement strategies* they use must be more tightly structured than in the typical classroom.

We developed several strategies that allow us to get students involved in the discussion, help them think critically, and create an environment that builds positive feelings about the experience. Two of them include the use of online polling and the chat box.

The polling feature allows an instructor to write true/false, multiple-choice, or Likert-scale questions. Stowell and Nelson (2007) found that with traditional response approaches such as hand-raising or the use of response paddles, participants are reluctant to participate because they do not want people to know if they got an answer wrong. With the use of online polling, anonymity is maintained and an instructor can see whether or not students are participating based on the number of students in the class and the number of responses collected. In this regard, an instructor can observe students engaging when they select a response.

We have used polling as an icebreaker to a class discussion, as an informal/formative assessment tool, and to gauge students' stances on certain issues related to education, among other uses. Our typical practice involves getting students to discuss their responses, which inevitably gets other students involved by either articulating their responses or responding to those of a classmate. Moreover, when questions are connected to the readings for the week, we are able to assess, informally, students' cognitive engagement with the material, that is, how critically they are developing conceptual understanding.

In conjunction with polling is the use of the chat box during class discussion. Most video conferencing software enables participants to interact via text or what is often called instant messaging. Since the norm is to have one person speaking at a time, traditional class settings require that an instructor remember the order in which students raised their hands, which is often overwhelming. Moreover, students may or may not feel inclined to write a note or question on paper and then later ask it or share the comment, thus an opportunity to observe student engagement is lost. However, with the use of chat, we have been able to not only promote the use of the chat as a thought or question holder, but also actually as a place to refer to during discussion.

In a dynamic discussion, it can be challenging for a student to listen, write, and think at the same time. Furthermore, students dread the all too familiar "shoot! I forgot what I was going to say" when too much time has passed before they are called upon to speak. By making a verbal reference to the chat box during our facilitation of a class a standard practice, students not only value it as a tool of discourse, but also have utilized it in ways we never anticipated. Students have posted links to websites, YouTube, articles, and other Internet resources that can be shared with the class. They have also posed their own questions that in turn foster cognitive engagement among their peers and reflect their emotional connection to the topic. Lastly, the chat serves as a transcript of the learning event—a histogram of sorts—that students can use as a study tool, extending their engagement with the content beyond class discussion.

4. The "Out of Class" Experience Is a Critical Partner to the Synchronous Class

Once we realized the learning benefit to rethinking the production and placement of what used to be lecture-based material (see #1, above), we completely rethought the use of out-of-class work. The asynchronous world became a jewel of a resource to us. We "flipped," that is we front loaded much of the fact-based learning into this environment through the use of tools like Voicethread, Screenr, Popplet, and customized video/lectures. Instead of using precious "live" class time lecturing, we scripted short lecturettes of essential points, embellished them with animation, and intercut them with videoed examples. We asked students to provide commentary on the reading and on each other's work through Voicethread, and demonstrate a particular skill through Screenr or short videos they filmed with their smart phones. All of this material was experienced before each live session.

As a result, the synchronous class experience changed. After viewing any required asynchronous materials, students spend the majority of their synchronous class time in collaborative "break out" groups, facilitated by the instructor, who jumps from room to room. These groups bring their findings back to the larger group, leading to whole group discussions of the content. We find we are able to move deeper into material more quickly, and move further with content and skill building than we do in the brick-and-mortar classes, as a result of this partnership between the synchronous and asynchronous environments. Not surprisingly, this "discovery" is affirmed by the USDOE report's (2010) finding that blended instruction (here they meant asynchronous and traditional face-to-face) produces greater learning gains than either modality alone. The impact has been so significant on our faculty that a number of our brick-and-mortar classes are moving to supplement or "flip" their use of live class time with the introduction of asynchronous resources.

5. We Got to Know Our Students, and They Us, Far Better Than We Imagined

One of our deepest fears was that the experience of teaching online would be impersonal. After all, many of us got in to teaching because of the opportunity to build relationships that might make a difference. A great surprise, then, was how quickly and easily we got to know our students. Because the platform included a social networking function, with individual profiles and walls à la Facebook, we were able to read about our students' interests, favorite books, and so forth before class began, and connect with them. The more we shared about our own interests, the more we reached out to our students, the more they responded in kind, eager to get to know us, each other, and the university. When commencement arrived, it was delightful to watch students, who had become fast friends, gleefully meet each other face to face for the first time. This lesson was perhaps the most heartwarming of all—not only could the technology help us facilitate learning in a mechanical way, but it could also help us build the relationships that are so critical to effective instruction.

Conclusion

If there is one lesson to be learned from our venture into the online, hybrid world, it is this: the most important element is not the tools, which is what online conditions are, but rather the quality of the instruction. When we struggled to engage our students in the first 10 minutes, the fault was not with the tool (the virtual classroom) but with the instructors who needed to figure out how to activate the same principles of good teaching within that new condition, and then learn the strengths of that new condition so that it could be exploited. The elements of good teaching, understanding one's content and one's learners, using data to know where your learners are and adapting your instruction accordingly, apply regardless of the condition or tool being used. Online tools, like any tool, cannot alone produce learning gains; they have to be employed thoughtfully, purposefully, and skillfully to achieve their maximum potential.

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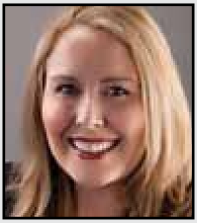

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License to Drive, License to Learn. Promoting Policy for Safe and Innovative Social Networking Use Schools

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ABSTRACT

This article advocates for the use of social networking tools as a way for teachers and students to enrich learning possibilities. While some school systems resist the use of social networking tools for learning purposes, others are moving forward with this idea. There is clearly a need for policy that will guide the decision-making and pedagogical orientations of school administrators and teachers. The authors suggest that policy surrounding the use of social networking tools such as Facebook, Twitter, and Instagram take into account two equally important objectives: innovation and safety. They propose that educational institutions create policies that empower learners to strengthen their communication skills, expand global perspectives, and create unlimited networking capacity.

Introduction

The *New York* Times published in 2011 an article featuring Erin Olson, an English teacher in Sioux Rapids, Iowa, who uses Twitter to create a backchannel for students as they discuss poetry. The backchannel provides a constant stream of analysis via short tweets of a poem called, "To the Lady," which flows through Twitter while students simultaneously discuss the poem in class. Ms. Olsen says the use of Twitter creates an encouraging environment for students who are normally reluctant to speak up in class to engage in discussion (Gabriel, 2011).

Don Featherstone, an English teacher at E. C. Drury High School in Milton, Ontario, Canada, has his students create a Facebook profile based on a character in a book. Mr. Featherstone directs the students to "fill in the Facebook page as if you *are* the character. Include pictures, likes, dislikes, etc., maybe links or lists that apply. Explore the platform, but make everything suitable for that character!" This approach allows students to analyze literary characters in a way that is both authentic and suited to students' technology-savvy existence (Featherstone, 2009).

Teachers who use social networking tools do so because they offer their students a medium through which to meaningfully interact with each other as well as with users beyond their classroom walls. In essence, these teachers expand the concept of classroom collaboration to include (potentially) anyone with Internet connectivity. For example, teachers and students can follow someone running for a local or national political office via their Twitter feed or Facebook profile and track public opinion shifts; ask students to interact with a National Geographic photographer whose work is posted in Instagram; or share local events, interests, and political events via a Tumblr blog, and discuss differences in cultural norms and values with children in classrooms across the world who read their blog.

Many students use social networking tools as a part of their everyday lives. This level of familiarity makes Facebook, Twitter, and other social networking tools convenient for teachers to adopt in the classroom. Because students understand this power, and even the potential drawbacks, *they* can potentially do much of the innovating in terms of facilitating academic exchanges. By contrast, students who are not allowed classroom access to these powerful tools may feel (and be) shortchanged by limitations to engagement with the world outside the classroom.

Social networking tools offer the potential to support knowledge creation through collaborative interactions by anyone, from anywhere, as long as they have access. These tools are open-ended and offer great power to educators; we cannot predict their future uses because we are still in the process of technological innovation (Hall & Hord, 2001). But we do claim that schoolchildren's access to a world of information (both reliable and not reliable), and to other people, is far greater today than it was a few short years ago.

As remarkable as these tools are, the outside world sees a dark side to increased access. Facebook has received media coverage documenting potential dangers (Carter, Foulger, & Ewbank, 2008). When teachers use Facebook with their students, they are encouraged to err on the side of caution. For example, the Lake County School District in Florida created "Guidelines for Employee Use of Social Media Networks" recommending that employees' blogs, Facebook profiles, and websites be "G-rated" at all times (Huffington Post, 2012).

Some policy makers, school administrators, and parents express concerns about teacher-student interaction online. Fountain Hills, Arizona superintendent Bill Myhr believes that teachers who "friend" students online cross ethical boundaries (Woodberry, 2011). Evidenced by many stories that appear about teachers and social media use, media outlets are quick to expose those teachers who have been reprimanded for the ways in which they negatively use social networking tools.

Developing Responsible and Socially Engaged Citizens

Teachers and students need to do what they do best—teach and learn. The authors of this article represent the perspectives of a State Legislator, university professor and researcher for teacher education, school board member, and school district professional developer. We believe that there is great potential in exploring the use of social networking tools for educational purposes. The goal of our advocacy is to facilitate the development of a culture of learning by expanding the reach of children and teachers beyond the four walls of the traditional classroom (Ewbank, Foulger, & Carter, 2010). We believe that school leaders can figure out how to use social networking tools to empower learners to strengthen their communication skills, expand global perspectives, and create unlimited networking capacity. We support our position through John Dewey's thoughts about technology and its role in society.

Dewey wrote extensively about technology in his seminal 1915 work, *School and Society*. In the 19th century, when mechanical technology was necessary to accomplish daily tasks, it was important for individuals to have the knowledge and skills necessary to be safe and effective technology users, including an understanding of how technology functions, a notion that Waddington (2010) calls "technological transparency." An example of technological transparency is found in Dewey's Laboratory School:

> [The student] followed the wool from the sheep to the rug, patiently contriving his own spindle, his own dye, his own loom.... He saw that while successive inventions of machines have led to the eventual betterment of social life, the immediate results have often been at the bitter cost of the discarded hand-worker whose plight illustrates an ever-present social problem caused by technological advance. (Mayhew & Edwards, 1936, p. 314)

Technological transparency provided citizens with agency and power because they understood the mechanisms important to society. Dewey's vision was that individuals would advocate for themselves as the industrial age progressed.

Dewey (1915) made a distinction between open and closed technology. Closed technological tools are those that users do not understand how the tools function, nor do they have influence on their design and evolution. By contrast, open tools are those that are more transparent to end users, because they understand the inner workings of the tool and its overall function. Dewey suggested society should privilege open tools because "citizens would be able to make technologies work for them, rather than simply being shaped by prevailing technologies" (Shaikh et al., 2012, p. 94). We posit that those using open tools are more likely to create innovation, because they have some control over the furtherance and development of the tool, and the results are useful for themselves as well as for others. It follows logically that open technology has the power to shape society rapidly, because the original creator does not maintain control over any modifications of the tools.

This line of thinking about the power of open technologies can be applied to Web 2.0 tools, as a form of modern-day tool associated with our knowledge-driven society (Shaikh et al., 2012). Although the interface of Web 2.0 tools cannot be modified by the user, they do allow users to create content, control their interactions, and socially engage with one another to make larger contributions. For example, Facebook users are afforded the possibility of agency, variety, and invention because decisions about content are theirs, and inspiration from one another matters in this medium.

Amy Hestir Protection Act in Missouri

State legislators in Missouri recently tried to stymie the idea of students using open technology in the classroom by passing the Amy Hestir Student Protection Act, a law that went into effect in the state of Missouri on August 28, 2011 (Gottlieb, 2011a). Named after a now 40-year-old-woman who was sexually abused by her art teacher when she was in junior high, the law was repealed less than one month after it was instated. The appealed law originally set out to require each school district to develop a written teacher-student communication policy, including a plan for in-person and online interactions. The law specified that any work-related social media website established by a teacher was to be completely viewable to the public, including school administrators, parents, and guardians. Furthermore, teachers were not allowed to engage in private, online social media communication (such as private messaging, or the "friends only" function in Facebook) with current or former students who were under 18 years of age. In summary, the law prohibited several types of teacher-student communication via social media.

The intent of the law was to protect minors against inappropriate adult interactions. However, the Missouri Teachers Association and American Civil Liberties Union identified several unintended consequences. According to the law, any communication about private matters between teachers and students would be made public, a violation of the U.S. Family Educational Rights and Privacy Act (FERPA) law of 1974. An additional problem with the law was that web-based tools constantly change without notice. This puts educators in a situation whereby they never know if new features or tools are "safe" or not.

In less than one month a series of lawsuits questioned the law's constitutionality. Missouri Governor Jay Nixon called for a special legislative session and the Amy Hestir Student Protection Act was repealed September 23, 2011 with the justification, "In a digital world, we must recognize that social media can be an important tool for teaching and learning" (Gottlieb, 2011b). This reminds us how difficult it is to create timeless legislation surrounding technology. Useful policy will need to embrace the positive impact that technology tools can have in education while still promoting safety, innovation, and accountability.

Laws and Policies Already Adequate, Yet Districts Take Traditional Approach

Many laws and policies are already in place that support these goals. For example, the 2000 U.S. Children's Internet Protection Act (CIPA) established that all public educational systems in the United States that are recipients of E-rate funding, special grants, and other federal aid in support of technology integration, use filtering software to protect students from potentially inappropriate content. A U.S. federal policy implemented in August 2011 requires that public schools and libraries that are E-rate recipients assure their Internet policies are updated to include provisions for teaching students safe use of social networking tools as well as awareness of cyber-bullying. Additionally, about half of the states in the U.S. have adopted laws that mandate filtering systems in publicly funded schools and libraries in order to prevent student access to questionable material (National Council of State Legislatures, 2012). Canada, however, has used existing law to regulate obscene content on the Internet, such as the Canadian Criminal Code (OpenNet Initiative, 2012).

Similarly, most school districts have acceptable use policies that both employees and students/parents sign before Internet use can be granted through school networks. When parents approve their child's Internet use at school, they affirm that they understand the benefits as well as the risks of students using the Internet. These policies promise parents that teachers will conduct training, provide direction, and supervise students who use Internet-based tools while in their care. Those school districts that have kept up to date on technological advancements have added provisions for social networking tools to their acceptable use policies. If a student does not have parental permission to use the Internet, teachers must meet educational objectives in other ways.

Additionally, social networking tools provide protection through their policies. For example, Facebook policy mandates that users must be thirteen years of age, and users between the age of 13 and 18 do not appear in public searches. All users must agree that Facebook "reserves the right to add special protections for minors (such as to provide them with an age-appropriate experience) and places restrictions on the ability of adults to share and connect with minors." Along those same lines Facebook provides a "Report Abuse" link and requests that offensive posts be reported (Facebook, 2011).

Social Media: A License to Drive, A License to Learn

Learning to drive a car is comparable in certain aspects to learning to use social networking tools. The vehicle (or social media) is a powerful tool that improves numerous capabilities. Over time, children gain more freedom as they become more effective with driving. This developmental perspective might be a useful approach to policy development surrounding social networking use in education.

Young Children—Teacher Navigation

When they are very young, children are passengers in cars that are driven by adults. Similarly, at this age, we suggest policy that promotes the use of social networks "driven" by teachers, with students' educational needs in mind.

For example, Union County Public Schools (North Carolina, USA) teacher Liz Benavides created a virtual pen pal program with Saudi Arabia via Skype. Elementary-age children communicated through Liz, with Prince Khalid Bin Alwaleed Bin Tala (Franco, 2011). Social media facilitated a rapid, convenient, timely, and comprehensive exchange of information.

Tweens and Young Teens—Teacher Supervision

When children reach their teenage years, they can earn a learner's permit and are granted permission to drive, but under the direct supervision of an adult who accompanies them in the vehicle. The adult in charge is accountable, to a great extent, to provide direct "sideline coaching" during that teen's use of any vehicle. Similarly, as teens show responsibility in the use of the Internet, it is appropriate that policy mandates teacher supervision in class as well as in online environments, to assure students make good decisions through a "sideline coaching" model about the use of social networking tools.

For example, Ann Flynn, Director of Technology for the National School Board Association, reports that a school in Cleveland, Ohio, USA, has turned the traditional book report into a social media experience. Students post their book report online, and *parents, teachers*, and other students read and comment on the report (Sorrentino, 2012). In this case, the teacher was responsible for guiding students—just as adults are required to be in the car of teenagers to assure safe circumstances, and not joyriding or racing.

Full Privileges for Qualified Students

Then, when teens have proven they know the rules of the road and can successfully and safely navigate the driving system, including handling unexpected behaviors from other drivers, they are granted complete freedom to drive on their own. With this level of independence, parents need to be able to trust these teens to make responsible decisions. This cannot happen without prior experience. Similarly, in the education domain, as students are granted more freedom to use social networking tools for learning, policy should hold students accountable for their behavior, including keeping on topic, conducting themselves professionally, and treating others with respect. Appropriate and firm consequences will be necessary for this level of freedom.

For example, Buffy Hamilton, high school librarian in Canton, Georgia, USA, discovered recently that the blogging platform Tumblr.com was blocked by the Internet filter at her school. She requested access, outlining a number of educational uses, including "crowdsourcing" favorite book quotes and book covers. Hamilton stated,

> Tumblr has been super hot with our teens for blogging in the last six months or so, and I would like to utilize Tumblr for digital composition and reflective thinking since it so easily allows users to post content in many formats/multimedia. I especially like how Tumblr lends itself to formal as well as informal networked learning and dovetails beautifully with a participatory stance on learning and librarianship (2011).

Future Directions: Promoting Safety, Innovation, and Accountability

While the specific example of the Missouri law ultimately failed as policy, provinces and states may consider adopting a refined version of this law, one that would protect students from the problems associated with social networking without inadvertently prohibiting students and teachers from using *any* social networking tool, even tools specific to education such as Edmodo, TeacherTube, Google Sites, and the Google Suite (Docs, Presentations, and Forms).

The best educational policy is one that allows students opportunities to learn in ways that are aligned with the 21st century workplace. Figuring out solutions to these issues will require a collective intelligence of all educational stakeholders and the concerted efforts of many outside the school systems.

The following are guidelines for policy development aligned with this perspective:

1) Provide safe environments for the use of social networking tools by students, for educational purposes.

2) Embrace teachers' creativity by granting them the necessary freedom to think *innovatively*, (within the boundaries of educational needs) as they explore the possibilities of social networking tools.

3) Hold teachers accountable to train, guide, supervise, and discipline students during the educational use of social networking tools while at school.

This year's kindergarten class will graduate from high school in 2025. With this long-range goal in mind, educators should ask themselves, "What will 2025 look like?" Technology is advancing so rapidly that a prediction of this sort is difficult. Yet, it is our duty to prepare them. As educational technology advocates, we challenge educators and policy makers to work toward achieving this goal.

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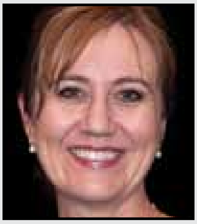

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Transforming Teaching and Learning Through Critical Media Literacy Pedagogy

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ABSTRACT

This article provides a framework and examples for critical media literacy pedagogy. More than simply guiding how students read and interpret the texts they encounter, critical media literacy pedagogy pushes to illuminate the underlying power structures that are a part of every media text. Throughout this article, examples from working with high school youth and preservice teachers are provided. In recognizing recent shifts in media production as a result of participatory culture, this article focuses on how youth-created media products are an integral part of a 21st century critical media literacy pedagogy.

Introduction

Working with partners, students in a senior advanced placement (AP) English class work to apply the concepts they have been studying in Jackson and Jamieson's (2007) book, *unSpun: Finding facts in a world of disinformation*, a book that aims to educate readers about how to sift through the reams of information that bombard them on a daily basis and identify spin, half-truths, and outright lies. Their teacher has assigned each pair a different chapter of the book. The pairs seek out examples that will synthesize the ideas in their assigned chapters with examples from around the world and compose a presentation using prezi.com that will share their findings with the class. They take advantage of multiple media, including newspaper clippings that detail medical fraud, advertisements that hype alcohol, and videos that focus on the effects of war. All of these things, the students contend, speak to the misinformation saturating the world.

In designing this assignment, the teacher sought to expose her students to rhetorical elements, such as euphemism or hyperbole, used to manipulate belief systems and to encourage her students to begin to critically analyze text. By pushing her students to look beyond printed pages, one might even say she is engaging them in media literacy. Indeed, the National Association for Media Literacy Education defines media literacy as the ability to "access, analyze, evaluate, and communicate information in a variety of forms, including print and non-print messages," (Media literacy defined, 2013) and the students in this classroom demonstrated these skills by accessing images from the media to illustrate the ideas represented in the chapter, analyzing the messages of each example through the critical lens of their assigned chapter, evaluating the merit of the message for each example, and communicating their findings through the media tool Prezi. The value of this assignment cannot be disputed. Students walked away with a deeper understanding of how language and other symbols can be used to manipulate people's understanding of the world. We contend, however, that teachers cannot stop with assignments such as these. Rather, students need to be empowered to produce media messages that move beyond sharing their understanding of a unit of study to creating multimedia texts designed to challenge the thinking of the world around them. By approaching instruction with this goal in mind, teachers can begin to engage in critical media literacy pedagogy.

The Origins of Critical Media Literacy

Critical media literacy has evolved from many disciplines, yet the principal arena of theoretical work comes from the multidisciplinary field of cultural studies. Over a century ago in Europe, theorists began seriously critiquing media and society. From the 1930s through the 1960s, researchers at the Frankfurt Institute for Social Research used critical social theory to analyze the ways popular culture and the new tools of communication technology encourage ideology and social control (Adorno & Horkheimer, 1944). In the 1960s, researchers at the Centre for Contemporary Cultural Studies at the University of Birmingham added to the earlier interests in ideology with a more sophisticated understanding of the audience as active makers of meaning, not simply mirrors of an external reality (Durham & Kellner, 2005). Using the lenses of semiotics, multiculturalism, feminism, and postmodernism, critical media literacy theorists developed a dialectical understanding of textual analysis, political economy, and audience theory that allows popular culture and media to be analyzed as dynamic forces that often reproduce dominant ideologies. This approach also opens up possibilities for counter-hegemonic alternatives (Kellner, 1995). In the 1980s, cultural studies research began to enter the educational arena. With the publication of Len Masterman's *Teaching the Media* (2001), many educators around the world embraced media education less as a specific body of knowledge or set of skills and more as a framework of *conceptual understandings* (Buckingham, 2003).

Various people and organizations across the globe have generated different lists of media literacy concepts that vary in numbers and wording, but for the most part they tend to coincide with at least five basic elements: 1) recognition of the construction of media as a social process; 2) hermeneutical analysis that explores the languages, genres, codes, and conventions of any text; 3) exploration of the audience's role in negotiating meanings; 4) problematizing the process of representation to unveil and engage issues of power, ideology, and pleasure; 5) examination of the institutions and political economy that structure media industries as profit-seeking businesses (Kellner & Share, 2007; Masterman, 2001; Thoman & Jolls, 2005).

Critical media literacy as we are defining it here is a progressive educational response that expands the notion of literacy to include different forms of mass communication, popular culture, and new technologies and also deepens literacy education to critically analyze relationships between media and audiences, information, and power. Along with this analysis, alternative media production is an essential component of critical media literacy as it empowers students to create their own messages that can challenge media texts and narratives. While some popular approaches to media literacy distance themselves from critical literacy and critical pedagogy (Scheibe & Rogow, 2012; Hobbs, 2011; Buckingham, 2003), we believe that critical media literacy depends on guiding students to explore difficult-to-see ideologies and connections between power and information. This approach embraces a democratic pedagogy, in which teachers and students study multiple narratives and ideological power structures as they push back on the popular myth that education can and should be apolitical. Like the title of Howard Zinn's book (2002) and documentary (2004), "*you can't be neutral on a moving train*," social justice educators like Zinn recognize the fact that education is by its very nature a political act (Giroux, 2001). In light of the current movement for standardization, high-stakes testing, and scripted curriculum, it is now more important than ever for all educators to recognize the conservative nature of education and commercial media, and challenge their role in replicating dominant ideologies and oppressive social structures.

Using critical media literacy, social justice educators can bring questions of racism, homophobia, classism, sexism, and so forth into the classroom through examining media and popular culture that students are seeing, hearing, and using every day. In addition, critical media literacy pedagogy is based on Freirian notions of praxis that link theory with action, especially as students create their own media representations for audiences beyond the classroom walls. Marc Prensky (2010) asserts:

> Even elementary school students can change the world through online writing, supporting and publicizing online causes, making informational and public service videos and machinima, and creating original campaigns of their own design. Anything students create that 'goes viral' on the Web reaches millions of people, and students should be continually striving to make this happen, with output that both does good and supports their learning. (p. 66)

To accomplish this, teachers need to move beyond the traditional notion of critical media literacy as a primarily consumptive process toward a more productive pedagogy.

Pushing Beyond Traditional Media Literacy

In recent years, we have seen a shift from using technology as tools to convey individual ideas and expressions to the leveraging of individual strengths through technology to create community involvement (Jenkins, Clinton, Purushotma, Robison, & Weigel, 2006). Jenkins and his colleagues (2006) describe this community involvement as participatory culture, explaining, "Participatory culture is emerging as the culture absorbs and responds to the explosion of new media technologies that make it possible for average consumers to archive, annotate, appropriate, and recirculate media content in powerful new ways" (p. 8). Yet, possibility and reality are often two different things. While large populations of students enter classrooms with years of experience using digital tools, their digital fluency does not mean they know how to capture the potential power of participatory culture (Campbell, 2005). These students "need to learn to manipulate their multimedia languages well, with conceptual and critical acumen" (p. 36).

The ideas presented by Jenkins and his colleagues (2006) agree with Campbell. They note research that suggests that participatory culture can increase peer learning, shift attitudes about intellectual property, diversify cultural expression, develop workplace skills, and empower conceptions of citizenship. They argue that accessing participatory culture becomes a part of the hidden curriculum and that students who are not fluent in this type of culture will be less successful in life after high school. "We are moving away from a world in which some produce and many consume media, toward one in which everyone has a more active stake in the culture that is produced" (Jenkins et al., 2006, p. 10).

Campbell finds the idea of leveraging information technologies a provocative potential in education, particularly in terms of production. Citing Jerome Bruner's *The Culture of Education* (1996), Campbell (2006) wonders if Bruner is suggesting that "one function of education is to give learners the symbolic systems they need to have recourse to more powerful symbolic systems" (p. 29). With carefully structured pedagogical guidance, Campbell believes educators can create a "metalinguistic" awareness that crosses boundaries previously constructed by genres, media, and intellectual disciplines. "For the first time, learners may 'write' not just with words or the illustrations common to one discipline but with an entire range of symbolic representations" (p. 29).

Our vision of the classroom coincides with that of Campbell. By embracing a critical media literacy pedagogy that emphasizes production rather than consumption, educators can equip students with the mindset needed to help shape their culture. Approaches such as the one we described in the opening of this article are important, but we cannot stop there. As De Zengotita (2002) points out, the issue is not whether or not we can differentiate between reality and the messages we receive on a daily basis, but whether or not we actually do it. His response to this question? "Of course not" (p. 35). This lack of differentiation between fiction and reality causes great concern. Cultural anthropologist Michael Wesch focuses much of his work on examining the potential, as well as pitfalls of technology, in the classroom. In an address to Higher Education Internet Technology Executives, Wesch (2007) sets forth two possible scenarios. In the first, he describes a world where society sees schools as increasingly irrelevant in their focus on information, equipping only the elite few with the means and creativity to control and produce content. He asserts that rather than watching the program, society itself becomes the program.

By taking control of the production of media texts, a productive stance within critical media literacy allows educators to distribute the means and creativity for controlling and producing content beyond a traditional information elite. Particularly, in an increasingly complex digital ecology, the ability to write not simply via print-based text but via multimodal and programmable mediums are an integral part of challenging power structures that manifest through media distribution. In his 2010 book, *Program or be Programmed: Ten Commands for a Digital Age*, Rushkoff writes:

> Digital technology is programmed. This makes it biased toward those with the capacity to write the code. In a digital age, we must learn how to make the software, or risk becoming the software. It is not too difficult or too late to learn the code behind the things we use–or at least to understand that there is code behind their interfaces. Otherwise, we are at the mercy of those who do the programming, the people paying them, or even the technology itself. (p. 128)

By approaching critical media literacy through a productive, rather than simply a consumptive, lens, educators can help shape society toward the second scenario outlined by Wesch (2007), where schools "encourage kids to use media and technology and not let it use them." In this world, every member of society views reading and writing as socially connected. In this world, there is a culture of vigilance toward digital security and privacy. In this world, "you, like billions of others, are not a program. You, like billions of others, are the programmer." In Wesch's vision, the role of youth as producers is innately tied to how they contribute to and shape the democratic society they are a part of. The critical production of this model hinges on the production choices students make in offering social change.

Implementing Critical Media Literacy in the Classroom

We frame a pedagogy of critical media literacy within the critical literacy traditions established by theorists such as Freire and Macedo (1987), Giroux (2001), and Gramsci (1971). As such, the notion of literacy is not framed solely within formative and career-related skills of production and interpretation. Instead, we encourage educators and teacher educators to build

> a more profound understanding of how the wider conditions of the state and society produce, negotiate, transform, and bear down on the conditions of teaching so as to either enable or disable teachers from acting in a critical and transformative way. (Giroux, 1987, pp. 14–15)

This reflective process of looking at the ecology of schooling helps frame the kinds of activities and lessons we have developed through teaching a teacher education course on critical media literacy.

UCLA's TEP Class on Critical Media Literacy

In the Teacher Education Program at UCLA, we have been offering master's level classes in critical media literacy for several years, and in 2010 we incorporated the three-unit course, Ed466 Critical Media Literacy, into the course requirements for all new teacher candidates. This graduate level course prepares educators for teaching K12 students to explore their relationships with media, technology, and popular culture by critically questioning different types of representations and creating their own alternative media messages. All students analyze as well as create media projects related to their teaching.

Through various assignments such as creating wanted posters that require images combined with words, alternative book reports using multimedia, social media for addressing problematic representations, photographs, podcasts, word clouds, and digital stories, the students authentically demonstrate their competence with digital media as well as their understandings of the politics of representation. The assignments are structured to integrate technology-related tools into the educational experience through a critical pedagogical framework that encourages candidates to assess the authenticity, reliability, relevance, and bias of the messages as well as the different medium. The assignments are also productive as they require students to not only analyze and become better readers, but also to produce with these new tools and become 21st century writers.

We combine various literacy skills with the intention of expanding our students' understanding of literacy beyond the limitations of print-based concepts. We encourage students to recognize that literacy today means reading and writing photographs, music, movies, advertising, popular culture and also printed books and magazines. This expansive view of literacy is combined with a deeper understanding of literacy that explores the always-present connections of information and power. In addition, an expansive view of literacy is often the most motivating as students learn how to incorporate photography, music, social media, computers, and other technologies into their teaching. This is the easiest aspect of literacy instruction to implement and often the most fun for students. However, the more critical empowering aspects of the class are the engagement of ideology and power in the literacy process while creating alternative media. This deeper analysis and use of literacy emphasizes the essential role that literacy can play in social justice education.

One assignment, the Wanted Poster, is an opportunity for new teachers to learn basic computer skills for combining images with words and visual design. The assignment also provides the space for student teachers to create posters to use as examples for their own students to see digital alternatives for demonstrating learning and reframing the discourse about whose story is seen and heard in the classroom. In one student project, a Social Studies student teacher created a wanted poster of Gabriela Silang, an indigenous woman in the Philippines who led her people in armed resistance against colonial domination. The text reads: "Wanted: Gabriela Silang; Description: First Filipinia to lead insurgent groups against the Spanish during the Philippine Revolution; Warning: She is armed and dangerous. Watch your back. She will swing at you with her bolo." When teachers and students create the opportunity to produce their own representations, they enact the power to determine whose stories are told and how.

Once teachers and students begin to recognize the power behind representation of others, we ask them to turn to themselves. In another activity, students use Voicethread.com to create their *Through Other's Eyes* assignment that involves posting an image representing a visual portrayal of an aspect of their identity that they have seen maligned in the media. They post the image and comment about how this representation negatively presents an aspect of their identity. Voicethread provides the ability for all the students to see and hear each other's reflection as well as add their comments to their peer's posting. In addition to providing experience with more sophisticated technology than the simple manipulation of images and text in the Wanted Poster, this assignment requires them to move beyond representation of others and push back at the media messages that saturate the world around us. In doing so, students have critiqued the portrayal of body image, immigration, domestic violence, alcoholism, and religion, as well as the intersections of racism, sexism, and classism. These powerful critiques help students explore the influence of visual images and the deep connection that media can have to identity, especially when the representation is negative.

In *Literacy: Reading the Word and the World* (1987), Freire and Macedo write, "Reading the world always precedes reading the word, and reading the word implies continually reading the world" (p. 35). Many of the activities in our preservice teachers' classes situated youth engagement, dialogue, and pedagogical reflection within the lived experiences that each student brought to the classroom. As educators, a focal point for the lessons we developed was deliberative reflection on how ideologies stemmed from the cultural readings of the world we've developed. For instance, Shor (1987) describes how reading the context of sitting within schools leads his students to understand the uncomfortable chair of the classroom as "a symbol of oppression" (p. 160). Within our own classes at UCLA, crafting these discussions and concepts of unpacking cultural hegemony within a critical media classroom meant building upon familiar media products and practices. One activity from the Ed466 class begins with students peeling the shrink-wrap packaging off of a liquid yogurt smoothie to expose the sterile white plastic bottle. After discussions about advertising and consumerism, students work collaboratively to transform the white bottle back into a sellable advertisement for different target audiences. The activity provides an opportunity for students to rethink product packaging and create target advertising that exposes the codes and conventions of advertising as it uses the languages of popular culture and marketing. Looking at the advertising in this activity helps illustrate that critical media literacy does not depend solely on the technology explosion of the last decade; it has always been important.

As the semester progresses, we continue to steep students in more sophisticated tools of media composition. To accomplish this, another activity takes students incrementally through the steps of creating a sound track with dialogue, narration, and sound effects to ultimately produce their own podcast that retells a classic nursery rhyme in one of many radio show genres such as a call-in talk show, sporting event, traffic report, weather forecast, or breaking news report. Later students combine these audio skills with the photography and visual literacy experiences when creating their multimedia alternative media projects. These final projects have been varied using different media and critiquing different topics such as a movie analyzing children's media, a documentary redoing the classic black & white doll experiment with kindergarten students, spoof magazine ads of iMac eWaste, and Prezis, Pinterest boards, and original songs critiquing sexist representations of women in the media.

It is important to note, however, that while we continued to introduce more sophisticated media composition tools, we also did not want our students to lose sight of the real purpose of the course, creating sophisticated authors of critical media literacy texts. Thus, we continued to mix traditional media with more contemporary genres. In a group project turned in near the end of the quarter a group of students remixed a recent issue of *People* magazine. The cover, preserved, was augmented only with a small sticker announcing: "Do not open without your social justice shades!" Throughout the magazine, nearly every page is remixed to critique the messages of the popular culture publication. For instance, the infographic in the original magazine, "Names he calls your boobs" is amended with the subhead, "So that you are dehumanized, objectified, and sexualized." The lo-fi approach to media production illustrates that writing, criticizing, and fomenting critical consciousness via a pedagogy of critical media literacy is not contingent upon the flashy digital tools available in the 21st century classroom. Instead, still building on the ethos of participatory culture, these students challenge culture hegemonic dominance through cutting and pasting text to build new critical narratives. By matching their own font to an article called "Sex Quiz: Find Your Pleasure Spot's Personality" that features a woman posed in revealing underwear, the students create an entirely new media product. Stating that, "this magazine is trying to turn your sexuality into something that only encompasses sexual and visceral pleasure, rather than understanding the deeper meaning of who you are," the newly transformed text elevates the popular culture magazine into an instructive tool that layers dominant and counternarrative on top of each other. The dialogue between problematic images of representation and sexualization next to the nuanced critique create a playful guide for critical media literacy pedagogy. Likewise a similarly constructed page functions as a how-to guide for informing viewers "How to Critically Analyze This Ad About Sex Toys."

Implications of Critical Media Literacy in the Classroom

It is important for us to be transparent that throughout the class some of the activities students completed and turned in did not articulate critical perspectives. Some students, for instance, created wanted posters that just described a math formula, some created nursery rhyme podcasts that were just funny, and some incorporated commercial media and marketing genres that they see frequently performed in advertisements and television shows. In redesigning the marketing and title for a bottle of liquid yogurt, for instance, some students invoked the same stereotypes to attract their target audience that they had previously criticized. While these activities may be seen as shortcomings by some when teaching about critical media literacy, we see these as necessary building points within a classroom community. Educators can work within these transitional activities that build criticality to gauge the comfort level, proficiency, and amount of support students need in honing critical media literacy. Each activity that we developed in our class of preservice teachers (as within a K12 class) builds upon the content and ideas developed previously. While some students exhibited frustration, resistance, or hostility to components of this process, meeting students where they are and offering avenues for them to explore their own media assumptions is necessary. We recognize that this resistance we've encountered in classrooms is an important and under-researched aspect of critical media literacy pedagogy. Giroux (1987) writes,

> It is important to stress that a critical pedagogy of literacy and voice must be attentive to the contradictory nature of student experience and voice

> and therefore establish the grounds whereby such experience can be interrogated and analyzed with respect to both their strengths and weaknesses. (p. 20)

As we continued to explore messaging, ideology, and hegemony over a semester, the work students completed built toward understandings of the politics of representation that underlie every media product students encounter. These new teachers were also building an awareness of hegemonic ideology that informs their pedagogical framework of inquiry and production, which will hopefully influence their future teaching.

For us, this notion of a pedagogy that builds on theory and real-world experiences of our students is a crucial component for thinking about how to incorporate critical media literacy into any content area or grade. A 21st century critical media literacy pedagogy is one that integrates discussions of media representation, power, and ideology into a class instead of teaching this content as something separate. Critical media literacy is not educational technology nor is it a collection of interesting lesson plans. Rather, critical media literacy is a pedagogy that should serve as a framework to guide teachers and students to understand the language and ideas of a discipline. Critical media literacy informs individuals and groups about how they encounter concepts in a history book, interpret a science experiment, or perceive an advertisement at a bus stop. The iterative process of looking at media and developing a personal, critical lens guides youth interpretations and ideologies over time.

We also see this pedagogy of critical media literacy as one that stands in contrast to how others are writing about media literacy more broadly. While participatory media is encouraging educators to more fully acknowledge and incorporate skills related to the manipulation of and exploration with digital tools, texts and articles focused on these skills do not acknowledge the necessity for critical investigation of how media is entrenched within existing politics of representation. We see claims of politically neutral pedagogies of media literacy as dangerous for today's connected youth. Such practices of adopting media literacy practices as non-critical tools reinforce Freire's (1970) banking model of education. Within this context, a media literacy pedagogy that is not critical—that does not confront and challenge the cultural hegemony that underlies the media products and tools created—is one that "attempts to control thinking and action, leads men and women to adjust to the world, and inhibits their creative power" (p. 77).

Approaching critical media literacy from a productive stance allows youth to harness their creative powers to help shape society. Yet, we cannot expect them to begin forming a new world from scratch. Rather, it is important that students study the media forces that are currently influencing their culture. Wesch (2013) describes the power of re-creating a media product versus simply looking at it. In his explanation, he points his audience to the World Economic Forum site at weforum.org. The purpose of this forum, according to the site's authors, is to serve as "an independent international organization committed to improving the state of the world by engaging business, political, academic and other leaders of society to shape global, regional and industry agendas." The addition of a dash to the url will take viewers to the site we-forum.org, which at first glance seems almost identical. This site, however, was not created by the World Economic Forum. Rather, using the original site as a mentor text, the second site's authors, the Yes Men (Bichlbaum, 2010), studied each aspect of the site in an effort to create a plausible site that presented a slightly different perspective. By studying one influential site, students begin to see how to shape their own messages. The depiction here of media production as a challenging and responsive counternarrative illuminates the possibilities of what Leah Lievrouw (2011) documents as "culture jamming." Lievrouw writes, "Culture jamming captures and subverts the images and ideas of mainstream media culture to make a critical point..." (p. 73). Culture jamming as seen in Adbusters' spoofs (https://www.adbusters.org/), The Yes Men hoaxes (http://theyesmen.org/), and Banksy's graffiti art (http://www.banksy.co.uk/), often use humor, irony, satire, and parody to make their point more appealing to the public at large. While some culture jamming has involved illegal activities, we do not promote breaking any laws. We bring these ideas into the classroom for educators to consider the pedagogical potential that this type of media production can provide. When humor overlaps social commentary, students can take advantage of the power of parody and satire to challenge hegemonic stereotypes about race, class, gender, or any identity marker. The way humor can be used as a powerful tool for exposing ideology is something we analyze when looking at episodes of *The Daily Show* and *The Colbert Report*. Integrating culture jamming into the curriculum provides the potential to access higher order thinking skills, challenge dominant myths, make lessons more engaging, and allow students to create media products of social significance that can be shared beyond the classroom. This critical use of humor is also part of youth culture as seen in popular media such as *The Simpsons* TV show, Tobuscus Literal Trailers, and online memes. Not only can humor be pedagogical and critical, but through bringing academic uses of humor into K12 classrooms, affective filters lower, engagement increases, and learning becomes fun.

Conclusion: The Possibilities and Challenges Ahead

As the possibilities afforded for learning engagement expand with recent advances in digital technology, so to do the challenges that lay ahead for critical media literacy educators. Returning to the teacher in the opening anecdote, shifts in technology mean it is no longer enough to simply analyze and explore the media products that youth frequently consume in school settings. The possibilities for media creation function as a mandate for what Morrell (2008) calls "critical textual production" (p. 115).

Critical media literacy, as we continue to state, is not constituted by ancillary activities within classrooms. It is to work toward a seamless praxis; the pedagogy of critical media literacy recognizes the multifaceted aspects of life and power in the 21st century. As Giroux notes (1987), "school life is not conceptualized as a unitary, monolithic, and ironclad system of rules and regulations, but as a cultural terrain characterized by the production of experiences and subjectivities amidst varying degrees of accommodation, contestation, and resistance" (p. 17). The advanced placement teacher in the introduction, like all critical media literacy educators, needs to continue to provoke and challenge critical consumption *and* production long after her students have finished collecting and analyzing media products related to *unSpun*.

Ultimately, the pedagogy of critical media literacy for which we are advocating is crucial for identifying liberatory pathways toward democratic citizenship in the digital age. Students must be able to respond to, infer varied meanings of, and develop their own media in dialogue with dominant media messages; these are dispositions of civic participation with digital tools. The possibilities of a critical media literacy pedagogy in the age of participatory media are unbounded. In spite of the current political attacks on education and teachers, critical media literacy offers the tools and framework to help students become subjects in the process of deconstructing injustices, expressing their own voices, and struggling together to create a better society.

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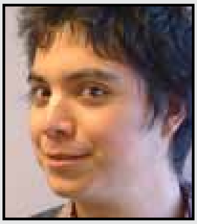

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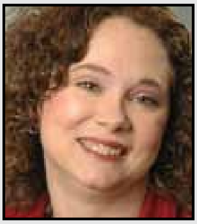

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The Benefits of Using Educational Videos in American Sign Language in Early Childhood Settings

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ABSTRACT
With the growing acceptance of American Sign Language (ASL) as a true language comes increasing possibility for incorporating it into the classroom, especially for visual learners. While children in general may benefit from ASL, early exposure to ASL is particularly important for Deaf and Hard of Hearing children (D/HH). In this article, we summarize research on the impact of an educational media series in ASL on early language and literacy development, provide research-based strategies for utilizing visual language and visual strategies during literacy activities, and offer recommendations for teachers about incorporating research-tested educational media in the classroom.

Introduction

It is well known that early exposure to both language and literacy is key for children's future success. There is also a growing awareness that children are able to acquire critical skills from various modalities, including pictures, graphics, and print (e.g., New London Group, 1996). Finally, there are many ways in which visual and verbal information can be presented, including during person-to-person interactions as well as through electronic media, such as computers, television, tablets, and cellphones, and more.

Often, when researchers and educators think about literacy and language development, they consider how children learn through sound and spoken language.

However, while some children may rely on sound in order to learn and interact with the world around them, others may rely more on visual ways of communicating. For instance, some researchers are coming to believe that Deaf and Hard of Hearing (D/HH) learners, in particular, benefit not only from visual strategies (e.g., showing print or pictures to supplement discussion), but also from a visual language, such as American Sign Language (ASL) (e.g., Bahan, 2009; Mayberry, 2007). The purpose of this article is to discuss how young D/HH children can develop early language and literacy skills through a visual language and visual language strategies embedded within a research-based educational video series, one that makes connections between American Sign Language (ASL) and printed English. Research results from five studies will be discussed, which will demonstrate how viewing the series can positively impact D/HH children's early language and literacy development. Discussion of the effects will include which language and literacy skills children learn, how and why they learn them, and provide suggestions for how educators can employ these and other strategies to encourage learning for young children, whether through multimedia resources or during read alouds.

Visual Language

Visual languages, such as American Sign Language (ASL), are genuine languages, each with its own grammar and syntax, distinct and separate from English. There are hundreds of sign languages currently used throughout the world. ASL is used throughout the United States and parts of Canada, and as with many other international sign languages, is now widely recognized as a language. For instance, over 160 colleges and universities in the United States now allow students to take ASL to meet the foreign language requirements. Furthermore, elementary and high school programs in almost every state also recognize ASL as a foreign language.

Early Exposure to Visual Language

All children need rich language environments and frequent experiences with language as they acquire language themselves. This seems especially to be the case for children who are at risk for language or literacy struggles, such as deaf children. For instance, deaf children who have early exposure to ASL have reading skills that are on par with their hearing peers (Chamberlain & Mayberry, 2008; Mayberry, 2007; Hoffmeister, 2000). Children can begin to learn sign language as early as six months old and thus can make important gains from early communication interactions with adults. But few deaf children are born to parents who are fluent in sign language, and therefore these children are not exposed to a fully accessible visual language from birth. In fact, 90% of deaf children are born to hearing parents, and, typically, parents of these children are learning sign language simultaneously with their child (e.g., Lane, Hoffmeister, & Bahan, 1996). As a result, these children often do not have access to fluent models of ASL from birth and may arrive to preschool already far behind their hearing peers with regard to language and literacy skills. This lack of early exposure to ASL may explain why the average deaf child graduates high school at a 4th grade reading level (e.g., Mayberry, 2010; Traxler, 2000). Therefore, a significant concern is how to expose these children to fluent language models from birth.

Fig. 1: Lucy the librarian models ASL and English print simultaneously during a read aloud in, "Our Trip to the Library"

Research on Language, Literacy, and Media

Traditional methods for introducing D/HH children to language and literacy vary drastically. On the one side are researchers, educators, and parents who believe that D/HH children should be introduced to language through an aural/oral approach and often with the help of new medical technologies (i.e., cochlear implants). Proponents of this side of the debate argue that deaf children will succeed in a hearing world only by utilizing oral language, and they focus on therapeutic training to develop listening and spoken language skills during the early childhood years (e.g., Svirsky, Robbins, Kirk, Pisoni, & Miyamoto, 2000). They also argue that deaf children learn literacy through sound-based strategies and that only by acquiring oral language will deaf children be able to develop literacy skills (e.g., Desjardin, Ambrose, & Eisenberg, 2009).

However, there is contradictory evidence regarding how deaf children learn to read; recent research indicates that deaf children may not need sound-based strategies to become literate. Therefore, on the other side of the debate are an increasing number of researchers and educators of D/HH support educating D/HH children visually (e.g., Miller & Clark, 2011; Mayberry, del Guidice, & Lieberman, 2011; McQuarrie & Parilla, 2009). Proponents of this perspective see deaf children as members of a minority population with their own language (ASL in the United States) and cultural group (Deaf, with an uppercase d), one that has its own cultural traditions, history, language, and schools. They also believe that deaf children are visual learners by nature (e.g., Bahan, 2009). Therefore, they argue that exposing deaf children from birth to a fully accessible visual language, such as ASL, will promote not only acquisition of a first language (ASL) but also children's acquisition of a second language (here, printed English) (e.g., Mayberry, 2007; 2010; Chamberlain & Mayberry, 2008). Rather than arguing against deaf children learning how to speak, they believe that, for those who might benefit from speech therapy, it should occur outside the regular classroom. This allows the teacher class time to focus on teaching core content and skills. In addition, for children who utilize speech therapy, having a fluent language base (ASL) typically enhances spoken language skills rather than hinders them (e.g., Mayberry, 2010). Proponents of this perspective make a case for educating deaf children through Bilingual-Bicultural methods, which places equal importance on two languages (ASL and printed English) and two cultures (Deaf and Hearing) and promotes strategies that help children make connections between the two languages. The educational video series described in this article is framed by this second perspective.

Sources of Language

Certainly, all children learn language primarily through live interactions—from the adults and other children with whom they interact daily. Traditionally, deaf children with hearing parents have learned ASL through Deaf adults at residential schools for the Deaf (e.g., Lane et al., 1996). However, with more D/HH children being placed in self-contained classrooms or mainstreamed in public schools (as opposed to schools for the Deaf), where the teachers may not be fluent in ASL, there is a greater need for additional sources of fluent language models.

Educational media.

Hearing children have long benefitted from engaging with educational media during the early childhood years, such as watching educational television programs that aim to promote language and literacy skills. Programs like *Sesame Street, Super Why*, and *Between the Lions* have been shown to significantly impact a range of early literacy skills, such as letter recognition, word recognition, phonological awareness, and vocabulary (see Moses, 2008 for review). The intent of these programs is not to replace learning that occurs at home or in school; rather, educational media is typically designed to supplement it. Hearing children have learned early literacy skills from viewing programs on their own as well as when supplemental programming and resources have been integrated into early childhood classrooms (e.g., Penuel et al., 2012).

There has been increasing evidence that deaf children also benefit from educational media. For example, when episodes of *Between the Lions* were supplemented with sign language, deaf children between the ages of 6 and 10 years were able to increase their knowledge of vocabulary (Loeterman, Paul, & Donahue, 2002). In addition, studies with preschool children indicate that videos in sign language used as supplemental tools during shared reading helped build their vocabulary knowledge (Mueller & Hurtig, 2010).

Recently, multiple studies examining an original educational series, *Peter's Picture* (**click here for video**), have shown that when educational programs are presented to preschool D/HH children in ASL[1] they have similar positive effects. In the first study, Golos (2006) examined the extent to which D/HH preschool children visually attended to a 43-minute educational video in ASL. Results revealed that children in fact did attend to the video and did so an average of 84% of the time. Because there was no sound in the video, children's attention was measured by percent of time that their eyes were focused on screen. There have been five subsequent studies, all of which have examined the effects of this series on improving D/HH preschoolers' language and literacy skills with and without teacher mediation (Golos, 2010a; 2010b; Golos & Moses, 2011; 2012; 2013). With each study, we have learned new information about the ways in which D/HH preschoolers interact with educational media and what they learn from their active engagement with it through the behaviors that they displayed during the times in which they watched the videos (see Table 1 for summary of the five studies).

Specifically, children who watched the videos displayed literacy-related behaviors while viewing and showed an increase in targeted ASL and early literacy skills. These literacy-related behaviors included: interacting with print on screen, sequencing main events along with the characters, predicting what would happen next or the meaning of a new word, making comments or asking questions related to characters or story events. For example, many of the young viewers signed and/or fingerspelled targeted vocabulary words along with the main character when he signed them. In addition, results indicate that deaf preschoolers learned the following language and literacy skills that were targeted in the videos: target vocabulary words (presented in both ASL and printed English), sequencing skills, and knowledge of story elements within the videos.

Although D/HH preschoolers showed these behaviors and learned targeted skills without teacher mediation while viewing the videos, they can learn even more when teachers encourage their interactions (Golos & Moses, 2011). During one study, teachers received training on ways to encourage children's interactions while watching the videos. After viewing one video two times during one week, children learned more targeted vocabulary words and engaged in more literacy-related behaviors than without teachers mediating their viewing.

The extent to which participants across the studies have attended to the videos and engaged in literacy-related behaviors while viewing may be due to both the visual effects (e.g., flashing lights, sparkles, words "magically" disappearing into the hands of characters on screen) and the research-based strategies aimed at attracting and maintaining viewers' attention that were incorporated into the video (see the section, Strategies That Promote Comprehension). What has been particularly interesting is that the D/HH preschoolers, from across the studies, who viewed the videos demonstrated the literacy-related viewing behaviors and an increase in targeted literacy outcomes regardless of their degree of hearing loss, use of amplification (i.e., hearing aids, cochlear implants), or past exposure to ASL (some of whom had little to no previous exposure).

What Is *Peter's Picture*?

Peter's Picture is an educational video series that was developed to provide a curricular resource for preschool deaf children as a supplemental tool to learn language and literacy. In each video of the live-action *Peter's Picture* series, Peter, a "real" (not animated) adult and the main character, takes Rika Roo (his hearing, life-sized raccoon sidekick) and four deaf children on an adventure. Prior to leaving for the adventure, Peter shows the children and Rika Roo what they will see at the special location. During each adventure, Peter takes pictures, and when they return to Peter's

Place, they sequence the pictures, make a book with the pictures and sentences they create together, play a word game, and finally, read their story "aloud" in ASL.

The structure of each video is based on a theme and a targeted letter of the day. Table 2 includes a list of the episodes, the focal letters, and target vocabulary words for each episode, as well as the cultural knowledge highlighted. Table 3 includes the literacy skills and concepts that every episode targets—that is, regardless of the adventure or theme, each episode aims to promote concepts of print, sequencing skills, and so forth.

Recommendations for Viewing Educational Media in the Classroom

As summarized, evidence from research on educational media reveals that D/HH children can learn targeted skills from viewing an educational video series that is presented in ASL and utilizes visual strategies. Viewing behaviors and learning outcomes increased even more when teachers interacted with children during viewings. In addition, although anecdotal, teachers from across the studies indicated that they begin to incorporate such strategies into their daily lessons after viewing the *Peter's Picture* series. This likely helped bridge what children learned through the media materials and what they learned through live interactions.

Another question remains, though: How can teachers use the *Peter's Picture* video series to facilitate children's learning of language and literacy? Each video includes effective strategies highlighted in the research literature: Some strategies were informed by studies of educational television that have successfully promoted hearing children's learning, including those used in *Sesame Street* and *Blue's Clues*, among others. Other strategies were informed by studies of Deaf adults' read-aloud practices with deaf children. These strategies are used repeatedly within each video and in different contexts with positive results.

Should educators use the *Peter's Picture* series, or other educational media, in the classroom, the following research-based strategies help to foster children's ASL and early literacy learning when viewing in the classroom.

View episodes multiple times.

Research shows that D/HH children can benefit from viewing the videos multiple times, and this aligns with what has been found when hearing children watch programming repeatedly (e.g., Crawley, Anderson, Wilder, Williams, & Santomero, 1999). Results from studies with D/HH children showed that children who viewed the videos two to three times attended to the video an average of 84% of the time, showed an increase in literacy-related behaviors across viewings (Golos, 2006; 2010a; 2010b), and learned targeted vocabulary, story elements, and sequencing skills (Golos, 2010b; Golos & Moses, 2012; see Review of the Literature on Educational Media).

Focus on different skills and concepts during different viewings.

During the first viewing of the teacher mediation study, teachers were asked to have the children watch the video all the way through, without necessarily encouraging interaction, and answer any questions children might have. During subsequent viewings, they explicitly encouraged children to actively engage with the content both during viewings and whenever they paused or stopped the video to pose questions and talk about target content. Educators can replicate successful interactions during video viewings by following these steps:

- Have children watch the video without teacher interaction
- Watch the video again and encourage active engagement
- In subsequent viewings, pause, question, and discuss

Encourage children to interact with print on screen.

As was successful in the mediation study, when a targeted vocabulary word appeared on screen (in print), teachers were asked to pause the video, point to the print, and ask children what the sign for the word was. Teachers were also encouraged to sign or fingerspell the target word and ask the child to point to the correct word on screen. Educators can follow these same procedures when viewing these videos in the classroom.

Encourage children to sign along with the main character.

During each adventure, the main character repeatedly asks the viewing audience to "sign together" or "copy" what he is signing. Children were more likely to sign along when the teacher also encouraged them to do so (Golos & Moses, 2011), and teachers can also encourage this behavior by saying, "Come on, let's all sign it together!"

Provide follow-up activities.

In another study (Golos & Moses, 2013), when teachers were given follow-up lesson activities and materials and instructed to review segments of the videos and conduct follow-up activities, preliminary evidence showed that children's mean scores increased from pre to post test on the ASL and literacy skills targeted in the videos. After viewing the video one time, participating teachers reviewed specific segments and did a follow-up activity. For example, participants and their teacher viewed the word game segment in the video. During the word game, each (onscreen) child gets one of the targeted words above his/her head. Then, a sentence appears on screen, and Peter asks the viewing audience which of the words (above the character's head) matches a word within a sentence on display nearby.

After viewing this segment, teachers were asked to have children play the same game in the classroom with laminated words and sentences. In another follow-up activity, teachers read "aloud" (in ASL) the same book that the characters create about their adventure at the end of the episode. Having a read "aloud" of the book in the classroom allowed teachers to revisit and repeat focal skills and concepts.

Following up in a classroom could entail these activities: vocabulary matching games (find the targeted word in the sentence); reading aloud the book featured in the videos and/or books related to the theme of the focal adventure; sequencing pictures of main events in the story; signing or fingerspelling target words and having children point to the print or picture.

Additional Effective Strategies to Facilitate Learning

Based on the literature examining Deaf adults' read alouds with deaf children, the following effective strategies were incorporated into *Peter's Picture* and can be used both during read alouds and during viewing of educational videos such as *Peter's Picture*.

Strategies that encourage attention and engagement.

Based on the literature investigating children's attention to and active engagement with educational television programming, the following strategies were incorporated into *Peter's Picture*:

- Ask questions directly to the children and pause after asking each question to give them time to answer. For instance, Peter looks directly at the camera—and thus the viewing audience—to pose questions, pause and wait for a response, then provides the answer (e.g., Crawley et al., 1999).

- Provide a literacy-rich environment. Like a quality classroom, "Peter's Place" is also filled with books, environmental print, and much exposure to language.

Strategies That Promote Comprehension

Make connections between ASL and English print.

During each video, each time a character's name is introduced or targeted vocabulary is signed, the printed word is shown simultaneously (e.g., Mather, 1989; Erting, 2001). In addition, each time a new vocabulary word appears on screen, Peter signs the word, explains what it means and then signs it again, using a "sandwiching" or "chaining" strategy (e.g., Padden & Ramsey, 1998) to connect the sign to the English print. Educators can use these same strategies in the classroom during a read aloud or vocabulary lessons by displaying the English print on a white board or chalkboard while they are signing a new word. After explaining the meaning of the target word, they can point to the word in print, sign the target word, then fingerspell the word, point to the print again and then finally, sign the word again (Padden, 1996; Padden & Ramsey, 1998; Erting, Thumann-Prezioso, & Benedict, 2000; Blumenthal-Kelly, 1995). Whether conducting a read aloud or introducing new vocabulary, teachers should always have both the ASL and English print visible (i.e., all of the children can see the pages) when they are signing.

Provide concrete visual information.

This can include describing in ASL what a word means, showing a picture of the targeted concept, showing the printed version of the target word, as well as what the object is in a real-life context (e.g., field trip). For example, when Peter introduces the word, "pepperoni," the word appears on screen with the picture and print. Peter explains what pepperoni is, and then (using the chaining technique described earlier) he points to the print, signs the word, fingerspells it, and signs the word. Later, viewers see what pepperoni is in a real-life situation when the character Paulie makes a pepperoni pizza.

Fig. 2: Peter provides concrete visual information in, "Our Trip to Paulie's Pizza"

Make connections between the story and children's lives.

For instance, after describing different types of tables where people eat, Peter asks the viewing audience, "What does your kitchen table look like at home?" Educators can make these same connections during a read aloud by asking a question or commenting on the text or picture in the book and connecting it to the children's lives.

Discuss information related to problem solving.

For example, in "Our Trip to Country Bob's Backyard," Rika Roo accidentally lets one of the chickens escape. So Peter asks the viewing audience to help him read signs in the environment to find the chicken's home. After he reads the sign, "Goat Pen" and explains what it means, he asks the audience, "Is that right? Is that the chicken's home?" After pausing to allow viewers to respond, Peter confirms it is not the chicken's home, and the characters proceed with finding the correct home for the chicken and returning it to its home.

Fig. 3: Problem solving ("Do the Chickens live there? Is that right?")

As previously mentioned, teachers can employ each of these strategies with D/HH children both as teachers and their students engage with educational media as well as during read alouds.

Benefits for hearing children?

Results from multiple studies indicate that D/HH children can benefit from exposure to and instruction in a visual language (ASL) as well as visual strategies used during educational media and during read alouds and this may extend to hearing children as well. Although deaf children are by nature visual learners, many hearing children may also benefit when teachers use visual strategies and visual language in the classroom. In fact, some preschools for hearing children already include some type of sign language in classrooms. Incorporating ASL into the hearing classroom may be particularly helpful for children who struggle with language and literacy skills by providing another route to learning certain early literacy skills. A future avenue for research is to study whether and how hearing children learn language and literacy skills from instructional and media materials in ASL. Another question is whether there is a difference between their learning from educational videos in ASL with sound and videos in ASL without sound. It is possible that doing so may help not just in learning the skills targeted in the instruction or materials, but they may also benefit from learning a second language.

If educators want to include ASL into the classroom, the most important thing to remember is to model the language accurately. The best way to model fluent ASL is to invite a Deaf adult who is fluent in ASL into the classroom and/or show educational videos that model fluent ASL. In this way, teachers can learn ASL simultaneously with their students and provide follow-up activities to offer additional learning opportunities. Teachers do not have to know ASL to use the educational videos series. However, to encourage teachers who may be hesitant to use videos that do not have sound, we are in the process of adding voice over and sound effects to the *Peter's Picture* videos (with one video already having sound). With or without sound, there is the potential that hearing children may benefit from teachers incorporating the research-based, effective strategies described in the Recommendations for Viewing Educational Videos section or Additional Effective Strategies to Facilitate Learning section. These can occur either during read alouds or when embedding interactive, educational video viewings into the classroom.

Fig. 4: Expanding on the text during a read aloud

Lessons Learned

An important issue that these studies are examining relates to language and literacy acquisition, and the best ways to promote those skills and knowledge. For deaf children, particularly those who rely little (or not at all) on sound, one effective "route" to language and literacy skills is through visual language (ASL) and visual strategies. When work began on this line of studies, we utilized *Peter's Picture* videos that were filmed in ASL only and not with sound, and deaf preschoolers' attention to the videos and appropriate school behaviors during viewing seemed unaffected by not having sound; they were able to view the videos in the classroom (separated by a divider from non-participants) and seemed to be minimally distracted by other activities and materials in the classroom that might be around them.

However, subsequent work with hearing preschoolers presented a new challenge when participants viewed the video without sound (as opposed to viewing the version with sound, as some hearing participants did). More than with deaf participants, hearing children seemed prone to distractions by sounds in the classroom, such as those related to other children engaging in activities or with materials unrelated to the *Peter's Picture* video. Early on in data collection, this seemed to affect some, though not all, of the hearing participants. As a result, one lesson learned is that when viewing videos without sound, hearing participants will need a viewing environment with fewer distractions. One effective solution in our studies was to ensure that viewing sessions occurred in a quiet room outside of the main classroom.

When considering how this will work in the everyday goings-on of a classroom, the teacher may find a space for viewings outside of her/his classroom, or the teacher can designate a particular area of the classroom as the "viewing area" where other materials (e.g., blocks, manipulatives, art materials, etc.) are not readily accessible. A teacher can also determine a time during which all children have the opportunity to watch the video (and thus, no other activities will be happening at the same time) or small groups can watch (with no sound) while other children engage in lower energy (and quieter) work.

Once all of the videos have sound, teachers may still decide to view the videos without sound some of the time as a way to immerse children in a new language. Whereas other times they may decide to view segments or complete videos with sound to review new concepts.

Conclusion

More and more frequently, teachers and parents are using multimedia resources in educational settings and in the home. Given that the average deaf child graduates high school at a 4th grade reading level, there is a critical need for these children to be introduced to high quality language and literacy experiences throughout the early childhood years. The key is providing early access to a fluent visual language (e.g., American Sign Language for deaf children throughout most of North America) and utilizing visual strategies to facilitate the language and literacy development of visual learners. Read-aloud activities are critical to include daily in the classroom, and using ASL along with visual strategies during these activities may increase children's comprehension as well as help children to make connections between ASL and printed English. The *Peter's Picture* video series is an example of an effective, *supplemental* tool that teachers (and parents) can also use both in school and in the home to help D/HH children acquire these skills and build a strong foundation for literacy learning later on.

Table 1

Summary of Five* Peter's Picture *Studies

AUTHOR (YEAR)	SAMPLE SIZE	VIEWING CONDITION	MEASURES	RESULTS
Golos (2010a)	N = 25 D/HH 3- to 6-year-olds, across 4 programs (3 self-contained, 1 residential)	Participants viewed a 43-minute video in the *Peter's Picture* series three times over one week without adult mediation	Transcriptions: each viewing session was recorded, transcribed and coded for the number of instances of signing of a targeted word, fingerspelling of a targeted word, and conversation related to the video Parent questionnaire: measure of demographic information and information regarding hearing status, services and communication used at home; administered prior to viewing sessions	Descriptive statistics showed the following for 25 participants' viewing behaviors from Viewing Day 1 to Viewing Day 3: • Signing of a targeted word: 287% increase from Day 1 to Day 3 • Fingerspelling of a targeted word: 130% increase from Day 1 to Day 3 • Conversation related to video: 170% increase from Day 1 to Day 3 • Participants in the self-contained class-rooms had larger increase from Days 1 to 3, on average, signing more target words than participants in residential classroom

AUTHOR (YEAR)	SAMPLE SIZE	VIEWING CONDITION	MEASURES	RESULTS
Golos (2010b)	Same sample as Golos, 2010a	Same viewing conditions as Golos, 2010a	Peter's Picture Assessment Tool (PPAT): measure of targeted/non-targeted vocabulary through items that asked participants to choose one of four pictures and then one of four printed words to match target sign or fingerspelled word at pretest and posttest Parent questionnaire: same as described in Golos 2010a	Descriptive statistics showed an average increase of 20% across items, from pretest to posttest, on the PPAT Qualitative analysis and descriptive statistics were conducted for four focal participants. Descriptive statistics showed: • Maria (4 years, 11 months; self-contained classroom): 37% increase from pretest to posttest • Greg (5 years, 10 months; self-contained classroom): 14% increase from pretest to posttest • Elisa (6 years, 8 months; residential school): 26% increase from pretest to posttest • Gary (3 years, 3 months; residential school): 24% increase from pretest to posttest

AUTHOR (YEAR)	SAMPLE SIZE	VIEWING CONDITION	MEASURES	RESULTS
Golos and Moses (2011)	N = 3 teachers, 9 D/HH preschoolers (3 to 5 years), across 2 self-contained programs	After receiving training, teachers mediated (encouraged engagement modeled ASL to print connections, etc.) participants' view of one video in the *Peter's Picture* series three times in one week	PPAT: same as described in 2010b Transcriptions: each viewing session was recorded, transcribed, and coded for the number of instances of pointing to the screen, signing of a targeted word, fingerspelling of a targeted word, and additional literacy-related behaviors for teachers and children Parent questionnaire: same as described in 2010a	Descriptive and paired t-tests (note small sample size) showed: • Mean number of instances of signing target words, fingerspelling target words, and additional literacy-related behaviors increased from Day 1 to Day 2, Day 2 to Day 3 and Day 1 to Day 3, except for signing target vocabulary from Days 2 to 3 • Students' responses to teachers (during mediation of viewing) increased from Days 1 to 2 by 33.5%, then decreased from Days 2 to 3 by 6% • Significant increase found for signing target vocabulary between Days 1 and 2 • Significant increase found for additional literacy behaviors displayed during viewing from Days 1 to 2 and Days 1 to 3 • Higher mean scores at posttest than pretest, but not significantly different on RDVA Comparing teacher mediation results to the Golos (2010b) sample's results (without teacher mediation), independent t-test showed: • Participants whose teachers mediated their viewing of the video signed and fingerspelled target words significantly more during viewing on Days 1 and 2 than participants without teacher mediation • Participants whose teachers mediated viewing displayed more literacy-related behaviors during viewing on Day 3 than participants without teacher mediation

AUTHOR (YEAR)	SAMPLE SIZE	VIEWING CONDITION	MEASURES	RESULTS
Golos and Moses (in press)	N = 33, 3- to 6-year-old D/HH children	Participants viewed one (of three) videos from the *Peter's Picture* series viewed two times over one week without adult mediation	ASL Receptive Skills Test: measured ASL receptive skills, administered at pretest Expanded PPAT: Modified into DVD format and expanded to measure target vocabulary and knowledge of targeted story elements (main events, characters, sequencing), administered pretest and posttest Parent questionnaire: same as previous studies	Descriptive statistics and repeated measures ANOVAs showed: • Participants' pretest PPAT total score significantly differed from posttest PPAT total score, with mean posttests scores being higher than mean pretest scores • Participants' pretest scores on each subtest significantly differed from posttest subtest scores, with mean posttests scores for each subtest being higher than mean pretest scores • No significant interaction found between baseline ASL scores and PPAT scores

AUTHOR (YEAR)	SAMPLE SIZE	VIEWING CONDITION	MEASURES	RESULTS
Golos and Moses (in preparation)	N = 7 D/HH preschool children and N = 2 teachers (school for the deaf)	Participants viewed one video one time, then with teachers (after having received training), they reviewed five specific segments and did a follow-up activity for each segment over a two-week period of time	Expanded PPAT: same as described in Golos and Moses (in press)	Preliminary results showed: • mean scores for the targeted skills increased from pre- to posttest • trending toward significance, but no significant differences were found between the pretest and posttest PPAT total and subtest scores (note small sample size)

Note: All of these studies were approved by the Human Subjects Committee, and we received signed informed consent from the parents of each participant.

Table 2:
Targeted Skills Within Each Episode

EPISODE	LETTER OF THE DAY	VOCABULARY	CULTURAL KNOWLEDGE
Our Trip to Paulie's Pizza	P	Pizza, cheese, napkin, pepperoni, table	How to get attention
Our Trip to the Library	L	Library, librarian, library card, quiet, borrow	ASL handshapes
Our Trip to Country Bob's Backyard	B	Backyard, egg, goat, chicken, rabbit	How videophones work

Table 3:
Targeted Skills Across Videos

SKILL OR KNOWLEDGE AREA	HOW SKILL OR KNOWLEDGE AREA IS ADDRESSED
Concepts of Print	Asking about and explaining that books have titles, where to start reading, and direction of print
Sequencing	Explicitly sequencing the five main events that take place during each adventure
Vocabulary (related to print)	Asking about, discussing, or explaining the meaning of *title, sentence, page, word, story, book*
Story Elements	Discussing characters (who they are), setting, and solving problems within the plot
Deaf Culture	Demonstrating and discussing turn taking and ways of getting attention; Modeling Deaf characters interacting with each other in ASL and in a Deaf culturally friendly environment. Modeling Deaf characters communicating through videophones

Note

1. At the time of investigations these videos did not have sound.

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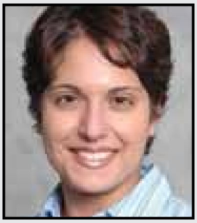

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The Tides of Teaching: Rising to New Levels of Understanding Through Negotiation and Conversation in an Online Reading Course

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ABSTRACT

This study, conducted with eight elementary/middle school teachers enrolled in an online reading course, asserts that through the development of relationships, the negotiation of a framework for study, and critical attention to generating and sustaining an environment conducive to learning, including interaction that promotes sincere conversation, that online learning can lead to substantial and meaningful professional insight. As a conceptual framework for this study I draw from images of the tides. Tides as metaphor provide me with a starting point for contemplation, an analogy from nature that, like teaching, has been an integral part of my life.

Introduction

Have you ever studied an incoming tide, that complexity of sea and land and moon pull, the relentless, alluring ebb and flow? For me, to sit and watch the sea as the tide comes in is almost spellbinding.

As I have watched the coming in and the going out of the tides over the years I have found an affinity with this daily rhythm. Having lived along the coast of Cape Breton Island, Nova Scotia, for more than 40 years, I have come to know the tides, the waters that lap the shores of our village. They have been as constant in my life as the sun that rises in the east over the small fishing community where I live and sets over St. George's Bay in the west. At first it might seem that this twice daily phenomenon, the rising and falling of the earth's water surface, is uncomplicated. But the motion of the tides entails a complex process governed by the laws of physics and mathematics. That which appears simple is often complex, as difficult to understand as how orbital forces produce oscillating currents and daily fluctuations in sea levels.

It has been my experience that understanding teaching is similar to interpreting the tides: on the surface, teaching may also appear effortless. However, investigation reveals teaching to be a complex profession, one elusive of definition (Graham, 2000). Still, we can begin to untangle the complexity through reflection and sincere, open conversation about our practice. Through such engagement, we can gain real insight about our practice and how best to face the daily challenges that come our way. Fiszer (2004) has pointed to the importance of a culture in which "teachers have opportunities to dialogue" (p. 16). Through dialogue, teachers gain "the space they need to refine their own experiences as a problem-solving exercise rather than a roadblock" (p. 16). However, the teacher interested in eliciting open and engaging conversation requires the right conditions. This study concerns the process I went through while teaching a fully online reading course for the first time and explains how I created an environment that encouraged open conversation. To verify the process, I probe one of the eight discussion threads of our course. As a conceptual framework for this study I draw upon the tides, which metaphorically provide me with a starting point for contemplation, an analogy from nature that, like teaching, has been an integral part of my life.

The Resonance of the Tides: Realizing the Conditions for Sincere Conversation in an Online Setting

Incoming tides gently pushed by the winds can create a peaceful tempo. The rhythmic motion can be soothing, and those who listen carefully may be comforted by the sounds and the rhythm. In relation to conversation, the tides sometimes seem to beckon; when interests emerge, conversation can grow into a deep and meaningful interaction. This paper explores the power of engaging conversation, how it helps teachers gain awareness about their teaching. It postulates that conditions for such conversation can be created in an online setting.

There are of course obvious disadvantages to online learning, ranging from inequities surrounding technological abilities to apathy towards group work (Coleman, 2012; Roberts & McInnerney, 2007) and the lack of physical presence and eye-to-eye contact. The disadvantages can make both teaching and learning in this environment difficult. Sometimes technical glitches occur that either take significant time to remedy, or cannot be remedied at all. I have found such things to interrupt the flow of the class, and I have had to respond with practical solutions that were necessarily imperfect. For instance, a technical problem resulted in my having to reconstruct class groups, but some of the rapport and level of comfort some of the teachers had in their original groups was thereby lost. Likewise, I have learned to make connections to people in online courses in the same or similar ways that I do face-to-face, but in a virtual environment I cannot re-create certain engaging and meaningful activities. I have realized that, as Meloncon (2007) points out, "if educators are changing teaching places, they need to redefine themselves in light of the change in landscape" (pp. 37–38). Teaching an online reading course resulted in my redefining both what I do and what I am. I gained a new confidence in my ability to adapt to a new way of teaching and an affinity with teachers acquainted with the tools of 21st century learning.

As my understanding about online teaching grew, I began to recognize its benefits, benefits that have been well established through research (Palloff & Pratt, 1999; Friesen & Anderson, 2004; Hurt & Brush, 2009). From easy accessibility, flexibility for scheduling, to experiencing a rewarding format there is significant evidence of the advantages that online learning can provide. Furthermore, as this study suggests, through the development of relationships, the negotiation of a framework for study, and critical attention to generating and sustaining an environment conducive to learning, including interaction that promotes sincere conversation, online learning can lead to substantial and meaningful professional insight.

Observing an Incoming Tide From the Shoreline: Cultivating a Positive Environment for Online Learning

To gain a basic awareness of what an incoming tide looks like, it is helpful to observe the sea from a good vantage point. From an elevated position, one can see the vastness of the waters, the tide-washed rock formations that rise along the coast, and the ever-changing play of light dancing on the headland. Such a panoramic view allows a certain perspective. Like an observer of the tides, in the beginning I stood back and carefully considered what teaching an online course might be like, and all that it might encompass. Although I had engaged in online courses throughout my doctoral studies, this would be my first time teaching an online course, and

I felt some trepidation. Online teaching meant facilitating learning while navigating some relatively foreign, uncharted waters. Yet, because of my years of working with teachers in various contexts, one thing I was certain of was that I needed to create a social learning environment where teachers would feel free to engage in open, honest conversation. Creating such conditions meant attending to details to help enable teachers to discuss their experiences in this way. In essence, sufficient knowledge and the right understanding, tone, and attitude would be crucial to shaping a liberating experience in which teachers might establish an "[i]nherent connectedness with others" (Atkinson, 1995, p. 4) and transform our loose group of course participants into a learning community.

Building a learning environment also meant starting with names and providing the opportunity to discuss areas of interest and other information. Each teacher in turn would begin a personal story, one that would continue to grow and would nurture the establishment of relationships conducive to professional learning. Naturally, I also wanted teachers to begin to make connections with the content of the course, and to realize that teaching reading in part means connecting with who we are as readers. Therefore, they were asked to begin sharing their literary histories (Tovani, 2000). In order to demonstrate my desire to work alongside these teachers, I modelled this activity by sharing my experience of an important book in my life, Barbara Joose's *Mama Do You Love Me?*, which I had left on my daughter's pillow the night before she was leaving home to attend university for the first time. The book tells a touching story about a daughter who attempts to find the limits of her mother's love; it is a book that encapsulated in many ways our own journey as mother and daughter. Sharing this experience helped to create an open environment in our online course and demonstrated that I too was a member of the group. It meant fostering an air of collaboration while facilitating the course; it meant being intentional in every way. As Lock (2006) puts it,

> The realization of online learning communities to facilitate teacher professional development is a matter of carefully and deliberately designing dynamic learning environments that foster a learning culture. This requires a pedagogical framework . . . where people engage in shared learning experiences mediated through technology. (p. 663)

While being intentional in my planning of the course, I also realized that community is born through negotiation and flexibility. In order to give credence to these words I invited our online community to reflect on the course syllabi and contribute views about how to shape it further to meet individual needs. This was most necessary, as the teachers enrolled, who were working towards their master's degrees, came from different backgrounds and professional experiences. They were divided on a variety of levels. Geographically, they came from all parts of the province of Nova Scotia; professionally, they assumed different roles, taught different grade levels, and held varying interests and beliefs about the teaching of reading. Conrad (2005) emphasizes a need to create "a general sense of connection, belonging, and comfort, that develops over time among members of a group who share purpose and commitment to a common goal" (p. 1). Creating space for each teacher to reflect on his or her own context and needs and to negotiate assignments, readings, and other course requirements created a sense of ownership and made the course more meaningful. Also, it provided more opportunity to learn from each other, or as Hargreaves (2003) points out, "[a] strong professional learning community brings together the knowledge, skills, and dispositions of teachers in a school or across schools to promote shared learning and improvement. A strong professional learning community is a social process for turning information into knowledge" (p. 170).

While sharing literary histories and co-constructing course expectations helped create a *real* space as opposed to a *virtual* one (Barab, Kling, & Gray, 2004), the course took on greater meaning when teachers set up and responded to discussion threads and engaged in weekly conversations. When teachers began to converse, a forum was created that allowed them to investigate ideas, reflect on practice, provide support, test assumptions, and engage in pedagogical conversations—truly going far beyond just reading course texts and regurgitating information. Conversation at many times was deep and sincere, leading to the community members' greater understanding of themselves and of their profession. As Trathen and Moorman (2001) point out, "[t]elecommunication tools can facilitate the occurrence of dialogue" (p. 219). While this may seem obvious, discussion threads in this course proved more than a means of facilitation—they were a very effective tool for inviting genuine conversation and helping teachers gain deeper understanding of their practice.

Methodology

This study concerns the experiences of eight elementary and middle school teachers enrolled in an online reading course in the winter of 2009 offered by St. Francis Xavier University. The topic of the course was the nature of the reading process, and it was delivered using the Elluminate and Blackboard systems. I did not set out to conduct a study about what I would learn during the course, but when it was over many experiences remained with me, making me wish to delve deeper into why it had been successful. After the course, I applied for and was granted approval to conduct research from our ethics board at St. F X. This allowed me to send by email the participant information and consent forms to each member of our class. The students were thus informed of the nature and purpose of the study and their potential involvement in it. They were assured of their right to withdraw at any stage. Most importantly, they were informed that while there was a possibility that information derived during the study might be published, they would not be identified in any way, and that all possible measures (storing data securely, etc.) would be taken to ensure confidentiality. Each participant was asked to sign a hard copy of the participant consent form and return it to me. All of these details were completed prior to beginning the research.

The course unfolded over 12 weeks, participants meeting online weekly for a three-hour session. Throughout the 12 weeks, teachers were asked to complete assigned readings and to engage in a variety of activities. Through these activities they deeply explored the complex nature of the reading process. However, as the course went on, I found that it was through participation in conversations during virtual-class time and in ensuing discussion threads that teachers really began to think deeply about their practice. These discussion threads and weekly conversations, in which each teacher shared experiences, became the main portals through which we began to explore personal beliefs and convictions about reading instruction. They eventually provided the data that I chose to investigate.

Over the 12 weeks numerous discussion threads were generated, and afterwards I considered my purpose and what I hoped to achieve by way of analysis. In returning to the threads and guiding questions that teachers referred to as they initiated or responded to threads, I determined that two overriding questions would help me to shape narratives: 1) What connections had the teachers made between the readings and their own experiences as readers or as teachers of reading? and 2) What new questions, insights, and possibilities did the readers gain through the readings in relation to their understanding of the reading process?

Transcript analysis, then, was inductive: a process of attempting to find each teacher's story in relation to the two questions above; to derive from the discussion threads an understanding of the "complex journeys grounded in the everyday experiences of the participants" (Butler-Kisber, 2010, p. 68), as well as to record their awakenings in regard to the reading process. I read the transcripts closely, using different colours to highlight and distinguish experiences, questions, insights, and other points one from the other as I coded the information. Once this coding was completed I began to shape each narrative. In doing so I used an approach to that of Rhodes (found in Butler-Kisber, p. 71): ghostwriting—that is, creating a portrait of each participant's experience, sanctioned by the participant, in which the researcher is explicitly absent. This being said, I inserted my own words in order to "integrate the text" (p. 71) and to give the narrative continuity while preserving the context. After scripting each narrative I shared it with the participant and invited input and approval. Each participant responded favourably. What follows is an exploration of one participant's journey through the course. First, I share Lily's story, that which I constructed after analyzing of all of her threads of conversation during the course. Second, I share the fourth discussion thread that Lily initiated, and how teachers responded to her discussion. Each teacher has been given a pseudonym. Teachers responded by sharing connections they made and experiences that they had had during their own journey of uncovering this process.

Shifting With the Tides: Teachers Engage in Sincere Conversation About Deciphering the Reading Process

It is liberating to watch the waves roll in with the tide, to observe how they flow naturally as they wash up on the shoreline. Conversation between teachers can be similar: it can flow unrestrainedly and freely as experiences are shared and practice is discussed. Many times during our online reading course teachers engaged in such conversation and as a result reflected critically about the complexities of both understanding the reading process and teaching children to read.

Lily's Story: Refining the Craft of Teaching Through Shared Conversation

Lily's participation in discussion threads resulted in questions about improving what she referred to as the *craft* of how to teach reading. As she reflected on her practice she asked the question, "How can I do better?" She continued to be introspective and pondered such matters as the techniques that she uses, her level of preparation and sensitivity to the needs of her students each day, her success in making reading a positive experience, and her ability to support students who struggle with reading. On several occasions she expressed having gained new insights. For example, following one discussion she admitted: "It was an eye opener for me as I read the statement that 'from grade 3 onward students received very little instruction in reading comprehension.'" She also came to realize that many students today are disadvantaged by their circumstances, and consequently "there seems to be a bigger gap in language skills and acquisition." In sharing a conversation that she had had in her staff room, she came to see that "children need to expand their vocabulary and their use of language: So many of our students are not engaging in meaningful conversations at home due to different lifestyles."

Lily continually reflected on her own reading strategies, and through discussion demonstrated that insights gained by doing this helped her to understand her students better. As a child she had struggled in learning to read, and through our discussions she came to think that her struggle might benefit her students. She also indicated that as she engaged in discussions from the course readings she made several other connections both to her own personal journey in becoming a reader and to her own practice as a teacher of reading. Some of the connections that she made served to clarify what she already knew, while others helped her to see the reading process through new eyes. "I found that I began to reflect upon my personal reading and what it is that I do as a reader. I've never really thought about that before."

Lily raised many probing questions throughout the course, questions that indicated that she was reflecting on and thinking more deeply about her practice. Some of her questions had their roots in past experiences, such as when she asked,

> How did I learn how to read? What methods were used then? If teachers used different strategies "back then," would I have struggled as much had I had the more updated strategies used now? How do I teach reading differently than I was taught?

Overall, she gained a greater appreciation of the importance of asking questions in order to develop her own understanding of the reading process, and also of allowing her students to ask questions.

Lily also shared ideas that arose from our discussions and that looked to the future. For example, she talked about working with her students in new ways: "I now will be looking at fluency and comprehension in a different light." She realized that students "who take longer to read a passage sometimes retain more of the information than those who read quickly. I think we have to consider the child as an individual." She considered the future in broader terms, thinking about the need for universities to prepare student teachers to teach reading more effectively.

As Lily engaged in conversation with her colleagues, she reflected on past and present experiences and considered these as windows into her future teaching. She spoke about continually making "mental notes" and realizing new possibilities for transforming her teaching and helping her students, especially those who most need her support. She observed that "[b]elieving in oneself is very important" and that we need to consider what we believe as teachers. Lily shared new insights into several areas, including standardized testing, independent reading, differentiation of instruction, and working with the public. Finally, she stated:

> The bottom line is [that] if students are not engaged in learning, it is difficult for them to learn. Education is constantly evolving and as a teacher, I too have to be willing to step out of my comfort zone and be willing to learn new things for the benefit of my students.

Responding to Lily's Initiated Discussion Thread: Teachers Engage in Sincere Conversation About the Reading Process

As Lily initiated the fourth discussion thread she begins by sharing a quotation from Donald Graves (a well-known author of many books on the writing process) about how powerful writing can be and how ideas can affect the lives of others. She spoke of a shift taking place in classrooms: the effort to include more nonfiction in students' reading, which until now has been strongly fiction-based. Lily talked about the need for students to see a sense of purpose in what they read and write, and how this can deepen understanding and motivate students to learn. She shared instances of her attempts to engage her students in real-life activities (authentic learning)—some impromptu, others planned—and indicated that she would seek to do this even more in the future. Lily invited her colleagues to think about authentic literacy:

seizing opportunities to include more authentic activities in their daily practice, integrating more informational text into their curricula, reflecting upon their own schooling and the authentic activities, or lack thereof, that they had had the opportunity to engage in.

Rachel was the first teacher to respond to Lily's thread and shared a memory of being younger and not recalling participating in many of the activities that she engages her students in:

> When I learned to read and write there were no opportunities for authentic literacy activities. Although I do remember in Grade One being chosen to go to the pond beside the school with another student and collect tadpoles for the classroom. Unfortunately I do not remember doing anything else with the tadpoles.

Sarah, another teacher in the course, shared stories about her grade five class writing pen-pal letters to another class within the province, an authentic activity that motivated her students to read and write. She also mentioned their perusing newspapers, which led to starting a class newspaper:

> They had found a real purpose to investigate newspapers. So their idea began to grow into a reality through lots of brain storming, researching, planning, negotiating, and hard work. As they discovered how to begin and write a newspaper, their questions led to other questions and considerations. Their enthusiasm led to a box being placed outside our classroom inviting the rest of the school to participate, asking questions to be answered through an advice column. One high academic student suggested how he might like to do a puzzle section. Even the more reluctant readers and writers were motivated into action. What an experience!

As Holly responded, she was reminded of her first year in a classroom after teaching music for several years. She described that year as her most authentic because she had had students engage in several different activities, such as using lemon juice to write letters to a stuffed frog and making ice cream in resealable bags in a snowbank. She went on to discuss the effect of what she perceived as changes in the school system:

> Unfortunately for both me and the students, times changed as I moved up to Grade Three and Four with Provincial Assessments. I no longer felt that I

> had as much time to run with those teachable moments they talk about that I had so previously enjoyed! What a shame.

Holly shared memories of having created websites with her grade four/five class one year and of teddy bear exchanges another. She discussed how such activities really had a purpose and engaged her students. She also talked about changes she had experienced in recent years:

> I look over my last couple of years in the classroom which were quite successful yet no longer was I allowed my couch and cushions in the reading corner, (allergies), the wooden park bench now in the reading corner was felt to be a hazard and the room looked very structured.

Finally, Holly shared her desire to create a more authentic environment for her students by turning their small school into a multi-aged learning environment. To this end, these were Holly's last words in the discussion: "The reading this week along with your stories and honesty has inspired me even more to go after the district to support a more 'Authentic Learning Environment' for our students!"

Sarah, Lily, Abigail, and Holly engaged in conversations about the lack of resources at their schools and how difficult it is to provide students with an authentic learning environment when financial funding is lacking. While they sought to find solutions to this problem, they bemoaned the challenge of covering so many outcomes when they have to struggle with outdated technology and other resource issues.

Ella agreed with the group and shared the following:

> So many of you have written about such great authentic learning opportunities in your classrooms…it is great! I too agree that the learning comes alive when students become so engaged in these authentic learning situations. They become so involved with the experience that they don't even see that they are *learning*. They are able to lose themselves in the excitement of the activity, let their guards down and not worry about *what the teacher is expecting them to do or say*, and truly engage in the situation. It can be so tricky to balance all of the demands we are faced with…but these authentic learning opportunities are what really matter. I would love the time to work with other teachers in the same grade to develop more authentic learning situations. They are too important to miss out on. As was

> noted by Purcell-Gates and Duke [2004], "more authentic literacy activities are related to greater growth in the ability to read and write [new genres]." [Duke, Purcell-Gates, Hall, & Tower, 2006, p. 354]

Ella recalled completing a science unit on living things the previous year and the excitement in her classroom as students rushed in each day to observe the growth of the bean plants they had started. She described how they kept diaries, drew diagrams, and made comparisons: "They were so actively engaged and just hearing them talk about their plants, compare theirs with others, and so forth made me realize how many more authentic learning opportunities I need to provide."

Millie closed the discussion thread by recalling an earlier story that Lily had shared about bringing a bicycle into the classroom and following the students' how-to instructions. She emphasized the need to provide authentic literacy learning for students, especially for those who struggle to read and write. She described a student she had taught in grade five who was a struggling reader, and how she discovered that what he really needed were more books to read that were not only at his reading level but also related to his interests. This student needed to be motivated to write:

> I quickly motivated him by tapping into his love of fixing cars with his dad and his uncle....off he went, authentically creating a piece of writing about working in cars with a drawing that labelled all of the parts of a car that he could name. I was delighted to see how impressed his classmates were with him. My bottom line: Authentic learning is the honey that will get you further than the vinegar (non-authentic literacy activities).

The braided conversations that flowed from Lily's discussion thread uncovered teachers' narratives of experience and how such experiences reflect their knowledge as teachers.

Reflecting on the Tides of Teaching: The Promise of New Knowledge Gained Through Conversation, Negotiation, and Attention in an Online Setting

If teaching an online course for the first time is rather like building a ship and setting sail on unknown seas, the experience of observing teachers engage in online learning, in weekly virtual classes and in discussion threads, is like charting the waters. Then, too, what the teachers went through in their process of discovery may

be likened to the tides. For sincere and open conversation involves constant give and take and a process of inevitable change, just as the tides ebb and flow and change what they touch in multifarious, often indiscernible ways. And, like the tidal wonder, the process of discovery for the teachers of this study held great beauty. Each teacher expressed a sense of discovery, moments in which they realized that they were undergoing change, moments of wonder or a sense of being involved in something not of natural but human beauty. There are, indeed, fewer things as beautiful as learning, and all of the teachers learned about themselves as teachers and about how in future they would apply what they had discovered in conversations in an online course to the challenges of teaching reading.

New understandings gained regarding online teaching.

Stepping back to consider insights gained while lacking the comfort and familiarity of a *real* classroom environment and experiencing instead an intangible world that initially seemed to merely mimic a real classroom environment took time, intentional planning, openness, and trial and error. While I discovered that many strategies for teaching online were similar to those used in face-to-face teaching, I also realized that many of these strategies could not be perfectly replicated in a virtual setting. It took time to become accustomed to hearing different voices, or tones, to understanding intentions, to interpreting meaning, to *reading* what teachers were attempting to relate in conversation. I realized (as mentioned earlier) that I needed to redefine myself in light of the change in landscape (Meloncon, 2007). Sorting out what I could continue to do, what I needed to make adjustments to, and what I needed to abandon, became part of the process of my transformation and integration into online instruction. Paying attention to what worked well was particularly helpful; picking up how teachers responded to my tone, choice of words, attempts to listen attentively, and activities for engagement in the course informed my instruction and moved me forward successfully.

Most importantly, through this study I learned that successful online teaching does not just happen. The process is complex and multifaceted, and must begin with the creation of a positive and safe learning space for open and sincere dialogue. As Lock (2006) points out, "[t]he creation of a safe and trusting space, the relevancy and currency of content in meeting the needs of the learners, the nature and richness of online discussions, and the nature of participation and interaction" (p. 674) are all factors that must be considered to ensure a successful online environment. Attention to each of these details enabled me to see the potential for learning in an online setting and to become comfortable in an environment that I initially felt uncomfortable in. Furthermore, I learned that engaging in such activities as discussion threads actually benefitted teachers in ways that I had not experienced in a face-to-face setting. By having time to participate thoughtfully and deliberately in written discussions, teachers had opportunity to discuss what mattered most to them. Finally, I learned that flexibility and negotiation are also an integral part of successful learning online. Respecting and assessing the needs of teachers, including the demands in their lives and competing priorities, goes a long way to earning their respect and creating a stress-free and predominantly joyful environment.

Did teachers gain new insights about teaching reading through negotiation and attention to the environment created for their learning?

In our online course teachers gained insights and deeper understanding about the reading process in numerous ways:

- revisiting their own assumptions about learning to read and teaching others to read
- deepening their understanding of how to create effective learning environments within their own contexts to promote reading
- increasing their knowledge in regard to comprehension, vocabulary, fluency, writing, and other components of language acquisition
- realizing more fully the complexity of both learning to read and teaching others to read
- resolving to consider what their future teaching might entail
- awakening to the fact that when they give expression to their insights, their new-found knowledge becomes relevant on a new level—they gain confidence to transform their practice and re-story how they live their daily lives in teaching

While the focal point of this study was not to delve into what knowledge teachers gained about reading during our online course, the learning that did occur suggests that the proper environment was created. Attending to many factors is essential, including finding ways to allow all participants to speak, encouraging attentive listening (which inevitably leads to thoughtful response), ensuring security, and facilitating the course in a selfless way with the interests of participants at heart.

Setting the conditions for learning by promoting sincere dialogue in an online setting?

Rogers and Babinski (2002) emphasize that there is great potential for supporting teachers "through the creation of dialogic communities" (p. 41). In other words, conversation alone is not enough. Teachers benefit from having such conversations within a social context, especially an open and inviting context that encourages dialogue through mutual respect, concern for each other, and genuine listening. Throughout the course the experiences related by teachers in trying to teach reading were often difficult, and having opportunity to discuss the difficulty genuinely helped them move forward. In this respect it is critical that space and opportunity be provided for teachers to talk. By adhering to what took place during the course and recognizing the importance of dialogue, teachers would see the relevance of open conversation in their own contexts and lives. They would come to realize that on more than one level through dialogue they gain the support and confidence needed to progress in a profession that is often complex. They would also come to realize that through conversation and sharing stories, they gain voice and opportunity to revisit their beliefs, and to re-story their teaching lives. Beyond thinking about dialogue and sharing of stories to gain agency, the kinds of stories teachers share must include those that get at the heart of practice. This can be influenced by talking to other teachers who will push them to rethink, yet again, some of their assumptions about teaching.

Finally, there were times in some discussion threads when the teachers engaged in disagreements, the conversation pushing them to think harder about their teaching approaches and methodologies. Having open and honest dialogue concerning some of the contentious issues that we face gives teachers a valuable opportunity to test ideas and to debate what they believe. As Rogers and Babinski (2002) state, "Despite its potential for encouraging confirmation and the building of community, dialogue also offers the potential for debate and criticism" (p. 54). Tense moments inevitably occur, especially when devoted teachers discuss a topic they have strong opinions about or that is deeply relevant to their work or beliefs. However, through such conversations we come to see that gaining greater understanding and knowledge about teaching reading is not necessarily about agreeing with one another, and that by talking freely and openly we can discover new ways of looking at how and why we teach as we do. An example of this from a later thread in our study occurred when Holly and Millie discussed fluency in reading. Holly raised questions about the necessity of reading fluently in order to gain meaning from the text and was captivated by the notion that reading fluently may not be necessary for comprehension. In response to this, Lily shared an entirely different view. She explained how she found that when she could help a student become a faster, more fluent reader, the student's attitude became more positive and his or her comprehension level increased. Through this conversation we come to see that gaining greater understanding and knowledge about teaching reading is not necessarily about agreeing with one another, and that by talking freely and openly we can discover new ways of looking at how and why we teach as we do. In the case of this course, when the proper conditions were created for open and honest dialogue, disagreements usually led to respectful inquiry, because they were not tainted by competition, self-interest, or prejudice. During our course I continually witnessed teachers asking honest and sincere questions and seeking ways to encourage other members of the class.

The teachers in my first online course about teaching reading demonstrated that they had undergone a process of change. I have thought of this process as being like the endless process of the tides, at least in the way that the tidal ebb and flow can be said to bring about change for the better. That, after all, is what learning is all about.

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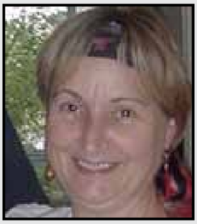

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Reimagining a Writer's Process Through Digital Storytelling

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ABSTRACT

Building on Hillocks' (1995) concepts of the declarative and procedural knowledge that writers need in order to craft effective writing, this article explores the writing process of one pre-service teacher as she moved from a personal narrative to an essay to a digital story. The authors argue that digital writers—in addition to needing declarative and procedural knowledge—must also understand knowledge of technology in order to more fully realize the potential of digital storytelling. Implications for teachers and teacher educators are discussed in relation to Mishra and Koehler's (2008) "technological pedagogical content knowledge," or TPACK.

Writing.

It is one of the three "R's" of education.

It is central to our lives as humans.

It continues to change as our world becomes increasingly digital.

And it is incredibly difficult to teach.

As with many subjects, teachers can be excellent writers, yet not have the pedagogical knowledge to teach others how to write well. Similarly, teachers may understand how to engage students in the writing process and have conversations about traits of writing, yet not have the deep knowledge and set of skills as writers themselves to share with their students. These challenges are compounded in a digital world. Writing is no longer simply an act of putting pen to paper; writers must navigate tools of technology that may support or constrain their ability to communicate a message. Given this ever-shifting landscape of what it means to write and be a teacher of writing, many teachers enter classrooms without developing their skills as writers, and even fewer as digital writers who compose websites, slide shows, or other forms of multimedia. As teacher educators and National Writing Project participants, we (Troy and Kristen) understand that teachers must be writers themselves (Lieberman & Wood, 2003; National Writing Project & Nagin, 2006). We must help the teachers with whom we work to develop their own knowledge, even as they consider how to help their students grow as writers. And, as we have considered the nature of knowledge that writers need in a digital world, we have shifted our teaching to include both traditional writing assignments such as personal narratives and argumentative essays, as well as digital writing pieces. Defined by the National Writing Project, DeVoss, Eidman-Aadahl, & Hicks (2010) as a "*compositions created with, and oftentimes for, reading and/or viewing via a computer or other device that is connected to the Internet*" (p. 7, emphasis in original), digital writing can include a wide variety of tools such as blogs, wikis, collaborative word processors, shared notebooks, and, as described in this article, digital storytelling. We want our students to develop their knowledge of writing in a digital world. We want them to practice writing digitally. We want them to think critically about how digital writing opens possibilities for exploration of self and other.

As teacher educators, we reflect upon these goals with the help of someone who knows this process well, Jodi, a pre-service teacher who developed her writing in Troy's class, "Writing in the Elementary and Middle Schools." In the fall of 2012, Jodi developed a number of writing pieces including a writer's profile, a personal narrative, and a "This I Believe" essay that focused on the broad idea of "social change," a theme inspired by her involvement with Alternative Breaks, a program at the university that sponsored meaningful volunteer work during academic breaks. Troy believed that by having his students engage as writers, they would better understand their processes, as well as the elements of this kind of personal essay writing. Later in the semester, Troy asked pre-service teachers to build upon this knowledge by creating digital stories that further explored a topic of personal significance. As defined by author and educational consultant Bernajean Porter,

> Digital Storytelling takes the ancient art of oral storytelling and engages a palette of technical tools to weave personal tales using images, graphics, music and sound mixed together with the author's own story voice. Digital storytelling is an emerging art form of personal, heartful expression that enables individuals and communities to reclaim their personal cultures while exploring their artistic creativity. While the heart and power of the digital story is shaping a personal digital story about self, family, ideas, or experiences, the technology tools also invite writers and artists to think and invent new types of communication outside the realm of traditional linear narratives. (Porter, n.d.)

Thus, the digital story project provided an opportunity for Jodi to express herself as a writer and to think critically about how to integrate technology into her own teaching. Jodi immediately connected the digital assignment to her "This I Believe" essay, recognizing that the digital mode may allow her to accomplish more by connecting deeply with her audience; she was unsure how to execute her plan.

Like all writers who are learning and changing as they build larger vocabularies, experience more in life, and gain a more sophisticated set of rhetorical skills, Jodi needed to add a layer to her knowledge. She needed to understand how the tools of technology could help her tell the story and how the form of a digital story could broaden the focus of her personal essay. Through her work with Troy, Jodi was able to develop her procedural, declarative, and technological knowledge to accomplish her writing goals, and we will elaborate on these forms of knowledge below. In particular, Jodi took the initiative to schedule a writing conference with Troy on the Friday before the digital story was due. Part of the talking and thinking that went on in that conversation was, fortunately, captured in some notes that Troy took while Jodi described her vision for the digital story and discussed how she might use the ideas from her "This I Believe" essay that could translate into a digital story.

Through the rest of this article, the three of us have worked collaboratively to provide a framework for thinking about Troy's decisions as a writing teacher and teacher educator, as well as Jodi's decisions as a digital writer. We begin by adapting Hillocks' framework of declarative and procedural knowledge that writers need and expanding that framework to include a third dimension that includes digital writing. Then, we share Jodi's reflections on the process of composing her digital story. Finally, we close with a discussion of how digital writing both expands and complicates the decisions that writers and teachers of writing must make as we incorporate newer literacies and technologies into our teaching and learning.

The Knowledge Writers Need

Hillocks (1995) articulated a sociocultural view of writing that evolves from a rich history of composition theory. He suggested that traditional writing instruction focuses on declarative knowledge—telling students what a given genre should look like or include—and he argued that "the important knowledge is procedural" (p. 99), or how to produce the writing itself.
Hillocks described the difference in this way:

> It is one thing to identify the characteristics of a piece of writing but quite another to produce an example of the type.... Knowledge of discourse, then, appears to have two dimensions: declarative knowledge, which enables identification of characteristics, and procedural knowledge, which enables production. (p. 121)

Perhaps a more blunt way to put his findings would be this: it's relatively easy for students to tell us about the qualities of good writing. That is, they generally know what good writing looks like. However, knowing how to craft good writing is much more difficult. In fact, Hillocks argued further that writers need knowledge of discourse (the form of the writing) and knowledge of substance (the content of the writing). Smith and Wilhelm (2006) conceptualized this knowledge in a table, aligning declarative and procedural knowledge of writing with the form and substance of that writing into a blank table, showing the relationship between these ideas (p. 124). We have adapted their table into Figure 1, elaborating on the intersections of these ideas.

	FORM	SUBSTANCE
Declarative Knowledge (Answers the question "what"?; can be tested.)	What the writing itself is, including the generic/conventional characteristics	The content, topic or subject of the writing
Procedural Knowledge (Answers the question "how"?; must be produced.)	How to generate the needed characteristics	How to generate the content (inquiry)

Fig. 1: An elaboration on Smith and Wilhelm's interpretation of Hillocks' declarative and procedural knowledge

For Smith and Wilhelm, then, using procedural knowledge is putting "declarative knowledge into practice" (p. 125). This framework suggests that writers need a knowledge of what, which includes identifying the characteristics of the genre and the content focus of the writing, as well as the knowledge of how to produce the writing in a way that effectively communicates the message.

Examining Jodi's path through Troy's class, we can see her expertise as a writer grow. In Figure 2, Jodi's final draft of the personal narrative, which was due about one-third of the way into the semester, is presented and, in Figure 3, Jodi's final draft of the "This I Believe" essay, due about two-thirds of the way through the semester, is shared. Both are worth reading, as they demonstrate Jodi's competence as a writer. As a future teacher of English who herself was an advanced writer, she possessed the declarative and procedural knowledge of form to write a personal narrative in the form of this essay. She knew how to focus on a main theme and to add appropriate detail to craft the essay. She was able to tap into her experience as a participant in Alternative Breaks to generate the content for that piece, focusing broadly on the idea of "social change." She successfully met the goals of the assignment and her personal goals as a writer, and she earned positive responses from her classmates, especially on the final line of her essay: "For this, I believe in social change."

It took a lot of effort to get me in the van the day the trip left. I was feeling a whirlwind of emotions that I couldn't process. I didn't want to have a life changing experience anymore, I wanted to stay the same for the rest of my life.

I was a sophomore who hadn't quite realized that what I needed the most was a little growth; strike that -- a lot of growth -- and a life changing experience.'s It would set up the foundation for the rest of my college career and now, my life. The world was mine, people were just living in it. I had a great boyfriend, lots of friends, was beginning to get involved at CMU and felt on top of the world. My RA approached me about doing something called an Alternative Break. He was just doing PR for the program and really trying to get as many people to sign up as they possibly could. I looked into what issues they offered for summer breaks and I was immediately enticed by the name Education printed on the screen. I called my mom and told her I was going to sign up for this Alternative Break thing and see what it was all about. She didn't think there was anything that sounded too harmful about a group of 12 CMU students going to a set location for the week and offering service in a local elementary school. When I put my name on the list for going to the break I was so excited yet I had nerves rushing through me because I had no idea what was in store for me. My friend also got the same break I did and he had been on several ABs before, in fact he was on the AB Advisory Board. But he didn't want to reveal the location we were going or answer too many questions about the break so that I could get the full experience that most ABers get.

My first meeting came around and I left feeling indifferent, the trip was in Reno Nevada and we would be there for a whole week. How was I going to make it 40 hours in a car and drive all the way across the nation? My family felt the same hesitations that I did because this was such a new experience for us all. We had no idea how we were getting from point A to point B, what the cost was going to be and what we would do for food. As the meetings went by I was getting more and more questions answered and I began feeling really prepared about going and doing this service.

Looking back on this now, the sequence of events that led up to this experience are a blur. Within, the span of a month, I had lost the most important people to me at CMU. My boyfriend broke up with me, my friends were slipping away and my involvements were all coming to a close due to the school year ending. I didn't know what I was going to do, I was going on an Alternative Break to volunteer and just to focus on that.

It took a lot of effort to get me in the van the day the trip left. First off, it was Four o'clock in the morning and I felt such a variety of emotions that my body was basically numb. I had to drive a van with five other passengers and I was not prepared of that, when they asked me to drive first, my stomach felt like it fell out of my butt. I got in the driver's seat and followed the lead van. I didn't have time to think about anything else but making sure everyone else was safe and that my driving wasn't terrible. Hours went by and I was still driving, I was beginning to grow tired but didn't want to let anyone know that I needed to stop. Eventually, we stopped and decided to switch drivers. The whole rest of the trip I was very quiet, unless my friend Robert was talking to me and trying to engage me in the conversation of the other participants in the van. I spent a lot of time on my phone, texting my mom and my friend Steve who was in the van in front of us.

The drive seemed to take forever but we arrived at our halfway point, Wellington Colorado. We got there when it was dark and slept for about 6 hours.As we got into the vans the next morning, I remember the smell of the fresh altitudy air in my nostrels and thinking how I felt so at peace. We got in the vans and continued the drive through the rolling hills and mountains of Colorado, Utah and Nevada. The change of scenery happened so quickly it was like someone had dropped tall buildings and lights in front of the mountains.

We got settled into our housing for the week and decided that we would explore the Biggest Little City in the World, Reno NV. It was unlike anything I had ever seen. We went to the top of a parking garage and I looked to my right, I could see snow capped mountains, and to my left, buildings and lots of lights. It was like a mini Las Vegas.

The next morning came around and I was going to my Kindergarten classroom for the first time, alone. *What do I do? Will the kids be different from my class at home? Do I have the skills to be effective? What do I say?* I felt lost. I walked in the classroom and was welcome with open arms by my teacher and the students. They had so many questions to ask me. From my favorite color to are you married, I was beginning to feel more at ease as the day went on.Each night we did a reflection that taught me more about who I was and what I stood for as an individual. It didn't matter if my opinion was different from someone else's. It only mattered that I respected the opinions of others and kept an open mind. As the week progressed its hard to describe my growth, I couldn't see it physically but I could feel it. I felt like for the first time in my life that Reno Nevada was a city made just for me.

To this day, I still struggle with finding the right words to describe the growth that I have experienced not only on this break but on the six break that I have been on. I can only allow my actions to speak louder than my words and hopefully my actions can one day become words.

Fig. 2: Jodi's personal narrative

Like the wind, change is something you feel, not something that can be seen. Change can happen in large quantities or through small acts of kindness. Cesar Chavez said "once social change begins, it cannot be reversed You cannot uneducate the person who has learned to read. You cannot humiliate the person who feels pride. You cannot oppress the people who are not afraid anymore. We have seen the future, and the future is ours." For this, I believe in social change.

Reflecting on my college career, it's hard to remember what my life was like before my first alternative break. I hardly have a single memory that doesn't include my time or the friends I have made through this program, whether it be as a participant, a site leader or a board member.

As a 19 year old participant with big dreams and under developed thoughts about the world, I thought that social change would be something easy, tangible and that everyone would quickly agree to. As a site leader, I saw the hope and sparkle in the eyes of my peers that turned this concept of social change, into something that could become a movement. Now, as a board member, I plan to incorporate social change in my classroom (as a teacher and a professor) and into my everyday life.

Through CMU Alternative Breaks, I have had the opportunity to develop into a life-long active citizen in local, national and global communities through diverse, direct-service experiences dedicated to social justice. To bring to life an example of a time when this statement has proven itself true is not an easy task yet it is one, much like my battle with social change, that I would be compelled to describing.

What the Alternative Breaks program has encompassed me with is not only a love for service, but also a realistic ability on how change can be made through small acts of random kindness. that the world has the ability to change us as people, but also that a small group of dedicated individuals have the ability to change the world. Like Chavez said, once social change begins it cannot be reversed, and my transformation as a leader is irreversible. For this, I believe in social change.

Fig. 3: Jodi's "This I believe" essay

As the semester moved forward, Troy shifted expectations, taking Jodi (and many of her classmates) out of her comfort zone as a writer by introducing concepts related to digital writing. In particular, he introduced the idea of digital storytelling, a genre in which digital writers combine a narrated script, images, transitions, video effects, and music to create short movies. Since the 1990s, when programs such as Windows Movie Maker and iMovie have come packaged on personal computers, the possibilities for creating digital stories have continued to expand. And, as one of many genres that he could ask students to produce as a final project in this methods course, Troy felt that digital stories offered a good way to synthesize students' learning from the semester.

After sharing two examples of digital stories, Troy introduced basic techniques for crafting such a text. These lessons focused both on declarative and procedural knowledge and included elements such as creating a timeline, including transitions, and recording narration. Still, even after writing about her experience in the

Alternative Breaks program earlier in the semester, when Jodi first tackled writing her digital story, she faltered. Like many students in the class, she had difficulty in capturing her ideas in text-based writing while preparing the digital timeline for the video components of the story. At her request, she scheduled a meeting during office hours with Troy, a conference she did not need to fulfill a requirement for the course, but chose to take on so that she could learn how to craft an effective digital story that she would want to share with her friends and family.

The Knowledge Digital Writers Need

Perhaps the reason Jodi needed additional support in the writing of this digital piece, one that built from the same personal experience as the text-based narrative she had written earlier, is that the framework laid out by Hillocks (1995) becomes more complicated when looking at digital genres. A digital story is a composition that involves spoken words, images, video, and other multimedia effects. Unlike its cousin, the personal narrative, the digital story provides writers with a broad palette of tools of technology that support rhetorical choices. In short, crafting a digital story requires technological knowledge, in addition to declarative and procedural knowledge.

So what knowledge does a writer need to create an effective digital story? As in the personal narrative, Jodi needed to understand first the elements of narrative (e.g., character, conflict, dialogue), but she also needed knowledge of images/video, music/sound effects, and transitions/captions/video effects. She needed to know that digital stories employee these techniques, but she also needed to know how to use them effectively to move her story forward and to capture the audience. Furthermore, she needed to understand the affordances of the technology both from the perspective of the genre (form) and the content of the story itself (substance).

Porter (in Hicks, 2009) has suggested that media can be used in three levels in digital storytelling. In her view, media might (1) decorate the story, (2) illustrate the story, or (3) illuminate the story. Decorating is easy; finding clip art or an image from the Internet will do, and matching it up with the script being read is sufficient. Illustrating takes a bit more work, in the sense that the digital writer may use her own images or create new ones, using them to highlight the spoken words. In order for media to “illuminate” the story, a writer needs knowledge of technology and how it intersects with both the form and the substance of the writing. The words, images, transitions, and sounds work together so that the "whole" of the digital story is truly more than just the sum of its parts.

Visually, we have enhanced Smith and Wilhelm's table by making it into a cube when thinking about digital genres, where the front of the cube encompasses what we know about traditional, print-based forms of writing and moving deeper into the cube generatively complicates what we know and leads us to (potentially) richer forms of digital writing. In this model, writers need to know both the "surface" level of declarative and procedural knowledge as well as the "depth" that they can add with technologies for digital writing (See Figure 4). As a concrete example, it is the difference between knowing how to describe a character in writing as compared to using an image to introduce a character and, with just enough writing, describe her in a way that illustrates or illuminates her picture. In this way, the introduction of technological knowledge intersects with both form and substance, complicating the one-dimensional grid of writer knowledge.

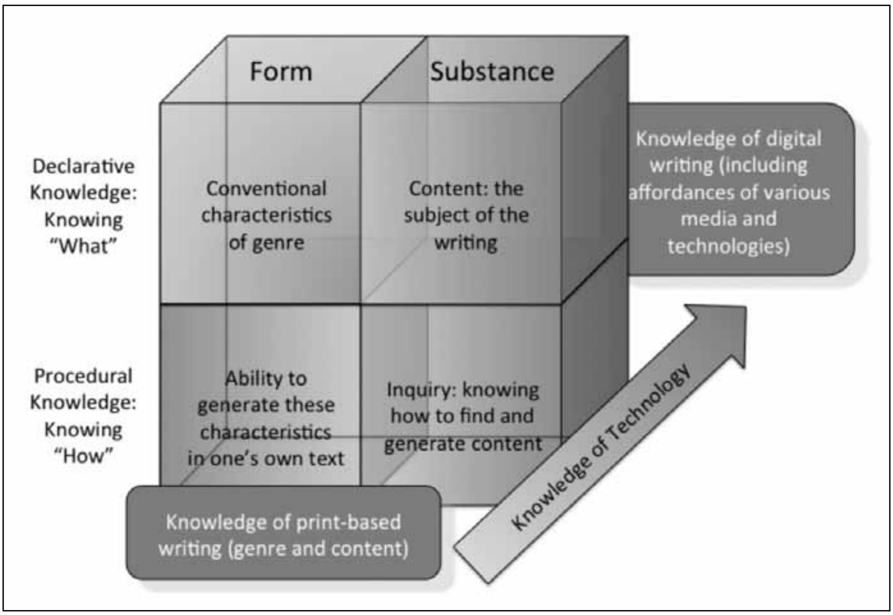

Fig. 4: A model for declarative, procedural, and technological knowledge in digital writing

To successfully create a digital story, Jodi (like all digital writers) needed to understand how to find and incorporate images, music, and other effects to illuminate her story. She could not complete the task without knowing what technologies to use, how to manipulate them, or in what ways these technologies helped her to develop both the form and the substance of her story. In our efforts to layer in technological knowledge, to deepen teachers' experiences as writers themselves, we need to help them understand:

- Declarative and procedural knowledge of form, in light of understanding the similarities and differences between a traditional print-based narrative to a digital story
- Declarative and procedural knowledge of substance, in light of using specific affordances of the technology effectively to draw her readers into the digital story

It is with this understanding of the digital writing process in mind that we now bring Jodi's voice into this conversation, hearing more about her thinking as she composed and revised her digital story.

Reimaging the Writing Process

In order to elaborate the dimensions in this cube, we recommend first reading the personal narrative essay and This I Believe essay about her experience, then viewing Jodi's Digital Story[1] before reading her reflection on the process of creating this piece.

Jodi's reflections on composing a digital story.

I know about stories. I know that when adults read to children, we ask them questions about the moral of the story, the emotions of the main characters, or the plot. In my early childhood development courses, I learned that these questions help children to experience a story, rather than just read it. Knowing that readers can identify with narrators and experience stories helped me envision the digital story that I wanted to create. Not only did I want to fulfill the requirements that Troy set in place for the assignment, I also had other goals. I wanted friends, family, and potential employers to see my personal development within the Alternative Breaks program. But I didn't just want my audience to hear me speaking about my life as I narrated the pictures I had collected during my four years in the program. I wanted my readers to feel as though they were experiencing my story with me.

In order to reach this goal I had to carefully structure my story, and I decided to ask Troy to meet with me for a writing conference outside of class. We met on a Friday morning, and began to think and plan together. I knew that stories contain a beginning, middle, and an end; however, I also understood that authors sometimes pick a point near the end of the story and then flashback to the beginning, allowing the reader to see the growth of the main character. I thought that a flashback might work well for my digital story. Starting at the end and flashing back, I hoped to show my viewers how much the Alternative Breaks program has helped me grow into the person I am today. I wanted to share that I have not always had the privileges I've been blessed with through the Alternative Breaks program, but that service has challenged me to be a better person. I decided that I could best tell this story through three different leadership experiences—being a participant, a site leader, and then a board member. Each of these topics had their own stories within them that would give life and meaning to the bigger picture of my writing. Troy listened to me talk, and he took notes about my ideas and we worked together to create this timeline (Figure 5):

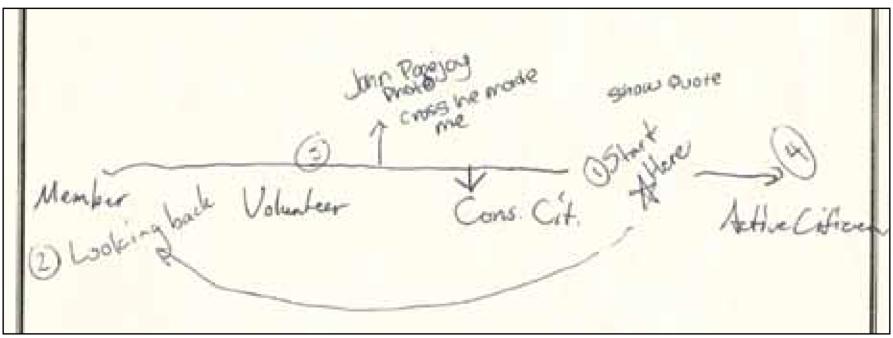

Fig. 5: Notes from Jodi's conference with Troy about her digital story timeline

Once I knew the content of my digital story, I had to tackle the task of constructing the video. I had experience creating a digital presentation that required me to choose a topic, pick a song, input pictures related to the topic, and post the video to YouTube. However, that assignment didn't need to tell a story. I wasn't sure how to take my knowledge of technology from that other task and apply it to creating a digital story that would come full circle. After watching the sample that Troy shared with us, I began to see how transitions and other effects could help reach my goal.

My "This I Believe" essay was already written, so I revisited it. I realized that I had felt constrained by the formatting of a typical essay and that I had struggled to write the paper about a broad topic like social change. I realized I needed to shift to writing about my journey through service-learning, and I knew the digital story could help me better connect with my audience by showing my personal experience with Alternate Breaks. As I tried to move from the written essay to the digital story, I thought PowerPoint would be a tool to help me. I copied pieces of my "This I Believe" essay into my PowerPoint document. I could see the slides on the right-hand side of the screen, make notes at the bottom of the page, and print out the slides to staple them together and have a paperback copy of my story. Making the story a book first helped bring to life the plot of my digital story—which ultimately became a personal and reflective story on a big chapter in my life.

After the story was sequenced, I recorded the narration one slide at a time. I closed my eyes and really listened to what I was saying, allowing myself to form a mental image of the story. I used these mental images to write notes on each PowerPoint slide about what I saw happening in the scene. Once this was done for all slides, I looked for pictures stored on my laptop, searched old albums on Facebook, and reached out to a few friends who had some photos, so I could begin adding visual images to my words.

From there, it was time to take all the pieces of the puzzle and put them together. Going slide by slide and recording my voice one slide at a time better allowed me to map out the timings of each photo and to put a transition in the middle so that things felt as if they were an integral whole. Instead of selecting pictures and quotes that were memorable moments from my break, I really made an effort to select photos and quotes that encompassed my experiences that would give my viewers a more meaningful experience. My peers had recommended that I take the line of "For this, I believe in social change" from my "This I Believe" essay and use that at the end of my digital story. Because my "This I Believe" essay was strictly text, my words couldn't convey the meaning I wanted them to. Revamping it, adding photos, and actually giving the words I was saying a voice was the biggest component in making that statement a reality.

I aligned my narration with the pictures in iMovie, yet there was still something that was missing. I didn't feel that the sub-stories fit well into the story as a whole. I decided to give each chapter a page turn and each sub-story

> a different transition (fade to black, pixelate, or a blur) to see if that make it more powerful. The transitions gave my digital story more depth. Whenever there was a page turn, it was symbolic of a new chapter occurring; whereas the photos that faded to black were meant to show that the small sub-story was ending and a new one was going to come. I used pixelations at the beginning and the end to create a mirage that allowed me to transition quickly into a flashback or flash forward moment. The transitions made all the difference, and everything fit together to make the story an integral whole that I am proud to share with family, friends, and peers in the Alternative Break program.

Jodi's Knowledge as a Digital Writer

We can summarize Jodi's declarative knowledge of form and substance, in this case of digital storytelling, quite simply: Jodi brought her extensive knowledge of how stories work to this process of digital storytelling, and she knew that the genre of digital story would allow her to connect with an audience by helping them "experience" her story. Particularly after Troy shared a model, she knew what a digital story looked like and that she could adapt her "This I Believe" essay in terms of content. In short, she understood the craft of story, in the broadest sense, and saw possibilities with digital storytelling.

Procedural knowledge, however, became more complicated, both in terms of form and substance for digital writing. She needed to develop her technological knowledge in order to create the form itself, and she needed to understand how to use technology to generate the content of the digital story. In some cases, the line between form and content blurred. For example, in the personal narrative, Jodi was able to develop her ideas about social change through the use of quotations and description. In the digital story, she had other options. She could deepen her exploration of social change through the use of her own images, effective transitions, appropriate music, and literally bringing in her voice through narration. To accomplish these goals as a writer, Jodi needed to understand how to use the technology to craft an effective, emotionally rich story (procedural). The use of these tools of technology was not just a matter of form, however. Since Jodi's story advanced via photos, accessing appropriate images became as much a matter of content as it was the form of the story. In fact, when she realized that she could not find adequate images on her computer, she downloaded them from Facebook and asked friends to send them to her. These methods of inquiry required technological knowledge beyond the movie making program, requiring specific communication with others that enabled both the form and the substance of the piece.

To use Porter's terms, Jodi's story was "illuminating" throughout, from beginning to end. Her process led her to develop knowledge of digital storytelling in all four quadrants of declarative and procedural knowledge, yet it was her knowledge of technology (both declarative and procedural) that enabled the production of the writing. The end result deepened her knowledge of writing—and her understanding of herself as a writer. This type of learning needs to happen for students as they continue to grow and change as writers in a digital world.

Conclusions

Jodi reflected on her experience:

> The process of writing a digital story has affected me as a writer in more ways than I could have ever dreamed. Through this, I see a different part of myself as a writer and as a reflector. We, as humans, have busy lives and are always going about our day-to-day tasks that can seem stressful and monotonous. Writing this story helped me take a step back and see everything that I have accomplished as a person. It allowed me to see where I used to be and just how far I have come. Every time I watch the video I identify with a different emotion and a different perspective on the story. As a writer, I have been able to see my process of writing and how I can use my words to create a powerful message. I've had the ability to move and educate groups of people that are familiar and unfamiliar with Alternative Breaks. Now, when I walk into an interview and they ask me about any ideas I have on incorporating technology in the classroom, what are Alternative Breaks, or even who I am as a writer, I have confidence knowing that I can answer their questions not by telling them, but by showing them.

One of the most interesting elements of composing a digital story is the recursive nature of moving back and forth between print text and video. Some students report that they write out the full script, whereas others organize all the pictures first. Most use some combination of the two, recursively moving back and forth between traditional alphabetic literacy and multimodal literacy. For Jodi, brainstorming began many weeks before in her personal narrative and "This I Believe" essay, and then on paper when working with Troy to develop the timeline. The most interesting part about the brainstorming was that, even as she described her experiences in the Alternative Break program in a chronological order, Troy began to hear patterns to how she described the changes in herself and these changes did not follow the chronology. Through their conference, they developed a story structure that met her writing goals. Jodi discovered that the genre of digital story opened opportunities for her as a writer.

As teacher educators and teachers continue to reimagine the writing process with many forms of digital writing, specifically with digital storytelling, we can learn much from Hillocks (1995) and Smith and Wilhelm's (2006) work. Pushing the boundaries of declarative and procedural knowledge of both substance and form to include the affordances of newer technologies allows us to build on theoretically sound interpretations of writing as we justify decisions in curriculum, instruction, and assessment.

Though we feel the need to go deeper into writing and to complicate our knowledge by assigning digital genres is self-evident in Jodi's story, we also consider the importance of developing what Mishra and Koehler describe as "Technological Pedagogical Content Knowledge" in teachers of writing. Specifically, one element of that framework, "technological content knowledge" could be useful as we continue to explore the types of knowledge that teachers need to have in order to succeed in teaching digital writing:

> Accordingly, Technological Content Knowledge (TC or TCK) is an understanding of the manner in which technology and content influence and constrain one another. Teachers need to master more than the subject matter they teach, they must also have a deep understanding of the manner in which the subject matter (or the kinds of representations that can be constructed) can be changed by the application of technology. Teachers need to understand which specific technologies are best suited for addressing subject-matter learning in their domains and how the content dictates or perhaps even changes the technology—or vice versa. (Mishra & Koehler, 2008, p. 9)

In moving the two-dimensional table of declarative and procedural knowledge into a three-dimensional cube that recognizes the effects and importance of technology, we appreciate how the "kinds of representations that can be constructed" are transformed as we move from print to digital text. In fact, we believe that the intersections of technology and knowledge of substance and form represented in this cube indicate that content knowledge for teachers of writing subsumes technological knowledge. In the digital era in which we live, technology cannot be divorced from a writer's understanding of craft and substance. It is within the intersection that Jodi reimagined herself as a writer, and it is within the intersection that we, as teachers of writing, reimagine what it means to teach writing.

Note

1. See http://youtu.be/krKHBIiwIF0

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ImMEDIAte Gratification: Examining the Use of Digital Media in Adolescents' In-School and Out-of-School Lives

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ABSTRACT

Using a mixed method research approach of qualitative case study analysis and quantitative surveying, this research[1] investigates the development of adolescent digital literacies and their use of mobile devices to further their understandings. More specifically, this article focuses on how a class of adolescents, ages 12-13, reflected on the impact of digital technologies and media on their lives while immersed in a rich media setting, using a social networking site and a combination of their own mobile devices and tablets that were provided to them by their classroom teacher.

Through the immersive use of personal mobile devices such as smart phones, tablets, and traditional laptops and desktop computers, adolescents inhabit an out-of-school world of burgeoning new media. Their lives are marked by extensive access to and engagement with, (a) a growing abundance of multimodal texts in digital form, and (b) a wide variety of robust communication and social networking digital tools, which inevitably help shape their digital literacy skills and their personal and community identities. At the same time, there has been a marked reluctance in educational settings to allow students to use their personal mobile devices and the new media they typically engage with, thus creating a disconnect between school and out-of-school experiences.

Using a multiliteracies pedagogy, mobile devices and social networking platforms can give students voice and agency in the context of their learning communities, and thus provide opportunities for them not only to learn subject matter but also to explore issues of identity and their place in the world around them. Using a mixed method research approach of qualitative case study analysis and quantitative surveying, this research investigates the relationship between a multiliteracies pedagogy and the development of adolescent digital literacy and identity. In this research we are interested in how adolescents perceive the impact of digital technology and media on their lives, as they examine the underlying messages of various media forms, as well as how ubiquitous access to mobile devices and tablets can potentially transform teaching and learning literacy practices. More specifically, this paper focuses on the case study of one 12-year-old girl, reflecting on the impact of digital technologies and media on her life while immersed in a rich media setting, using a combination of her own mobile devices and a tablet that was provided to her by her classroom teacher.

The research project in general explores the intersection of adolescents' out-of-school new media experiences with digital literacy education, in a classroom setting in Ontario, Canada. The student participants read, viewed, and discussed several texts, both print-based and multimodal, and used a social networking site (Ning)[2] to respond to these texts that focused on the role of new media in adolescents' lives. The research capitalizes on students' nascent digital literacy skills through the use of mobile devices and tablets and builds classroom-based research knowledge in the rapidly growing field of digital literacies. Adolescent lives include the abundant use of digital texts, making it necessary to redefine or reconsider our literacy and learning practices, including our pedagogical choices. Traditional print resources such as reference books, novels, and text books have been staple tools to help provide knowledge for student learners for many generations; the reality, however, is that the cadre of technology present in the average North American home far exceeds the technological resources of a school's classroom or computer labs. Realistically, with students sharing a handful of desktop machines, and with every teacher in the school vying for time in the computer lab, these are not a viable option for regular and consistent student access to digital learning. Mobile devices, with their portability, wide range of resources, immediacy of content and their clear, visual interfaces offer exciting possibilities for student learners. Social networking tools, which are already a big part of adolescents' digital lives, are increasingly used by organizations and educational institutions to provide information, to communicate with customers and students, and to offer educational service. In this context, we make extensive use of the social networking tool Ning, accessed through mobile devices. The Ning is a safe, secure environment that has similar affordances to Facebook.

Theoretical Framework

Multiliteracies

Within a multiliteracies framework there is an emphasis on students as producers or "Designers" rather than just consumers of text (Cope & Kalantzis, 2000). The New London Group's (1996) concept of multiliteracies highlights the relevance of new forms of literacy associated with emerging multimedia, multimodal technologies. From our experience in schools, teachers are increasingly aware of and attracted to the educational potential of new media devices and web-based tools, especially as the conventional notion of literacy in curriculum has shifted to reflect a multiplicity of literacies. Although institutional obstacles prevent most teachers from taking advantage of this potential, school districts are starting to address this issue. The idea of multiliteracies (New London Group, 1996) is theoretically grounded in the sociocultural tradition, which views literacy not as something you have that is functional and autonomous, but rather as a series of social practices (Harste, 2003) inferred from events and mediated by texts. The traditional view of literacy and the reading and writing of print text has expanded to include viewing and communicating in many different ways, about texts of all kinds, including images, video, music, and sounds, gestures, and more. New literacies, as defined by Lankshear and Knobel (2007), are not characterized solely by their digital or technical features. They also involve a new mindset or a new ethos that focuses on participation, collaboration, and distribution (Lankshear & Knobel, 2007). Digital tools have increasingly become tools of mediation and communication and many facilitate the kinds of sharing that are conducive to literacy education ideals. Contemporary social interaction is characterized by changes in the materiality of texts as well as changes in the ways we make meaning. Kress and Van Leeuwen (2001) suggest that in a digital environment, "meaning is made in many different ways, always, in the many different modes and media which are co-present in a communicational ensemble" (p. 111). Jones and Hafner (2012) argue that digital media offer new ways of doing different kinds of things, making different kinds of meanings, relating in different ways with those around us, thinking about things differently and being in different ways, that is, the kinds of social identities we can perform or adopt. Weber and Mitchell's (2008) notion of identity as "personal and social bricolage" views identity construction as "an evolving active construction that constantly sheds bits and adds bits, changing through dialectical interactions with the digital and non-digital world, involving physical, psychological, social, and cultural agents" (p. 43). The rapid adoption of new technologies and the social networking platforms that have become ever easier to access has implications for the adolescents who use them.

We borrow the notion of "multitextured" teaching from Beach, Appleman, Hynds, and Wilhelm (2011), which advocates (1) using multiple texts, including print literature, but also a wide variety of digital texts and (2) using these texts to read critically against the texts of their own lives. The authors explain, "in the process of viewing literary texts against a backdrop of other popular and canonical texts, teenagers can begin to move more critically through the 'identity crises' that Erikson talks about" (p. 34). As Beach et al. suggest, it is not about walking away from literacy practices that we know work; however, it is becoming increasingly important to better understand how adolescents, who have grown up in a digital age, use and interact with digital media in the context of their literacy practices.

Communities of Practice

Although adolescents use their mobile devices to access information anytime, anywhere, they use them primarily to get and stay connected. Collaborative knowledge construction is one of the oft-cited benefits of online learning, but in order for effective learning to take place instructors must foster and develop an "affinity space" (Gee, 2004) or "community of practice" (Wenger, 1998, 2000, 2007). Gee (2004) describes affinity spaces as "specially designed spaces (physical and virtual) constructed to resource people [who are] tied together ... by a shared interest or endeavour ..." (p. 73). Wenger (1998, 2000, 2007) has coined the phrase "communities of practice," which he describes as groups of people who share a concern, passion, or interest for something they do and learn to do it better as they interact regularly. Anderson (2001) suggests that "[i]nformal sharing of experiences is often the most valuable result for groups of [individuals] engaged in formal education, and it is likely that it constitutes a significant enhancement to … education" (p. 32). Social networking sites position users as co-authors and co-developers and tap into their collective intelligence. They are constructed to facilitate the collection and sharing of user-generated content. A social networking network (such as Ning) fits within the social constructivist paradigm that views the building of new knowledge as a social and collaborative enterprise. We extend Wenger's (1998, 2009) notion of communities of practice to school and classroom communities that use an inquiry approach as they strive to have students see themselves within a larger world and what that means within a diverse society. As learners develop socially, cognitively, and emotionally, it is necessary that they understand that everyone has rights and responsibilities within a given community. No longer is the curriculum simply the novel or the facts to be learned but, rather, the students and their teacher together using books, other authentic resources, and their own opinions and experiences to create the "living curriculum" as a true community of learners (Connelly & Clandinin, 2006).

Methodology

A case study approach was used to collect in-depth data related to how the students engaged with the learning material through mobile devices. Although we used pre- and post-project surveys to find out what kinds of digital technologies the students were using both at home and school, the bulk of the study is qualitative in nature, in keeping with the established practice of in-depth studies of classroom-based learning and case studies in general (Stake, 2000). As Bruce (2009) points out, case studies "provide the best articulation of adolescents' media literacy processes, especially as much of the emergent forms of their use has not been studied" (p. 302). The case study method is also appropriate for studying a "bounded system" (that is, the thoughts and actions of participating students or the learning-community connection of a particular education setting) so as to understand it as it functions under natural conditions (Stake, 2000). Individual students, and their digital texts, were considered as individual cases. We examined all of the data for each individual student, and in the analysis of the authoring of the digital texts, we were particularly interested in moments that might be interpreted as "turning points" (Bruner, 1994) in the representation of identity and/or the conceptual understanding of the impact of new media on adolescents' lives.

Setting for the study.

The study involved one class of 24 middle school students, ages 12-13. The students read and critiqued a variety of texts, both print-based and digital, all of which focused on adolescent issues related to the role of new media in adolescents' lives. They participated in literature circles that focused on the following novels: *Speak* by Laurie Halse Anderson, *Divergent* and *Insurgent* by Veronica Roth, *Dear Jo* by Christina Kilbourne, *Stargirl* by Jerry Spinelli, and the *Uglies* series by Scott Westerfeld. They also examined online texts such as "It's a Book," by Lane Smith, which is a social commentary on the digital age, and a National Film Board documentary called "The Colour of Beauty," which chronicles the experiences of a young black model as she struggles to break into a profession which traditionally favours Caucasian women.

They responded to these texts and shared their opinions during face-to-face meetings with their peers and teachers in organized discussion groups, as well as online on a social networking site (Ning). They also created their own digital and multimodal texts to be shared with a wider community as a way of presenting themselves and communicating about things that concern them related to their own identities. For example, they deconstructed advertisements and then developed their own online magazines or e-zines with a "healthy living" focus. They created and presented word clouds using Tagxedo and Wordle to convey their thoughts about body image and the media. They created digital poetry related to the theme of body image. They shared their work in a variety of venues, including on blogs which are housed on the class Ning, on the project website and through a dramatic production they scripted themselves. This took the form of a mock broadcast of a TV talk show containing song performances, advertisements, and interviews with each other on the effects of media on body image. For the purposes of this paper we focus on one specific case—Gigi (a pseudonym)—and her survey responses, comments on the Ning, digital magazine, and digital poem.

Data collection and analysis.

The qualitative research makes use of a case study methodology which includes detailed field notes, students' writing and contributions to the social networking site (Ning), transcribed interviews with students and teachers, the digital and multimodal texts created by students, and video recordings of selected learning/authoring activities. We elicited information regarding attitudes towards issues associated with the impact of new media on their lives primarily through writing prompts using a Ning forum. For the purposes of this paper we draw on data from one student's survey responses, her written reflections on the class Ning, and her oral presentations to the class based on her creation of a digital magazine and a digital poem.

Analysis of the data required several different layers of coding and interpretation. In the first stage the bulk of the data was coded for various themes that emerged. We coded the Ning transcripts following traditional coding procedures (Strauss & Corbin, 1990). The multimodal texts created by the student were also analyzed within a framework of semiotic meta-functions (Kress & Van Leeuwen, 2001; Jewitt, 2008; Burn, 2008), which considers design and production as representational, interactive, and textual. Because of the complex blending of multimodal data elements, we also used the digital visual literacy analysis method of developing a "pictorial and textual representation of those elements" (Hull & Katz, 2006, p. 41); that is, juxtaposing columns of the written text, the images from digital texts, and data from interviews, field notes and video recordings to facilitate the "qualitative analysis of patterns" (p. 41). Our analysis focused on the various modes of expression (i.e., visual image, gesture, movement) and how these work in concert to create meaning.

Findings and Discussion

Overall we noticed a marked increase in the level of students' engagement when they used technology to access media sources and create their own digital products. The ubiquitous access to current media texts provided both immediacy and relevance in their learning and they further developed their research skills as a result of the constant access to information at their fingertips through the use of the tablets. In terms of their digital literacy skills, the students made gains in their understanding of how to use a variety of digital media software applications and hardware devices, in their ability to critically understand digital media content and applications, and in their knowledge and capacity to create their own digital texts with digital media. Their teacher also noted that there was improved collaboration as students shared resources and roles in project work. Through informal comments made in class and on the post-project survey administered to all of the students, they reported feeling "privileged" to be given an opportunity to participate in the use of devices in the classroom. Most notably, however, students demonstrated gains in the development of their critical literacy skills. To support some of these claims, we take a closer look at "Gigi's" case, which follows below, as a representative example of how one student became more critical in this technology-rich environment. Gigi's case is not atypical. We selected her as a focus for this case study, because as a committed athlete she took a special interest in the topic of body image and healthy living. She was not the top student in the class academically, nor was she the strongest writer.

Gigi's Case

The surveys and the Ning.

Gigi was described by her teacher as a

> 12-year-old Grade 7 student who is conscientious to the point of perfectionism, intrinsically motivated and very driven. Her personality and identity require her to strive to do her utmost in all pursuits, academic, social, and athletic. She is a staunchly loyal friend, defender of the bullied, and sincerely and deeply empathetic to those who are in distress.

Gigi described herself on the class Ning as an optimistic person:

> I think that I am optimistic because I try to never let anything get me down. It is difficult to stay positive when things just aren't going your way in life

> and it feels like the whole world is against you. However, I always try my best. I try to cheer up not only myself, but my friends and peers as well. I have a lot of chances to be optimistic because I play a lot of sports. When your team is losing you can't give up or you will never get the points back. I think that is where I shine most in optimism. I will admit that when it comes to school work, it is harder for me to be positive if I am having trouble or I don't understand, however I still work at being optimistic and I think that it is important to always try.

Gigi also confirmed her teacher's description of her perfectionism when she talks about what she believes is her "weakest trait":

> I think the trait that I am least likely to be known for is courage. The reason for this is because I get nervous very easily and tend to shy away when I feel intimidated. I feel like I get nervous because I like to do things perfectly and I get VERY scared that I will mess up. I think that I can change this by being more open to mistakes and try to learn from them rather than let them bother me! I think if I were to build up my courage I would do better in school because I would take more chances instead of not trying because I'm scared of messing up.

The lack of confidence that Gigi demonstrates in the previous Ning post may also have been at play when she wrote about whether she preferred to write journal entries with pen and paper or on a class social networking site, in this case the class Ning. In the pre-project survey students were asked how they felt about the prospect of writing their journals online and Gigi responded:

> I don't really mind because sometimes I enjoy writing things out by hand, partly because it is fun, but also because I like to upkeep my penmanship skills. It is also nice because in a journal your thoughts and ideas aren't public and aren't there for the judging of other people. However, I also really like to use technology and to type. I work faster when I type as well which sometimes can be beneficial.

Although she clearly states that there are benefits to both traditional pen and paper journals and online journals, the thought of having her work "judged" by others seems to intimidate her. In the post-project survey that was administered five months later however, Gigi clearly indicates that she preferred writing her journal on the Ning:

> I really liked using the Ning a lot. I though it was very easy to use and follow and definitely preferred it over using a paper journal because I think that it is much easier to receive feedback (positive or negative) when it is posted for everybody to see. I enjoyed getting the feedback and/or questions about my responses because I am always looking for ways to improve my writing and the inquiries I got from other people really challenged me to think about what I was writing and helped understand some of the things that I didn't include, but should have.

The Ning certainly became a place where students could get immediate feedback on their writing from their peers and often their teacher, but it was also a forum for discussion and reflection. For example, their teacher asked them to read an article and then consider how technology and the Internet specifically impacted their lives in positive and negative ways. Gigi wrote:

> Like most teens or pre-teens, I do use technology for fun, I e-mail, I go on YouTube to watch videos and I play games, I have a gaming system and a camera and all that great stuff that I love! However, technology also comes as a great benefit when I'm doing school work. Even though there are a lot of websites that can give you faulty information on the internet, there are also plenty of legitimate websites with very accurate facts. So, I guess that I am saying, technology is a big part of my life! But, I don't let technology take over my entire life. I am very physical in and outside of school. I play soccer all year, I also love to read. So in my case technology is just a bonus in my life. I had a choice and still have a choice. I can decide whether or not I want technology to control me. I choose no.

As an avid reader, Gigi also reflected on the future of "the book" in a digital age. She did not seem to be overly distressed by the idea that print books would "become a thing of the past" and seemed to accept the advent of the e-reader for her own reading.

> I think that the idea of books becoming "extinct" is definitely a possibility. My reason for saying this is that right now it is basically our digital immigrants that [are] fighting to keep books around and popular. However our society continues to adapt at the same time and the gap between the number of digital natives and digital immigrants is quickly growing. At some point we will be a world filled with digital natives, as they are all being born into the world of technology. With our society moving further and further

> away from books and closer to new technology it is more likely that at some point books will become a thing of the past.

Interestingly, some of the students in this project were using Kobo on the tablets to read some of the books that were chosen for literature circles in the classroom but Gigi did not comment on this experience in her Ning responses.

Deconstructing Media Advertisements and Creation of Digital Magazines

To be digitally literate, Selber (2004) argues that students have to be proficient in the use of digital technologies but they also need to be producers of their own digital texts. He also suggests that students need to be critically aware of how and why technology is used. Selber describes students who have critical literacy as "informed questioners of technology" who can "question [computers'] designs, or challenge the grand narratives in which computers are implicated," and who become "empowered knowledge workers" (pp. 74–75). We wanted the students to be users, critics, and producers of digital media and to that end, we asked them to deconstruct online ads and then create their own e-zines in response to what they had learned by producing a magazine that promoted healthy living rather than the unrealistic expectations of beauty and lifestyle projected by the media.

Before beginning work on their own digital magazines, the students deconstructed the media messages found in current commercials. Working with a partner, Gigi chose to analyze a television commercial for Dior J'Adore featuring Charlize Theron. She was able to articulate the subtleties in the ad that serve to contribute to negative body image and she discussed the ways in which the use of colour, light, and music create an atmosphere of strength and confidence. She commented, "We interpret it as confidence … She's doing it just for herself … which makes the perfume more appealing." She and her partner compared this ad with the commercial for Taylor Swift's perfume, Wonderstruck, which is much more romantic and features a potential love interest in the background. They were able to comment on the underlying messages of both ads and were able to comment on the differences. After deconstructing their own ads and listening to their peers explain the media messages in their ads as well, the students felt that they now looked at ads even outside of school with a "more critical eye" than average consumers, and even their parents.

Working in groups of approximately five, the students created digital magazines that included their own ads. The student-created ads used media to shift the focus from "unattainable perfection" to "healthy living." Gigi's group created a digital magazine that featured healthy food, an active lifestyle, and a realistic attitude toward body image (see Figures 1 and 2).

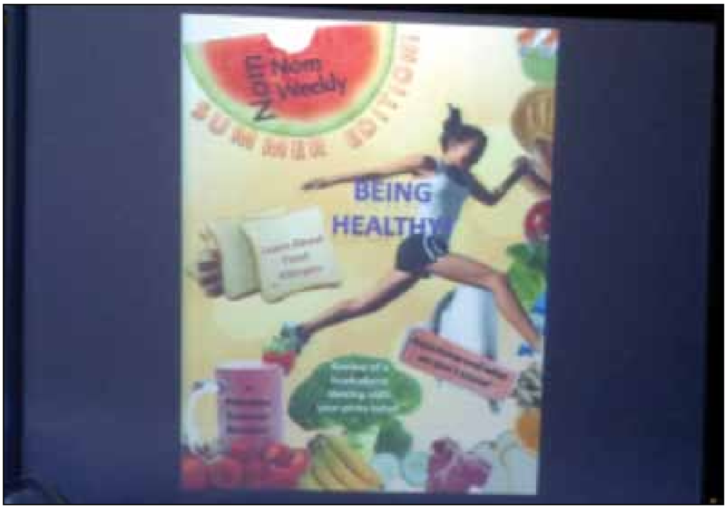

Fig. 1: Digital magazine cover page

Fig. 2: Digital magazine table of contents

There was a great deal of evidence of critical thought in the creation and subsequent presentation of the digital magazines to the rest of the class. In follow-up discussions, students talked about their new awareness of pervasive negative messages in media and the harmful effects these can have on adolescents. In their magazines they chose positive body-image models such as Adele to demonstrate importance of health over extreme thinness. They made comments such as:

> Hopefully after reading this magazine, kids who struggle with their body image will learn to love their bodies, and even if they can't, try to improve themselves to be healthy and happy, naturally and without harming themselves.

> When you start to think positively of yourself, you won't feel the need to change or even harm yourself to become your "ideal."

Gigi was able to articulate the importance of this experience to her own learning. She felt that the creation of the magazine would help students decode the media messages found in advertising and serve to promote a healthier attitude toward food. In an article she wrote for the digital magazine, she focused on the importance of healthy eating when participating in sports and how good food would contribute to better performance. She also noted how creating the magazine in a digital format enabled her group to produce a high-quality magazine. In her post-project survey, Gigi commented:

> I really enjoyed creating the digital magazine because I thought that it was taking something that was fairly basic and bring it to the next level by using technology as our resource to create it. On the computer there are many more options to make your magazine advanced (i.e., videos, animations, and a wide range of design options.)

The Digital Poems

The digital poems very clearly demonstrated the students' ability to deconstruct the media's messages. Gigi worked independently to create a poem that brings multiple modes of expression (i.e., visual, gestural, linguistic, spatial, aural) together to make meaning. She used strong, graphic images to warn her peers about negative media messages (see Figure 3) and she was able to communicate the reasons for all of her design choices in a presentation of her poem to the class. She discussed the use of fonts, images, music, and word choice in a way that demonstrated her understanding of how each element contributes to the overall message. It is beyond the scope of this paper to elucidate all of Gigi's design choices, but here we give some representative examples.

Fig. 3: Gigi's digital poem (slide sorter view)

Gigi let her digital poem play through for the class first and then restarted the video to begin her explication. The soundtrack for her poem is "Beautiful" by Christina Aguilera and the images are timed to coincide with the length of the song. Gigi began by explaining her choice to use fonts that look like handwriting. She comments, "This is someone telling their own story so I wanted the font to look like someone was writing it—it's more personable." She explains that the poem is "about loving who you are" and says she was striving for a "sense of solemnness" in the poem, which required her to "dull down" the colours in the images (most of which are taken from the Internet). She used several images of young girls putting on makeup and dressing up and commented, "I didn't want to glamorize things like this. I didn't want to make them seem like these amazing things that should be bright and happy because it's kind of looking at them negatively." Gigi argued, "people's images of themselves have been so messed with" by the media and this is reflected in her choice of the image in Figure 4.

Fig. 4: Media messages are everywhere

Gigi explained,

> It took me forever to find this picture and I was really happy when I found it. It felt like it was really good because … it really goes with poem … saying 'these are all the things she's saying about herself and how she gets labelled and a lot of the words are repeated which I think is also really good. You don't think 'I'm not pretty enough' and get on with it. When you think that it's something that goes through your mind every day and you think about it constantly. It's surrounding her because it doesn't just affect you in one place—it's everywhere and once you think it, you can't get it out of your head.

This image coincides nicely with Aguilera's lyrics, "Now and then I get insecure/From all the pain/I'm so ashamed …" (Perry, 2002).

All of the girls in the images are different and Gigi explained that initially she had tried to edit the girls' appearances so that they all looked similar. But then, she explained, she decided that even though this was one girl's story, she wanted the girls to represent "a lot of different types of people, ages, showing that lots of people have to overcome and deal with these obstacles."

One of the most provocative images, shown in Figure 5, is of a young girl who has been made up to look like an adult model. The image is labeled to draw attention to the many unnatural alterations made to the child to get her ready for a beauty competition.

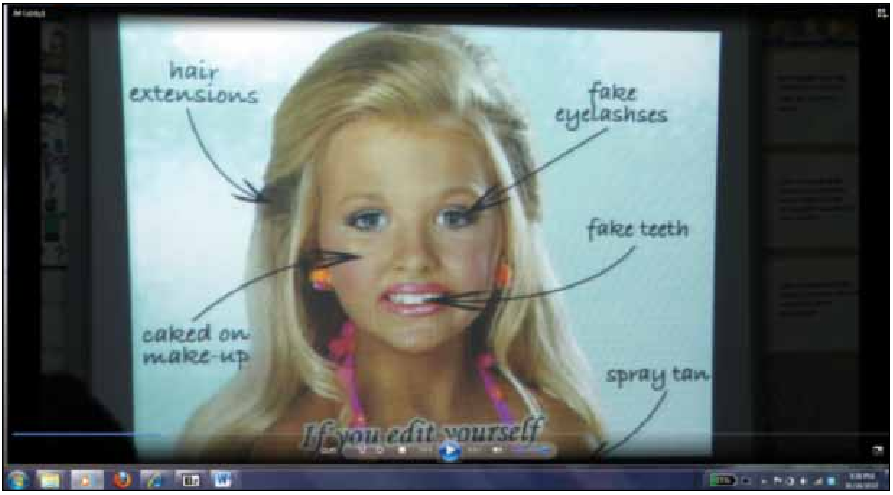

Fig. 5: "Fake little barbie dolls"

Gigi became quite angry as she explained that she chose this image to draw attention to the impact that negative media messages have on even very young children. Making a reference to the TV show "Toddlers & Tiaras" she commented,

> I've watched that show before and it's sickening to see how they act. Having a four-year old child saying facial beauty is the most important thing and if you're not beautiful then you can't win in life … it's disgusting! So I really wanted to show that because I think it's important for people to understand that even if a kid says that they like being dressed up and pampered, that's not going to help them in the future … when they can't always be like the fake little Barbie doll they won't feel confident in themselves.

Gigi's message, that girls should "love and be themselves," becomes clear by the end of the poem. In Figure 6, Gigi argues that "it's not okay" to try to be someone else, despite what your friends or peers expect.

Fig. 6: She won't be you

Gigi's poem intentionally concludes in bright colours. In the final two slides (Figures 7 and 8), Gigi explained, "she looks confident. I put 'perfect' in a pink glow because I wanted to put emphasis on the positives. Some people can still manage to overcome all the negative media messages and this image gives us reassurance that it's possible." In the last image, Gigi uses a heart-shaped fingerprint and explained to the class, "everyone has a different fingerprint and this is a representation that everyone is different. Also the shape of a heart, which I liked because it's saying that not only do you love yourself but you love the fact that there is difference in the world."

Fig. 7: Image of confidence

Fig. 8: Difference is good

Gigi's digital poem and her explanation of the design choices she made demonstrate evidence of critical thought, particularly of how the media manipulates its audience and how adolescents can and should resist the pressure to look and be a certain way.

A Way Forward With Mediated Learning

Different technologies impact the kinds of things our students can do, the meanings they can express, the relationships they can have, the thoughts they can think, and the social identities they can assume in particular situations. If we think about any technology, we will be able to determine what the constraints and affordances are: so, for example, one constraint of social networking tools is that we have to be particularly careful about privacy; but social networking tools enable us to connect with people all over the world in different ways, whether we are using LinkedIn to build our work networks or whether we're using Pinterest to share projects or recipes with like-minded people. Although we outline some of the constraints and challenges we came up against below, we have chosen to focus on the affordances that the digital media offered the students in this research project.

Given their reliance on and their affinity for the use of technology in their out-of-school lives, it is not surprising that the students who participated in this research project demonstrated an increase in their level of engagement while using technology to access resources in their in-school lives. Although getting students more engaged through the use of digital media is an important benefit, they became proficient and critical users of the technologies, as well as proud producers of their own digital texts. By gaining access to both digital resources and the necessary technological tools with which to explore these resources, students were able to develop their knowledge and application skills, and to demonstrate these new skills by participating in collaborative activities on the social networking site, Ning, by deconstructing and reconstructing advertisements, and by creating their own original multimodal digital poetry. Over the course of the project, students were asked to think critically about the impact of digital technology and media on their lives, and to examine the underlying messages. The immersion of the students in the world of digital technology during their in-school lives exposed them to a wide variety of resources which they would not ordinarily have had the opportunity to explore in a traditional text-based classroom environment, and which clearly demonstrated the potential for the development of adolescents' digital literacies and identities.

From our experiences working with these students, we believe that to move forward with the integration of digital media, we need a new pedagogy, one that is inquiry based, focused on real-life problem solving, based on content that matters to adolescents, and one that allows them to express themselves through multiple means, anytime, anywhere. In this project we found the pairing of tried-and-true "traditional" literacy activities such as literature circles with digital literacies that focused on accessing information and digital tools via the Internet and creating multimodal digital texts that promote awareness of an important adolescent issue very successful.

However, there were a number of challenges to overcome during this research project, not the least of which was ongoing accessibility issues and other barriers to implementation including time, resources, and support. At the inception of the project, the school's wireless technology was still in the early stages of implementation, and there were frequent, sporadic outages and long interruptions of service. Also, the school board's web filtering system initially restricted access to the Ning and it took several weeks to be unblocked. This led to a delay in the students being able to contribute their responses, and a resulting decline in their productivity. The devices themselves also had some limitations such as the lack of keyboard, sites requiring Flash, the inability for students to create presentations using Prezi or to use Tagxedo or Wordle, as well as other compatibility issues. Additionally, as the students came to the study with varying degrees of technological knowledge, some training on the devices as well as on how to navigate through the online resources was required. This was frustrating at times for the more proficient technophiles in the class, and led, in some instances, to some mild off-task behaviour. A few students required frequent monitoring, particularly when using their own devices; off-task behaviour was generally limited to the watching of YouTube videos and the playing of online games. Overall, as a group, the students embraced the project with great enthusiasm and came to rely upon both the devices and the access to technology as daily components of their in-school lives.

This project has led to future research examining the use of mobile devices in grades 6-10 classrooms in Ontario and in Newfoundland. In a 3-year federally funded project that began in September 2012, we are looking at the use of mobile devices to develop critical and digital literacy skills and to develop a guide for best practices in this area as school boards continue to equip their schools with WIFI.

Notes

1. This research is generously funded by the Ontario Ministry of Research and Innovation's Early Researcher's Award.

2. Ning is a private social networking platform that can be set up as a forum in which users exchange ideas, reflections, videos, images, and music files, and allows them to engage in an ongoing dialogue with one another. Personal profile pages are customized by the participants, much like Facebook. Content and the invitation of participants is controlled by the site's administrator in order to assure privacy and appropriateness of content.

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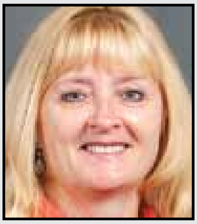

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E-Learning Pedagogy: Addressing Struggling Learners in Regular K-12 Classrooms as an Intransigent Design Problem

Susan Imholz and Ricki Goldman, New York University

ABSTRACT

As online education providers gain a foothold in the US public education system nationwide as supplemental and primary providers of curriculum materials, they are replicating some of the same pedagogical mistakes that brick-and-mortar schools have created in the curriculum development process—by not accommodating the struggling learner. Our paper and discussion concerns K-12 online content providers and their curriculum development processes.

The Problem

Many e-learning virtual education providers have mastered the art of creating electronic books, however they may not be employing pedagogical practices that are easily accessible to challenged learners, who are technologically unsophisticated. In many ways they are repeating the same structural weaknesses of traditional schools by designing materials that address the motivated, talented learner at the expense of students who are on either side of "the bell curve," so to speak. More specifically, online education providers are producing curriculum whose goals are implicit, but unstated in procedural descriptions of their use in the context of school classrooms, or informal alternative education settings where students are accessing e-learning platforms. Furthermore, these platforms are biased toward the culturally sophisticated student who has had the benefits of supplementary socioeconomic support in the form of 24/7 access to computer resources, tutoring, and enriched electronic learning environments; the same group who has been the most well served in traditional public schools in the past. While online e-learning has the ability to personalize the learning process for students, most are not taking advantage of these design capabilities, or recent education research which addresses struggling K-12 students (Hoover, 2011; Israel, Maynard, & Williamson, 2013; Joseph, 2010; Lightbrown, 2010; Misquitta, 2011; Slama, 2012). Taking into consideration the perspective of the learner, and students' particular needs, is the new creative challenge for instructional designers. This is both a design issue and a pedagogical issue, which is how we will address the problem going forward.

The problem, as we have stated it, is tangential to an ongoing line of inquiry as to why cognitively oriented technology innovations have not been adopted and become more widespread in K-12 schools. Fishman, Marx, Blumenfeld, Krajcik, and Soloway (2004) explored this question at length and came to the conclusion that

> …a primary reason is that research to date has not focused on issues of how such innovations function at the level of school systems. This results, in part, from the fact that much design-based research focuses on a designed product or resultant theory and not the system variables that impact the scaling potential of the work beyond the sites where the research was carried out. (p. 69)

Today—over eight years later—the marketplace has provided a means for entrepreneurs and online education companies to access public funds for delivery of distance learning platforms in public schools, but has largely circumvented issues of quality and efficacy in regard to pedagogy. One way of looking at this situation is that we now have two parallel K-12 design systems (traditional schools and virtual online education providers) that have not assimilated the most innovative and powerful uses of technology for learning.

In this paper we employ a historical lens proposed by Le Masson, Hatchuel, and Weil (2011a), experts in strategic management and innovation, to broaden the discussion of innovation integration to a systems level analysis as Fishman suggested. This approach assists us in thinking about why online learning platforms have not been able to incorporate new knowledge, strategies, and models shown to provide additional scaffolding to struggling learners. The historical perspective that Le Masson and colleagues have crafted and that we are sharing, integrates psychology, cognitive science, and management of creativity with engineering science in the formation of design science. A full description of their work can be found in their book, "Strategic Management of Innovation and Design" (2011b), which addresses the types of project management structures and processes that support truly innovative design, versus the design and manufacture of objects that are well established in the marketplace.

The Historical Perspective

Le Masson et al. (2011a) analyzed the relationship between creativity issues and design methods with interesting results, shedding light on why current developers of online curriculum are misfiring as we will show further on. In preliminary work on the topic of creativity and design,

> …Hatchuel (2011) noted that recent design theories form a consistent body of knowledge that tends to increase the creativity of design. This result seems to confirm our belief that there are historical dynamics linking creativity issues and the development of new models of design reasoning. (2011a, p. 218)

This premise prompted the research question explored by Le Masson et al.—an investigation into the assumption

> …that new models of design reasoning emerged to address new creativity issues; that the models that led to wide-spread methods [of product development] also helped to better address these creativity issues; and that the models and related methods were finally criticized [and replaced] for not addressing new, emerging creativity issues. (p. 218)

So to summarize, Le Masson and colleagues propose that design theories and methods evolve to meet the creative challenges of historical circumstances. As this relates to established design efficiencies for digital curriculum development, the challenge to the status quo involves a dialogue between new learning science, unique affordances of new media, and the limits of traditional forms of design activities. For purposes of our discussion, we are going to generalize from experience in the field and hypothesize that a majority of online education providers are presently employing a four-step method of curriculum design:

1. Using K-12 US state and Common Core subject matter standards as guidance for the development of courses, companies employ subject matter experts to write curriculum content and structure lessons in text format, inserting multiple choice exams for pre and post comprehension.
2. This material is transferred into digital media, which involves passing content to technical staff who define the look and organization of the learning platform web pages, add graphics, animation, and perhaps audio narration of text, to enhance textual material.
3. A quality review of the completed lessons is done for accuracy, consistency, alignment with standards, and proofreading.
4. All of the previous phases of activity are taking place in multiple locations, some or all of which may constitute a virtual project management enterprise in design and delivery.

To make accommodations to students of differing levels of ability or knowledge, spaced repetition (Bjork, 1994, 2011; Bjork & Linn, 2006) is a favored pedagogical approach used in online learning platforms to capture struggling learners who are in need of extra reinforcement when presented with new ideas and concepts. However, reading the material again more closely is not a strategy you can expect to work if there is a basic comprehension issue. What is needed instead are opportunities for students to revisit the same material in a somewhat different way so that comprehension can occur. If digital technology can offer many scaffolding strategies for doing this (Wu & Looi, 2012; Shapiro, 2008; Stewart, MacIntyre, Galea, & Steel, 2007; Deakin-Crick, 2007; Holton & Clarke, 2006; Graesser, McNamara, & VanLehn, 2005), why is it they are rarely used in K-12 e-learning pedagogy?

Our view is that online platform providers need to embrace advances from the well-established field of learning science which has called for designers to become more creative and also more focused on the inclusion of all students. Is this lack of progress primarily a knowledge problem? A barrier to advancement caused by financial constraints? Or, is it a glitch in the production process? Let's turn to the work of Le Masson and colleagues for further direction. Their insights and analysis of how design theories incorporate and resolve creative challenges provide a framework and language for deconstructing the problem. What follows is a much-abbreviated synopsis of their work. Pascal Le Masson is professor and chair of the Design, Innovation, and Management in Engineering Design (MINES) program at Paris Tech. His colleagues, Armand Hatchuel and Benoit Weil, are on the faculty in the same program.

The Three Tensions Between Creativity Issues and Design

Le Masson, Hatchuel, and Weil investigated the interplay between established production and design practices and the creative forces impinging upon them to bring change. Their study gives us a fuller understanding of how businesses and institutions get stuck in the wrong production and problem-solving models. The rubric used in analysis is composed of three tensions, which are defined as the central drivers of change:

(1) How to apply new knowledge:

- How is knowledge managed?
- What is the absorptive capacity of human resources to digest new information?
- What are the knowledge "fixations" of the organization, or its core rigidities?

(2) Defining the design process as divergent or convergent:

- Creativity tends toward divergence, and divergent thinking
- Production processes typically involve initial divergence, followed by convergence

(3) Organizational leadership characteristics (linear or circular):

- Established product management styles are strongly linear (one-way directives), and therefore poorly structured to adapt to creative teams (circular process) vs. dominantly circular management style where focus and productivity are lost
- An overly linear product management style may stifle absorptive capacities of staff and lose opportunities to apply new knowledge; circular management may not converge on solutions in a timely way

As subjects for study, the authors chose three different design theories that emerged over time, each considered to be a milestone in the evolution of the field of design science. The time line spans from the mid 1800s to the mid 1900s. The three theories, *ratio theory, systems design theory*, and Bauhaus design theory, were each examined in relation to different product development processes and outcomes: (1) ratio theory and the development of algorithmic thinking as it applied to construction of water wheels; (2) systems design and the creation of formalized product management organization and research and development departments (R&D) as applied to automobile companies, pharmaceutical companies, and electronic manufacturing;

(3) Bauhaus design and the cultivation of creativity as subject matter in industrial design, formalizing activities that institutionalized "a form of mutually addressed collective creativity" (2011a, p. 231) in the product development enterprise.

In quick summation, Masson and colleagues noted that each successive design theory incorporated a greater number of creativity issues and variables, and these issues were drivers of innovation. Additionally, they perceived "fixation effects" or perseverative behaviors and practices which were creative impediments. In turn, these fixations spawned new design theories and models of thought to overcome them. Fixation effects can be mechanical or material in nature, related to managing knowledge, or organizational processes according to the authors. A closer look at all of the case studies will allow us to return to our subject of current online curriculum production methods with a heightened sense of awareness about the creative and administrative forces impinging upon and "fixing" the status quo.

The Method of Ratios

In the first case, **the method of ratios** was studied. As design theory, the ratio method emerged as an innovative solution to a fixation on the replication of existing objects (water wheels) with little variation. The originator of the method was an accomplished engineer and instructor in Germany's Technishe Hochschule in Karlsruhe named Redtenbacher. Professor Redtenbacher devised a series of diagrams and a decision-point script that technical builders of water wheels would review prior to meeting with a potential client and surveying the features of the landscape (Redtenbacher, 1858). The script addressed four key variables: the client's budget, the choice of a metal or wooden wheel, the height and water fall flow, and useable flow. These determining features, in turn, specified which of Redtenbacher's diagrams to employ for further guidance. Redtenbacher's diagrams provided step-by-step directions on construction of all the parts needed to complete the customized water wheel. These plans were dimensionless, but showed the ratios between all the parts. According to the rubric developed by Le Masson and colleagues (2011a), the three tensions that shaped the ratio method were:

Knowledge

- The ratio method provided models of existing objects and guidance as to how to use and extend expert knowledge and adapt it to many different contexts.

Convergence vs. Divergence

- The ratio method ensured convergence towards one acceptable solution, but it also prevented the builder from converging too quickly on a design.

- Redtenbacher's script identified precisely the moment in the design process when it was possible and fruitful to diverge the construction process and the type of investigation that was relevant.

Product Management & Organization

- The ratio method defines specific forms of dividing work; the script distinguishes between two roles in the design process—the expert rule maker (Redtenbacher) who designs rules, and the builder who is the rule user.
- The rule maker exerts leadership by extending his knowledge and defining areas of freedom to be delegated to the rule-user, and the builder exercises creativity in the execution of the plan.

Systems Design Theory

In the second case, **systems design (SD)** was studied. Systems design emerged in the 1920s and 1930s as "a method that reopens spaces for creativity, pushing designers NOT to re-use existing knowledge but to explore new knowledge...in a rigorous efficient way" (2011a, p. 225). As assembly line production facilities sprang into existence in the 20th century for automobiles, pharmaceuticals, and electronic devices, product management and development procedures began to rigidify. This gave rise to a form of design fixation in which "designers tended to re-use outdated and obsolete design rules, or fix upon existing rules and machine elements" (p. 224). Systems design reasoning was devised to front run the product development manufacturing process by introducing robust knowledge exploration, knowledge acquisition, and absorption phases prior to the finalization of specs for production purposes. Design exercises were incorporated into the workplace for teams of designers which included: a) cataloging all possible solutions to a design problem prior to penning prototypes, b) a design materials exploration phase, c) an added phase for descriptions of functional linkages between sub elements where testing and error analysis was conducted in recursive fashion, d) lastly, descriptive prototypes were created which became the basis of final product making. According to Le Masson and colleagues, the three tensions that shaped systems design were:

Knowledge

- SD aims to fight the fixation caused by existing design rules—it recommends when rules should be used and devised supports for the creation of new knowledge for expansion at the right time.

Convergence vs. Divergence

- SD organizes convergence by predefining the order in which known objects should be described and defined. The hierarchy of steps maintains divergence in the process.

Production Management & Organization

- SD enables an increasing level of complexity in the engineering of projects. It also facilitated the systematic design of subunits that ensured their integration by recursive testing and analysis loops prior to finalization of a prototype.

Bauhaus Design

In the third and last case study, the authors looked at Bauhaus design methods. Bauhaus, as a set of design principles, was derived from the curriculum of Walter Gropius and his school for artists and designers in Germany in 1919. Le Masson and colleagues characterized Gropius' mission this way: "[the school] aimed to serve the modern development of housing from the simplest appliance to the whole dwelling" (p. 227). Paul Klee, Wassily Kandinsky, and Joseph Itten were all faculty members who were instrumental in developing program courses. What distinguishes the Bauhaus from other design theories and methods of its time is its emphasis on the cultivation of imagination and creativity as skills and sensibilities that can be strengthened as opposed to inherent gifts. Class exercises challenged students' perceptions of the world, their biases, and instinctual associations between form, function and aesthetics. Le Masson and colleagues describe Itten's vision of the process as "developing a theory of contrasts [which] aim to open new creative worlds to students not only in the sense of providing new means of expression but also of improving perceptions" (p. 228). The fixation that the Bauhaus method resolved is one of fixed associations and attributes of things, which artists and designers absorb unconsciously. These associations include: form with color, form with specific materials, textures, in short "clichéd" design practices that become an obstacle to original ideation. The Bauhaus program was highly structured and systematic in its approach, cultivating teams of designers in a group process that strengthened their ability to critique and support one another. Students were first introduced to sensory exercises: they studied old masters to learn rules of composition; then drew from memory and feeling instead of training their eye for faithful reproduction of objects; they engaged in tactical exercises to sharpen observations and sense of touch. After this series of experiences, students were afforded more self-directed research and finally art production. The end product was, by design, art/object making inspired from the inside-out—creativity that was not based on imitation but personal interpretation, infusing products with artistic uniqueness. Ultimately, the Bauhaus approach to design impacted many different products including furniture, building design, typography, and consumer goods. According to Le Masson and colleagues, the three tensions that shaped Bauhaus design were:

Knowledge

- The Bauhaus devised a method for designing new textures and household goods based on overcoming the clichés and limitations of fixed associations to promote creative expansion.

Convergence vs. Divergence

- Bauhaus methods encouraged a multi-layered approach to exploration of materials that converges with the final product.

Production Management & Organization

- Bauhaus method focuses on the development of cohorts of students who learned to compare and contrast their work, to develop their creative powers.
- Bauhaus methods combined art and technique in a novel way, by cultivating imagination first before product design, and was characterized by strong leadership.

Historical Analysis and Its Application to Online Curriculum Design

The historical approach is useful for many reasons. It allows us to: learn from the past, look more closely at the intricacies and complexities of the design process as an evolving problem-solving activity, gives us a context for examining our current design problem as a whole gestalt, and provides us with a better understanding of why we are where we are today. The key findings of Le Masson and colleagues relate to dialectical tensions spurring change, and were identified as; (a) opportunities for new knowledge integration, (b) when convergence vs. divergence is needed in regard to increasing opportunities for creative influence, and (c) how the product development process is managed.

Using this rubric to evaluate the current status of online K-12 education curriculum and the four-step design process, we define the systemic creative challenges to higher production values as:

> *A solution to enable designers to integrate and use new knowledge about a variety of learning styles at the right moment in the curriculum development process*

How should new knowledge be shared and distributed throughout the organization? Decisions about new knowledge required in course production follow from making a commitment to a particular population of students, getting to know the needs of those students very well, which in turn informs choice of pedagogical strategies for curriculum development.

> *A solution to prevent designers from continuing to reuse obsolete design rules*

The current rules for curriculum design are replicating content in such a way as to represent a previous media—books—and thereby replicate a "one-size-fits-all" approach to course development. This fixation is rooted in institutional and bureaucratic structures (publishing companies and school systems) which are over a century old with deeply ingrained organizational methods. The four-step process lacks structured divergent exploratory phases on two important dimensions in the production process: learner modeling (what are online companies learning about their students that can be fed back into the curriculum design process), and exploration of technology's unique characteristics for fostering collaboration and engaging learners.

> *A solution to enhance and refresh representations of students which change the definition of student engagement, creating a richer portrait of the learner*

The core knowledge deficit and creative challenge in regard to upgrading the curriculum development process, as we see it, is an in-depth understanding of the learner. This requires building more comprehensive design descriptions of student behaviors. One way to begin this process with design teams is by creating dialogue and asking questions. For example, how would instructional designers incorporate additional student feedback in the learning platform that included:

- informal knowledge students bring to their studies
- students' degree of understanding of the material presented through a choreographed line of questioning
- emotional tone and attitude the student brings to the activity
- students' ability to engage with the technology and learning platform that is being presented

Organizational Management

In the K-12 world, one course will never be designed to work for all potential learners; the diversity of student needs in public school systems is simply too broad. This is the sticky wicket that public K-12 education has as its mandate, nevertheless. In regard to management style, Le Masson and colleagues might suggest what is needed to succeed in the marketplace is strong executive leadership with subject matter expertise in learning science, and a management team that can set priorities flexibly and define a student and product focus within an organization.

In practice, entrepreneurial companies tend to have a linear style of managing the product development enterprise, and more often than not, have no research and development departments to advise them. The marketplace drives course development—what potential clients want and need is the primary impetus for new course creation. Timing is also an important factor, which means that there is no room for reflection upon the template for course development if you need to be first to market. These are the stark realities and financial constraints shaping the design of curriculum materials for entrepreneurs. On the other hand, many of the larger corporate and institutional players in the marketplace with R&D departments and bigger budgets have not overcome bureaucratic structures and rules locking them into the four-step design model, and consequently do not innovate.

Good Design for Struggling Learners

The Bauhaus design method is a superb model for good online curriculum for struggling learners. Here, we are bypassing Le Masson and colleagues' contextual presentation of the Bauhaus method as a management production process, and discussing the method as it applies to the design of education software. The notion that creative exploration and skill building need to precede problem solving and concept evaluations for K-12 students has been a feature of many project-based software programs for a long time, beginning with Seymour Papert's Logo (Papert, 1980; CTG at Vanderbilt, 1992; Schank & Cleary, 1995; Barron & Darling-Hammond, 2008). This method of structuring curriculum allows for formative assessments of student skills and the front-loading of remedial instruction, sparing many struggling students from the odor of defeat and failure that testing imposes upon them as a screening device versus an evaluation of understanding. The Bauhaus approach can also provide struggling learners with an opportunity to review and absorb academic material many different ways so that comprehension can occur. Our present-day exemplar of design of this caliber is the work of the Concord Consortium.[1] Their open source web-based software materials are focused on science and mathematics, are built by experts, and are free to students and teachers. Now the proviso: we have to acknowledge that the expense of creating Concord Consortium programs and the costs associated with supporting its software platform are considerable, and may be beyond the reach of many entrepreneurs entering the marketplace of online education. The good news is that it's already available.

As Le Masson and colleagues' analysis of the Ratio Method demonstrates, the level of support for transferring expert knowledge to a broader audience is central to its being scalable and this seems to be another issue at hand. If we look at our stated problem a little differently by taking into account the availability of well-designed software that is free to be used by anyone or any organization, then a solution to improving online curriculum quality for struggling learners is readily at hand. Online education companies might consider creating a new management function in the form of a *modern master builder* who is a pedagogical expert, who can discriminately supplement traditional base-line curriculum with exploratory, skill-building games, and software projects that are free in the media membrane. This is cost efficient, and an immediately actionable means of upgrading product offerings with the added benefit of spurring internal comparative analysis.

The Role of the Regional Accreditation Boards in Improving Online Education Products

There are external pressures on online education providers, large and small, to take stock of their design methods and instill more circular and recursive production processes. The most influential are US regional and accreditation bodies. Many online education companies are choosing to become accredited with national review boards that have opened candidacy to virtual education providers. They include: the North Central Association Commission on Accreditation and School Improvement (NCA CASI), Southern Association of Colleges and Schools Council on Accreditation and School Improvement (SACS CASI), and Northwest Accreditation Commission (NWAC), Western Association of Schools and Colleges (WASC), and New England Association of Schools and Colleges (NEASC). E-learning companies are signing on because of financial incentives which accrue upon being successfully accredited, along with the requirement that they do so by US state level Departments of Education in order to obtain contracts to provide supplemental and full online course programs to students. At this date, there are 46 states that provide supplemental online education to K-12 public schools, the majority of which are high school courses, and 28 states that provide full-time online curriculum to a much smaller number of schools serving mainly high school students. Once an online provider decides that it will embark on the accreditation process, it performs a "self-study" analysis. This review is guided by the accrediting agency and includes a thorough examination of the organization's programs and courses, teaching and tutoring faculty, facilities and resources. Preparation for a first official review may take a full year, depending upon the readiness level reported by preliminary survey assessments and the types of remediation structures an online provider chooses to put in place before being evaluated.

The type of data collection processes that online education companies are asked to adopt in the accreditation review includes closing the loop on perceptions of curriculum quality among all stakeholders. Surveys weigh student, parent, and teacher feedback equally with that of the organization's administration. Above all, it is the accrediting bodies' mandate to implement a variety of benchmarks that chart a course of continuous qualitative improvements across all aspects of the education provider's company that has impacted the e-learning marketplace significantly (including: administration, teacher professional development, curriculum quality). Benchmarks require data points that don't currently exist for many online providers, which prompt considerable internal re-organization. The collective wisdom of accrediting agencies is that they are imposing circular evaluation processes, devoid of content or explicit management directives, to create organizational improvements. Benchmark indicators of success are self-defined by accreditation candidates, encouraging integration of "continuous improvement" goals and objectives with company/organization core mission, values, and strategic plans. The accreditation process also requires the full participation of company staff in the evaluation review, which has changed the character of organizational development and caliber of professional development activities.

Bringing the discussion back to changing the prevalent digital curriculum design culture, we can see that signing onto the accreditation review process will disrupt the four-step method and accelerate the expansion of new phases of design and creativity challenges by: (a) encouraging the integration of feedback from students, parents, and other stakeholders with curriculum improvements, providing a richer portrait of students and student needs, (b) encouraging the use of data and feedback from students, parents, and other stakeholders in developing professional development activities across the organization which are specifically tied to perceived deficits.

Conclusion

We began with the observation that virtual education and e-learning platforms, by and large, seem to be replicating 20th century methods of education in digital formats. Le Masson, Hatchuel, and Weil provide us with a deeper understanding of what this means, and how the procedural and perceptual shifts in our use of technology bring new creativity issues into focus. Moreover, the authors' historical analysis reveals the complexity of design evolution, and the interplay of factors involved in repetitive production models that have outlived their usefulness. We used this work to help clarify the creative challenges and tensions "fixing" uses of technology in curriculum development for online education. The obstacles to change in e-learning design are a confluence of factors and tensions that are characteristic of our historical moment.

What would also be helpful is a kind of "truth-in-labeling" criteria in the pedagogical approach used by e-learning courses which is described and categorized in such a way that it becomes visible to the clients (school systems, teachers, parents, and administrators) whether a course is actually designed to address the target population it claims to serve. We suggest that online education providers: (a) examine their model of the learner and the learner's experience for depth and complexity in regard to their pedagogical goals; (b) raise questions with their design teams as to whether they are incorporating a sufficient number of design phases and variables to accommodate multiple learning styles, and to address the populations that they purport to serve; (c) urge management to incorporate these issues and questions into plans for continuous improvement, and organizational evaluation of effectiveness; (d) integrate the use of well-designed, high-quality project-based software materials that are freely available online. We also acknowledged the important role US regional accreditation bodies are playing in accelerating change in design methods used by online education companies.

Note

1. Please see Concord.org

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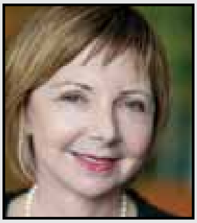

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LINK TO:

http://steinhardt.nyu.edu/faculty_bios/view/Ricki_Goldman

http://www.pointsofviewing.com

Getting Intelligence Into the Minds of People

Robert W. Lawler

ABSTRACT

In conversation, Seymour Papert once asked me, "What's the point of studying Artificial Intelligence if not to get intelligence into the minds of people?" His question inspires my juxtaposition of explorations of Natural Learning and Constructed Personal Knowledge. Since "you can't learn about learning without learning about learning something,"[1] the analyses will proceed with two examples. The first, focused on strategy learning at tic-tac-toe, concludes that learning depends on specific relationships among the elements of the context in interaction with processes of incremental cognitive change. The second analysis, focused on mastering a solution for Rubik's Cube, argues the importance of reformulation of representations as a strategy for learning in more complex situations, and that the integration of multiple modalities of representation can be a key to "getting the intelligence into the minds of people."

Introduction

In *Sciences of the Artificial*, Herbert Simon (1969) introduced his discussion of "The Psychology of Thinking" with a novel perspective on agent-context interaction:

> We watch an ant make his laborious way across a wind- and wave-molded beach. He moves ahead, angles to the right to ease his climb up a steep dunelet, detours around a pebble.... Thus he makes his weaving, halting way back to his home.... Viewed as a geometric figure, the ant's path is irregular, complex, hard to describe. But its complexity is really a complexity in the surface of the beach, not a complexity in the ant.... An ant, viewed as a behaving system, is quite simple. The apparent complexity of its behavior

> over time is largely a reflection of the complexity of the environment in which it finds itself.... (p. 63)

Simon concludes that his aim was exploring a similar vision of behavior, but with "human being" substituted for "ant." Over many years he pursued that aim, especially with his collaborator Alan Newell. In a broad and detailed case study of my first daughter's learning, I captured a complete history of her play at tic-tac-toe. Although simpler than chess and various puzzles that Newell and Simon (1972) explored,[2] tic-tac-toe touched upon some of the same issues that were grand themes in the early days of Artificial Intelligence research, such as representing knowledge, strategic play, and interactions of thinking and environment. With further inspiration from psychological observations and the epistemological focus of Piaget, and from the data-orientated ecological psychologists, Barker and Wright (1971), I was able to exploit my case study material for the computational generation of paths of learning. Together, these enable a new idea of what makes discovery-learning possible and memorable (computer modeling turns this verbal "idea" into a worked example, with process detail).

Natural Learning

Many people believed, years ago, that computer modeling of student knowledge would enable the development of computer tutors sufficiently intelligent that they could replace poor or non-existent teachers.[3] That engineering effort has largely succeeded and been absorbed into the technologies of our day. The scientific frontier of Artificial Intelligence, in the Minsky paradigm,[4] focused on how knowledge could function (intelligence) and change (learn) through failures and repairs in articulated (specified and organized) knowledge structures.

What was most wonderful in my human case study[5] is seeing how learning can occur through serendipitous successes—events at least as important as failures—because such learning exemplifies learning through side effects, which may be more common for people than learning through the analysis of process failures, as in debugging. If recall of surprising successes can be reformulated as a new plan for future action, the process can be a prototype for Natural Learning, processes by which we all learn a bit more than we knew before about the business of everyday life; in Artificial Intelligence (AI), such knowledge is called "common sense." Exhibiting such processes in extensive detail was the agenda of the project in which SLIM

(**S**trategy **L**earner: **I**nteractive **M**odel) was developed.[6] Our effort was to use information from the child learning case study for guiding our knowledge representation, for following the development of strategies, and for examining the interplay of such development and the possibilities for learning based on specific experiences of play. The final focus was on the question of what it was that made learning possible at all, given limited initial knowledge and weak learning mechanisms.

Learning Landmarks in the Human Case: (1)

At the start of the study, Miriam played solely in a tactical way. Her moves were focused on selection of cells by preference for the center cell if available, then any corner, with side cells moves as a last resort. Although she knew forming forks was desirable (we called that "getting two ways to win"), she did not show any notion of how to achieve a fork. This changed after one specific incident:

> I visited the Boston Children's Museum with Miriam, Robby, and his friend John. One single incident made a tremendous impression on Miriam and markedly influenced all her subsequent play. John and Miriam both played tic-tac-toe against the Museum's computer. When they fell in the pitfall of a side response to the computer's invariable middle opening, they were regularly defeated. The computer - which could be accurately described as playing with the Newell and Simon rules, always responded in the corner to their middle openings, so the children's best game was no better than a draw. Eventually Robby got a turn (the others peering over his shoulder) and opened with a corner move. The game unfolded... and Robby won. John and Miriam were astounded. Robby clearly owned some powerful knowledge. Since he was glad to share that knowledge with them, that one three-corner fork entered Miriam's repertoire and exerted a dominant influence in the development of her play. Tic-tac-toe became a game of frequent choice as The Intimate Study began.... This particular form of the game is my archetypical example of strategic play, quintessentially a game length plan for the single player -- as contrasted with the single cell move preferences, either choices or responses, of tactical play...[7]

Miriam now had a pattern-oriented goal but no plan to achieve that pattern. Play with Rob degenerated to negotiation (taking turns at winning), complaining (when blocked), and cheating (to circumvent blocks). I stopped their play against each other and became Miriam's primary opponent. Her play was "egocentric," in the sense of being focused on her goal, not because she was insensitive to her opponent's possible moves, but because she did not comprehend and had no way to deal with the opponent.

Learning Landmarks in the Human Case: (2)

The second major advance was the beginning of mental play. This grew out of a practice we called "Turning the tables," thus: When we played and Miriam lost a game, I urged her to replay the same game with our roles reversed, i.e., we would replicate a game, move for move, which she would win in the replay because she was playing as the opponent to whom she had lost. Mental play began this way

> At one point, I was called away from play by our doorbell and asked the two children not to play any games until I returned.... Coming back, I found Miriam had been playing tic-tac-toe against herself, in her words, "making smart moves for me and the other guy."

Her multi-role play worked by setting herself the strategic goal and assigning tactical play to "the other guy." This split was eventually the foundation for the next landmark.

Learning Landmarks in the Human Case: (3)

At the end of the study, Miriam invented a strategy different from a variation of her archetypical three-corners fork.

> Reviewing her play of the intervening years, Miriam stated that she played rarely and mostly against herself (30 games in two years was her estimate). As I introduced my objective, Miriam proposed one of her own: to apply a newly discovered strategy against me. When I asked her to discuss it with me, she responded, "No way! Then whenever I play you'll know my tactics."

Miriam's new strategy, the Middle and Corners Fork, is nonetheless clear from her play on the game and ... in a final comment on the discovery of this new strategy, Miriam added that she had stopped the game and only days later noticed the fork created with her third move. (This is verified by the appearance of the original game: the first six markers were made in brown crayon and the last winning move in ball pen ink.)

Conclusions for Modeling

In relating case study details to computing models, one might use those details much as one uses boundary conditions to specify the particular form of a general solution to a differential equation. So we use the psychological study here, as a foundation for the representations used in the models, and as justification for focusing on key issues: the centrality of *egocentricity* in cognitive self-construction and the *particularity* of the naive agent's knowledge.

What I drew for representation from these naturalistic observations was:

1. a decision to represent separately a goal as a pattern, and a plan as a list
2. a willingness to see new learning as recognition of a new strategy, after the fact, by reflection on the player's own actions.
3. a recognition that mental play is necessary for analysis because simulation of "the other guy" implies the player can understand the opponent's reasons for action, as compared to some "mysterious and incomprehensible other" with whom one can cope only by social interactions or wishful thinking.

With respect to focusing on the development of a strategy, I review here the one simplest strategy to invent, to exhibit the interaction of knowledge with opportunities within the intellectual "landscape." With respect to better grasping that "landscape" of learning in this mental environment, we used a computer-embodied model to generate the suite of all games that could be played from a single opening move, then to examine those games in which the opening player experienced an unplanned win. By cataloging the sets of games which could be won without a plan, based upon a given known plan in the model's repertoire, we construct genetic pathways of plan descent.

Using Simulations to Track Paths of Learning

Learning Through Interaction

One virtue of machine learning studies is that they allow us no "miracles." They can completely and unambiguously cover some examples of learning with mechanisms simple enough to be comprehensible. Further, the computer's aid in systematically generating sets of all possible conditions helps liberate our view of what possible experiences might serve as paths of learning. When we do generate all possible interactions through which learning might occur, we can more thoroughly explore alternate paths and the suite of relationships among elements of the ensemble.

Strategies for achieving specific forks are the knowledge structures of SLIM (**S**trategy **L**earner, **I**nteractive **M**odel). Each has three parts: a Goal, a sequence of Actions, and a set of Constraints on those actions (each triple is thereby a GAC). We simulated operation of such structures in a program where SLIM plays tic-tac-toe against variations of REO (a programmed **R**easonably **E**xpert **O**pponent). REO is "expert" in the sense of applying uniformly a set of cell preference rules for tactical play.[8]) Applying these strategies leads to moves that often result in winning or losing; that leads to the creation of new structures, by specific modifications of the current GACs. The modifications are controlled by a small set of rules, so that GACs are interrelated by the ways modifications can map from one to another.[9]

To evaluate specific learning mechanisms in particular cases, one must examine and specify which forks are learned from which predecessors in which sequence and under which conditions of opponent cell preferences. The simulation avoided abstraction, in order to explore learning based on the modification of fully explicit strategies learned through particular experiences.[10] The results are *first*, a catalog of specific experiences through which learning occurs within this system and *second*, a description of networks of descent of specific strategies from one another. The catalog permits a specification of two desired results: first, which new forks may be learned when some predecessor is known; and second, which specific interaction gives rise to each fork learned. The results obviously also depend on the specific learning algorithm used by SLIM.

Consider how SLIM can learn the symmetrical variation to one particular fork (refer to the cell, plan, and game representations in Figure 1, below). Suppose that SLIM begins with the objective of developing a fork represented by the Goal pattern in the set {1 3 9} and will proceed with letter moves in the sequenced plan [1 9 3] (as in Figure 1). SLIM moves first to cell 1. REO (numbers) prefers the center cell (5), and moves there. SLIM moves in cell 9, according to plan. When REO's second move is to cell 3, SLIM's plan is blocked. The strategic goal {1 3 9} is given over—but the game is not ended. SLIM, now playing tactically with the same set of rules as REO, moves into cell 7, the corner cell remaining. Unknowingly, SLIM has created a fork symmetrical to its fork-goal. SLIM cannot recognize the fork. It has not the knowledge or information to do so. What happens? REO blocks one of SLIM's two ways to win, choosing cell 4. SLIM, playing tactically, recognizes it can win and moves in cell 8. *This is the key juncture.*

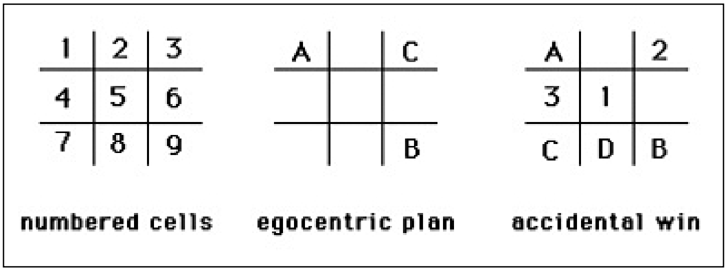

Fig. 1: Cell, plan, and game representations

SLIM is programmed to recognize "winning without expecting to do so" as a special circumstance. Even more, SLIM assumes that it won through creating an unrecognized fork (otherwise REO would have blocked the win). SLIM takes the set of its first three moves as a pattern for a fork. That pattern {1 7 9} is made the goal of a new GAC. SLIM examines its known plans for creating a fork (there is one, [1 9 3]) with the list of its own moves, executed in sequence before the winning move was made [1 9 7]. The terminal step of the plan is the only difference between the two. SLIM modifies the prototype plan terminal step to create a new plan, [1 9 7]. SLIM now has two GACs, two forking strategies, for future play.[11]

The complete set of results involves consideration of all paths of possible learning, even those deemed unlikely a priori, and concludes with the complete specification of all possible paths of learning every fork given any fork prototype. For corner opening play, the first six GACs form a central collection of strategies. Their interrelations can be represented as trees of derivation or descent (as shown in Figure 2).

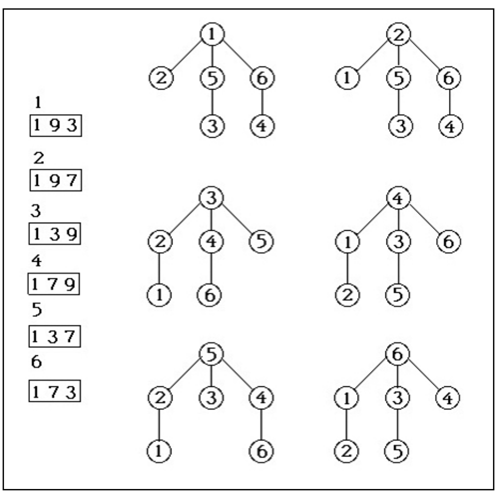

Fig. 2: Plans learnable from the plan specified as the top node of the descent trees

The tree with strategy three as top node (beginning with only GAC 3 known) may be taken as typical. Play in five specific games generates the other five central GACs, i.e., five central strategies. The specialness of the six central nodes is a consequence of their co-generatability. Some of those are directly generatable, can generate each other (such as GACs 1 and 2); they are *reciprocally* generatable. Some lead to each other through intermediaries (such as GAC 1 and 3); they are *cyclically* generatable. For these six central strategies, the trees of structure descent can fold together into a connected network of descent whose relations of co-generativity are shown in Figure 3.

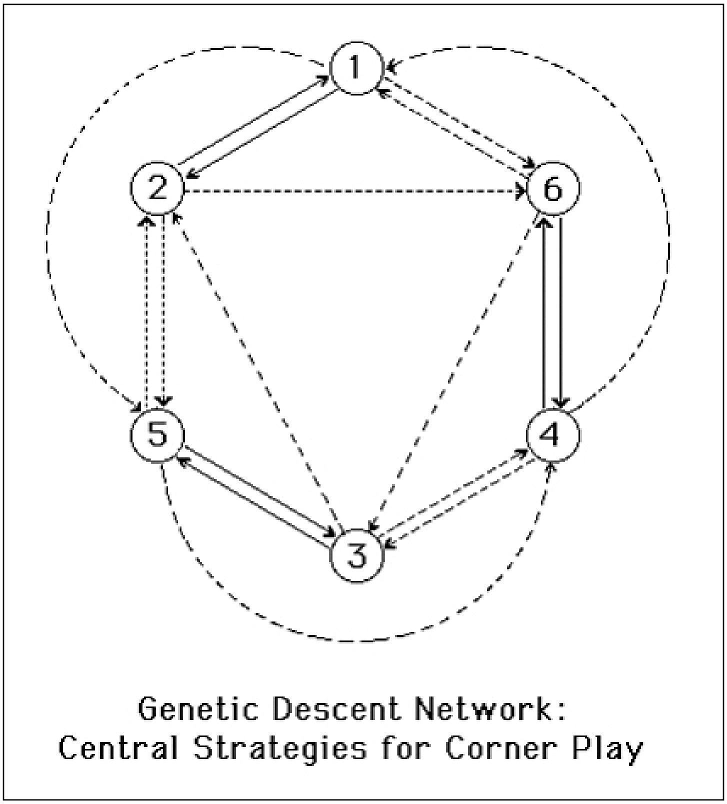

Fig. 3: Genetic descent network: Central strategies for corner play

The form of these descent networks is related to symmetry among forking patterns. But they include more: they reflect the play of the opponent, the order in which the forks are learned, and the specific learning mechanisms permitted in the simulations. These descent networks are summaries of results.

Reflective Summary

Working with SLIM started with the general principle that learning happens through interaction. The model was constructed to represent the behavior of both the learner and the opponent in explicit detail with specification of representations and learning algorithms giving the notion a precise meaning. Through focusing on particular detail, we are exploring how knowledge can be extended by specific changes without abstract generalization. The question is of general interest if one admits that particularity and egocentricity are common characteristics of novice thought.

In analyzing the possibilities for learning, the basic principle applied is to try all cases and construct an interpretation of them. There are many paths of possible learning, some central and some peripheral. In SLIM, the criterion of centrality is co-generativity. We first aggregate results of all possibilities in a fully explicit manner. SLIM highlights co-generativity, represented by those connections in the central group (strategies 1-6) permitting each one to be learned no matter which is adopted as the prototype fork. Peripheral strategies[12] are rarely learned because they can be learned in few ways. The aggregation of trees is systematic and constructive though not formal: one pulls together the empirical results of exhaustive exploration (trees of descent in Figure 2) into a new representation scheme (the genetic networks of descent in Figure 3).

Through the aggregation and reformulation of results, a new generality was achieved which suggested an idea, call it a "learnability principle," that co-generatability of related but variant knowledge forms is what makes learning possible in any domain. This principle would support knowledge stability in minds with reconstructive memories, such as Bartlett (1932) suggests humans have. This idea—identifying the learnability of a domain with its connectedness—is a direct consequence of the knowledge state transformations being the learning algorithms of the system. One may paraphrase the situation thus: "you'll learn where Rome is, if all roads lead there."

In tic-tac-toe, we have focused on a two dimensional puzzle, size 3x3. At first glance, Rubik's Cube is similar, as a 3x3x3 puzzle. But further dimensions are relevant. Color enters consideration as well as constraints implicit in the interior mechanism. Let's look at the situation generally before plunging into puzzle solution.

Constructed Personal Knowledge: Mastering a Solution to Rubik's Cube

Over 350 million Rubik's Cubes have been sold worldwide. When a cube is "solved," each of the six faces has a single color. There is one such state. There are many more unsolved states.[13] There are different methods for solving this puzzle; typically one solution is provided as a guide when a puzzle is purchased, e.g., a "7 Step Solution Guide." Many people take up this puzzle to prove they are "smart."[14] Often these cubes remain disordered and are set aside, and the confident problem-solvers are defeated. Rubik's Cube remains an opportunity for a personal learning experience and more, an example of activities involved in learning to solve, to understand, and to remember a puzzle solution that many find too difficult.

The Challenge Rubik's Cube Presents

Rubik's 3x3x3 cube first appears to be an assembly of 27 different little cubes (call them "cubies") linked together internally. The mechanism takes up the central cubie and the six face-center cubies. These seven never move (except by cube rotation). Thus there are 20 moveable pieces, i.e., 12 edge cubies and 8 corner cubies.

What makes the puzzle engaging

As purchased, the cube comes in its solved state. This proves it *can* be solved. The cube can be held in your hand; it is even sold with a solution booklet. Everything about it is familiar, except the mechanism inside. Clever people conclude, "I can do this."

What makes the puzzle hard

Multiple modalities: *recognizing visual patterns is essential* to solving the cube; *planning* requires foreseeing how sequences of moves change multi-facial patterns.

Sameness of views: it is easy to get lost in regards to orientation.

Sameness of operations: it is easy to lose track of "where you are" in move sequences.

Interactions: changing the state of any face, edge, or cubie ALWAYS impacts others.

Progress requires re-balancing focus from "placing" cubies to protecting those in place.

Plans are hard to remember: mid-solution sequences typically involve 6-8 steps; backing out is hard; if confused, you need return to a state where you can restart.

Apparent disorder can mask closeness of the solution.

Becoming Competent at Solving Rubik's Cube

Most of us are not going to invent our own solution. In this analysis, we will adopt the solution provided at purchase in the booklet, "7 Step Solution Guide." Our goal is an exercise in understanding *that* solution with sufficient recall of the details so one can apply it flexibly without any external support.

The "Solution" booklet specifies one common way people refer to the faces of the cube [front, back; right, left, upper, down] and names the operations on the faces. For example: "F" means rotate the front face one quarter turn in a clockwise direction; "Ui" means rotate the upper face one quarter turn in a counter clockwise direction. An "algorithm" can be expressed as a list of operations, thus: [U R Ui Ri Ui Fi U F]. There is no way I can remember such a list of actions and execute each operation without making errors. I need to develop some other way of thinking that I can understand, remember, and execute without errors. These notes on my ways of thinking may suggest how you can create a way of thinking you can remember.

A Common Strategy for Approaching Such a Problem

Determine what does not change, what changes, how changes can be undone, and how the problem can be broken into parts. Since the 6 face-center cubies never change places, they serve as reference points. The 12 edge-center cubies can appear in any of 12 locations, with 2 orientations; there are 8 places for corner-cubies and 3 orientations.

A single twist of any face can be undone by the inverse twist, e.g., Fi negates F. For a sequence, the order must be reversed while replacing each operation with its inverse, e.g., [Ri Ui] negates [U R]. Negation quickly gets tricky for longer sequences of twists. Additionally, after any single twist of a face, the prior state of the cube can be restored by completing a cycle of restoration, e.g., the state prior to move [U], can be restored by repeating the twist [U] three times more [U U U]. With sequences of twists, restoration by repetition becomes impractical very quickly.

Can the problem be broken into manageable sub-problems? That depends on what you can manage. It asks, "What can you recognize and remember?" The "7 Step Guide" is confusing. Manageable, for me, demands some measure of progress, "achieved goals" that can be remembered. And it is very helpful to be able to characterize "manageable" sub-problems. I see the Rubik's cube solution in 3 initiatives:
Solve the bottom layer: this is the easy problem. (Steps 1 and 2)
Solve the middle layer: this is the tricky problem. (Step 3)
Solve the top layer: this is the challenging problem. (Steps 4-7)

Part I: Solving the Bottom Layer

The booklet's first goal: solve the green cross.[15] This is easy since you don't have to think about cubies that do not have a green side. Turn the cube so the green center cubie is on the upper face. Find any edge-cubie with a green face. Rotate that face so the green face of the edge-cubie is next to the green center-cubie. Rotate the top (green-centered) face so that the edge-cubie's second face is next to the center-cubie of the same color. Good start, you have the first edge-cubie in its place!

Next, put a second green edge-cubie in the "same" relation to the green center-cubie and its other face color center-cubie—without permanently moving the first edge-cubie away from its matching side face. Get all four green-edge cubies in place. You can do it by trial and error, for the second, third, and fourth "green-and-X" edge cubies. (This will take a while, but it's easy and it's good familiarization and practice.)

Fixing orientation problems: it often happens that some of these cubies are oriented so the green color of the cubie is on the "wrong face" (the one adjacent to its second color center-cubie). The booklet presents a 4-move procedure to flip this cubie to the goal orientation; [Ri U Fi Ui], where the lower case "i" means: "for this move, rotate the specific face counter-clockwise." To explicitly specify the rotation-sense of moves, we represent a clockwise twist with a "+" sign, and counter-clockwise twists with a "-". Thus: [Ri U Fi Ui] -> [R- U+ F- U-]. "How to view the cube" is important too.

See: 3 faces visible, green on top; edge-cubie flip-target on right face.

Do: procedure: [R- U+ F- U-]; after, verify the target cubie's orientation.

Review: why does this work? *You* have to be able to answer for yourself. I find it helpful to reverse the procedure by [U+ F+ U- R+], thus restoring the prior state, then to step through the procedure again, carefully watching the target cubie to see how each move affects its orientation and relation to the other cubies.

With the first five cubies in place, if we can do the four corners, we'll have a direct solution for the bottom layer! How to do it? One cubie at a time.

Reflection: notice that we have modified the representation of the operations performed on the faces of the cube. This is done to explicitly specify an aspect (sense of turning) of the operation. This is important because it brings into concrete specification an element of the operation that otherwise would be "assumed as a default," i.e., remembered.

The greencross, step one's now "achieved goal," marks a significant change. One must begin to think about changes using procedures that do not relocate other cubies already in their target positions. With the green face on top, the booklet proposes locating a cubie in the current bottom then rotating that bottom layer until that cubie is directly under *the place it must go*; call that the cubie's home position. The goal is to get the four green corner-cubies home. The booklet proposes [R- D- R+ D+]. This rotates the corner-cubie's home position into the face opposite the green face and twists that opposite layer to insert the target cubie into the "home" position, then restores the home position to the green face. The booklet directs execution of this procedure 1, 3, or 5 times. Why is this number variable? It's *neither obvious* to a novice *nor explained*.

The number of execution required depends on the original orientation of the target cubie when under the home position. There are three possibilities:

See: 3 faces visible, green on top; the target cubie under its home.

> if its green color is on the front face, then do variation 1 [D- R- D+ R+]

> if its green color is on the right face, then do variation 2 [D+ F+ D- F-]

> if target-cubie's green color is the bottom face, Do setup procedure [R- D- D- R+ D+]; it puts the green color on the right face, under its home. Then do procedure variation 2 [D+ F+ D- F-].

Review: why does this work? The symmetrical variations are "the same" in the general sense of bringing the home position to the bottom layer where a different cubie can be inserted into the target edge. When the target-cubie's green color is on the bottom, the setup procedure changes its position to the right face where variation 2 is used.

There is an issue here which some would see as one of *principle*, i.e., is it better to represent knowledge by a uniform procedure which is harder to understand or is it better to represent knowledge by multiple alternatives which may be easier to learn and remember? I see the issue as one of *choice*, yours, which depends on your personal style and established ways of thinking. Do you understand why these procedures work? ... Yes? Congratulations then, you have mastered the first layer of Rubik's Cube!

Part II: Solving the Middle Layer

When you turn the cube, setting it down on the green face, you will see that the middle layer is already "half-solved," because all the face-center cubies are where they belong (they always are). What's tricky in the middle layer is inserting four edge-cubies in their own home positions, with the proper orientation. Of course, this must be done *without changing any cubies in the bottom layer*, except temporarily.

The typical situation is that an edge-cubie belonging in the middle layer can be placed over a color matching face-center cubie. Assuming the cube is oriented so that the home for the target cubie is on the vertical forward edge, it must be true that the "unmatched" face of the edge cubie is either on the current right face or the current front face. These symmetrical states require solution by symmetrical procedures. Look for any edge-cubies that are already in their home positions. If there is one, turn the cube so the next vertical edge is forward. Observe the colors of the front and right center-cubies. Find an edge-cubie that has both those colors on its faces. Choose that cubie and rotate the top layer so that the side color of the chosen cubie matches either the front or right face-center cubie color. The booklet specifies an eight-step procedure and a symmetrical variation to insert that chosen cubie in its home.

For me, eight steps is too many to remember. The risk is significant confusion and errors, which require starting over. I need an idea that appears simpler than either [U R Ui Ri Ui Fi U F] or [Ui Fi U F U R Ui Ri]. But **think** about it. If the states are symmetrical, then there must be some symmetry in the procedures which reveal their internal structure.... Notice that the last four moves of the first procedure are identical to the first four moves of the second, and the last four moves of the second are identical to the first four of the first procedure. I can represent this as two "sub-procedures:"

> for a target cubie on the right face, do: sub 1 [U- F- U+ F+] sub 2 [U+ R+ U- R-]
> for a target cubie on the front face, do: sub 2 [U+ R+ U- R-] sub 1 [U- F- U+ F+]

Reflection: this specification of sub-procedures is based on a need to understand, resolved by observations on the structure manifest in a set of operations. This defines a "manageable" sub-problem by aspects of the problem, as distinct from the needs and limitations of the problem solver.

Remembering these sequences of four moves is still hard. We cannot change the specific moves or their sequence, but we can group the moves by what sequences have in common, their "sense of twist" (signs plus or minus, meaning clockwise or counter clockwise), thus:

- > right face cubie: sub 1 [U- F- U+ F+] sub 2 [U+ R+ U- R-] -> [-UF +UF] [+UR -UR]
- > front face cubie: sub 2 [U+ R+ U- R-] sub 1 [U- F- U+ F+] -> [+UR -UR] [-UF +UF]

One can even pronounce the move sequences as syllables; this could aid recall, even though the syllables be non-sense. Now, wherever there is a middle layer home position not occupied by its color specified appropriate cubie, one specifies:

See: 3 faces visible, green on bottom; forward edge "empty"; chosen cubie above right or front face-center cubie.

Do: either the front face or right face procedure above, as appropriate.

Review: Think about what's needed to replace the forward edge-cubie while keeping the base layer cubie "under" it. In completing the bottom (green) layer corners, it was enough to "slice" a single cubie into an edge to complete a single color edge, then rotate that edge into the green layer. For the middle layer, one must assemble a two-chunk portion of the forward edge which can be rotated to the vertical in a single move. But that can only be done after the "two-chunk" forward edge is joined perpendicularly to the bottom layer edge which shares the corner cubie. Apply your visual imagination; understanding THIS point is worth all the time it takes you.

Part III: Solving the Top Layer

The "7 Step Solution" for part III involves four steps in this order:

1. solve the top (blue) cross
2. re-order the top edges
3. re-order the top corners (1)
4. re-orient the top corners (2)

The first three of these appear simple because they are designed to return to the initial state, except for movement of the targeted cubie.

1. Solving the Top (Blue) Cross

This goal places top layer edge-cubies in the correct orientation (blue on the top layer). There are four such edge-center cubies. Either zero, two, or four of these will have the upper face (blue) color. If four, then the blue cross is already completed. The six moves of the procedure below flip two of these cubies with every execution, one in each three-step sub-procedure:

See: 3 faces visible, green on bottom; turn the cube until you see the top center cubie blue, or a blue arrow (3 cubies) pointing at you, or a blue bar (3 cubies) from the left to the right face.

Do: procedure: sub 1 [+FRU] sub 2 [-RUF] once, or two times if needed, until you see a blue cross (possibly with more blue cubies) on the top face. THEN turn the top layer so that a maximum number of top-edge cubies are adjacent to the same-colored side face-center cubies.

Review: If the top layer shows none or 2 edge-cubies blue on top, this implies there are four or two top-edge cubies that are blue on the side. The procedure flips the top-layer edge cubies then restores the lower level layers.

2. Re-Ordering the Top-Edge Cubies

Since now all the top-edge cubies will be of the same face color, we can distinguish them by naming each for its side face color. You can always match at least one top-edge cubie with its same-color side face-center cubie. Choose one and consider this the head of a list, e.g., yellow. As I rotate my cube clockwise on its green base (viewed from the top), the sequence of side-face colors is [yellow orange white red]. To solve the top edges, it is necessary to put every top-edge cubie in alignment with its side-edge color-matching center-cubie. If I list in sequence the top-edge cubie face colors during the same cube rotation, I might see they are [yellow orange red white]. The order of the last two top-edge cubies needs to be swapped. The booklet provides an eight-step list of moves to do it [R U Ri U R U U Ri]. Using exactly the same moves, I describe it this way:

See: 3 faces visible, with green on bottom, orient the cube so that the two cubies to be swapped are to the left of the forward vertical edge.

Do: procedure: sub 1 [+RU-R+U] sub 2 [+RUU -R]. If a second set of top edge-cubies needs to be swapped, do it again. No more executions should be needed.

Review: The procedure matches each side face with its top-edge side-color cubie. One is always possible. Two swaps are all that is needed to re-order the other three.

What remains to complete part three? Get all top-corner cubies in appropriate corners (1), and make sure each top corner cubie is oriented to color match its side faces (2).

3. Re-Ordering the Top-Corner Cubies

As with the top edge-center cubies, where we needed a procedure to reorder the sequence to get them "in the right place," so here we also need a procedure to sort the corner cubies into their appropriate home positions. This is how I represent it:

See: 3 faces visible, with green on bottom; if any top-corner cubie is in its appropriate home position, rotate the cube to make it top of the forward edge.

Do: procedure: [+UR -UL][+U -RU +L] (this re-sequences the corners list; you may need to do it twice).

> if there is no corner cubie "in the right place," execute this procedure once as a setup procedure, then follow "what to do." (This implies a maximum of three executions).

4. Flipping the Top-Corner Cubies

The solution's nearly complete. Go on **carefully**. It would be a shame to mess it up now!

See: three faces visible, with green on bottom, red as front face. Do **NOT** change the orientation of the cube until the solution is complete.

Do: rotate the top layer until a cubie needing to be flipped is top of the vertical edge;

> do procedure: [-RD +RD] 2 or 4 times, pausing when the cubie has been flipped.
>
> Rotate the top layer to bring another cubie needing to be flipped to the top vertical edge. For each cubie needing to be flipped, do procedure [-RD+RD] 2 or 4 times, pausing when the cubie has been flipped. (Expect the lower layers of the cube to appear "messed up" at this point. Moves to flip the last corner cubie, done faultlessly, will restore order to the lower layers as well as completing the top layer solution.)

When no more cubies need to be flipped, align the top edge pieces with their side color matches. The solution should be complete; **stop**.

Review: During this final stage, the configuration of cubies can still appear to be a mess. One might think a miracle would be needed to solve the cube at this point... and *then a miracle happens*: at some point while performing this procedure, the cube "solves itself." Any one who has succeeded in solving the cube will know from experience that this DOES happen. A novice will have to take the statement on trust. Best for everyone is an understanding of why the inter-dependencies of cubies, moves, and patterns make this conclusion necessary and obvious.

Why Does the Double [-RD +RD] Work?

Let's assume the cube is now solved. How did that actually happen? Talk of "miracles" is a metaphor here. Such "happy accidents" are excuses we accept as explanations if we cannot or will not pursue deeper understanding. HERE is an opportunity to understand complex inter-dependencies, if you want to.

A *key point* is one never need to do so *in full detail*, so long as you are satisfied that: when you change one cubie, you do something similar to but different from that for other cubies in comparable positions, interconnection of the cubies guarantees eventual return of a solved state.

> why "guarantees?"

> there are only FEW cubies in play (you can see the four corner cubies that are changed)

< the operation is designed to change the orientation of a single cubie, but all four in play are being changed at the same time.

The complete cycle of executions is six to restore the original location and orientation. As Groucho Marx once asked, "Who're you gonna believe? Me? or you own eyes?"

An execution of [-RD+RD] moves the target cubie to its front face diagonal corner. There are two ways to return that cubie to its home position. The first is to undo the execution by running the procedure in reverse, with the signs changed, that is, [-DR+DR]. This restores the cubie to its original location and orientation (but if it needs to be flipped, why do that?)

The second is to repeat the execution of [-RD+RD] twice. This restores the location of the target cubie but changes the orientation, rotating the blue face from top to front. Then rotating it from front to right. Two more repetitions will move the blue face from right to top, then from top to front. Two final repetitions will restore the original orientation by moving the blue face from front to right then from right to top. These six repetitions comprise a cycle of restoration.

Think about what is happening with other cubies as you focus on the target. They are changed also as a "side-effect" of your actions on the target cubie. If you undo the procedure for the target cubie, you also undo the side effect changes to the other cubies.

But what happens when you repeat the procedures in a cycle of restoration? Since the six executions of [-RD+RD] suffice to restore the location and orientation of the target cubie, the interdependence of the cubies' states, created by their mechanical connection, argues that pairs of executions will repeat location changes and triplets of pairs will restore the original orientations—when no errors are made. This explains "the miracle of the cube solving itself" in the final step.

Succinct Solution Summary:

1. **solve the bottom layer**: 1). by forming the green cross with edge-center cubies color-matched to corresponding face-centered cubies; 2). by bringing the corner-cubies home in the color matched orientations.
2. **solve the middle layer**: by making the bottom layer the "down" face then inserting four edge-center cubies in their doubly color-matched "homes."
3. **solve the top layer**: 1). by forming a blue cross with edge-center cubies color-matched to corresponding face-centered cubies (at need, swap edge-center cubies); 2). by bringing the corner-cubies home in the color matched orientations (at need, swap the corner-cubies); 3). flip faces of corner cubies for color-matching at need.
4. **remember the procedures** for each step of the solution.

Remembering This Solution

Mnemonics, enhancing recall with various schemes, has been a theme in our culture for a very long time.[16] Today, the acronym "HOMES" helps school children recall the list of Great Lakes (Huron, Ontario, Michigan, Erie, Superior). The hopeful sentence "Good Boys Do Fine Always" may aid recalling the lines of the base clef. Cicero depended on tours through architectural sites to structure and recall his famous orations. My memory needs all the help it can get, so I developed a set of mnemonics to counter the confusion potential of Rubik's Cube (they're set out in Figure 4). They are useful to me because they connect to things I've long known, and are strange enough to minimize confusion. My main point is that they are *personal*, useful to me, of little use to anyone else, except as examples. Consider #2, "Blue Cross is not frou-frou." Frou-frou means "frilly." This works for me because I was a computer consultant for Blue Cross nearly 50 years ago, and I know well their business attire was as staid as IBM, for whom I worked then.

Similarly, I enjoy employing Saint Anselm's Ontological Argument for the existence of God in mnemonic #3, partly because his slogan "credo quia absurdum" (I believe BECAUSE it is absurd) has annoyed me for a lifetime. (A petty revenge, 'tis true.) The bizarre monologue ascribed to Tonto (#4) —politically incorrect indeed, and reflecting the uncertainty of my children about my political leanings—reveals the key functional component. These mnemonics are formulae for translating a silly verbal construct into a procedure for *twisting* Rubik's Cube. This is clearest in #1, which starts with algebraic sums of sub-procedure representation terms and ends with unconnected words whose syllable rhymes reflect the sequence of sub-procedure twists. Finally, mnemonic #5, which is little more than a name for the results of the operation, is for me a connection to some kind of muscle memory for executing the procedure. This works for me too. You have to create mnemonics that work for you.

Remembering This Solution:
One needs to recall five physical-manipulation procedures for this solution, one with a symmetrical variant. Developing mnemonics related to personal experience or to something a bit silly can help recall.* These personal mnemonics are presented here, not as good examples, but to emphasize that YOU have to invent your own way of remembering these complexes of what **you** see, what **you** plan to do, and what **you** can remember. All three are critical to understanding and solving Rubik's cube. I wish you good luck!

1. for middle layer cubie insertion from: **my mnemonics**:
the Right face: **[-UF+UF] [+UR-UR]** (encoding with rhyme) zip-zip, no "duffer"
the Front face: **[+UR-UR] [-UF+UF]** zip-zip, the "sheriff"
The algebraic sums of the sub-procedure symbols are zero. Moves for the "right" procedure rhyme with "duffer" and start with counter-clockwise rotation, while the "front" procedure rhymes with sheriff and starts clockwise.

2. for creating a "Blue Cross" in the top layer: **my mnemonics**:
Form the BlueCross: **[+FRU] [-RUF]** (up to 3 times) Blue Cross is not frou-frou (It's more "FRU-RUF")
Once a consultant at Blue Cross, I know insurance office attire is not frilly; it's conservative business dress.

3. for reordering top-layer center-edge cubies: **my mnemonics**:
Re-order Edges: **[+RU-R+U] [+RUU-R]**: St. Anselm ["Are you, minus 'are', you ?"]
i.e.["Are you you? minus 'are'?"]
This recalls an ancient argument about whether existence is a necessary attribute of a perfect God.

4. for reordering top-layer corner cubies: **my mnemonics**:
Re-order Corners: **[+UR-UL] [+U-RU+L}** Tonto Changes Mind: ["You right, not you left"]
but then ["You, not right you; more left"]
You can decode the direct correlation of moves and the bizarre monologue of this silly mnemonic.
As always, the trick is getting from the mnemonic back to the procedural move encodings.

5. for flipping top-layer corner cubies: **my mnemonics**:
Flip Corners: **[-RD+RD]** *2 or *4, with cube position fixed Double (Corner Swap and Flip)
This mnemonic is merely a title, descriptive of the procedure result, not a link to other symbolic memories.

Fig. 4: Remembering the Rubik's cube solution

Conclusions

Returning to Herbert Simon's metaphor of the ant on the beach, our aim to understand learning as a side effect of thinking in specific contexts is what requires us to "look inside" mental processes and their possibilities of change. The issue of representation is thus central for formulating and expressing Artificial Intelligence notions of thinking and learning. The study of AI should lead to considering the role representation plays in peoples' problem solving. What we learn from our worked example of mastering Rubik's Cube is that flexibility in applying representations may be key to being "smart enough" to solve Rubik's Cube. Deployment of various representations and functions, mastery of a variety of such "ways of thinking," is more important to intelligence than "native ability" (as sampled by traditional tests such as the Stanford-Binet).[17]

Archilochus, a soldier-poet of ancient Greece, wrote a famous couplet:

The Fox knows many tricks.
The Hedgehog has just one, but it's a good one.[18]

If we can glimpse in mnemonics some tricks of the Fox and see in the formal methods of mathematics the one good trick of the Hedgehog, note that Artificial Intelligence found its home between the Fox and the Hedgehog, applying strong methods where possible and weak methods when necessary. Thus I find it a very "human," opportunistic approach to solving problems. But are tic-tac-toe and Rubik's Cube serious problems, worthy of understanding and mastering, especially as they have involved us in such down and dirty, nitty-gritty problem solving? "**YES!**" is my resounding answer, since these examples approach "thought experiments" that permit us to ask:

What makes learning possible in a task domain? How can mathematical and epistemological ideas advance peoples' understanding?

And if it helps any reader take a neglected or embarrassing Rubik's Cube out of the closet, then note these exercises meet Feynman's criterion of worthwhile problems:

> No problem is too small or too trivial if we can really do something about it.... The worthwhile problems are the ones you can really solve or help solve, the ones you can really contribute something to. A problem is grand

> in science if it lies before us unsolved and we see some way for us to make some headway into it. I would advise you to take even simpler, or as you say, humbler, problems until you find some you can really solve easily, no matter how trivial. You will get the pleasure of success, and of helping your fellow man, even if it is only to answer a question in the mind of a colleague..."[19]

If Feynman's view is adopted, we'll be "getting intelligence into the minds of people."[20] Seymour would be pleased.

Notes

1. This is an echo, of course, of Papert's well-known quip that, "You can't think about thinking without thinking about thinking about something."

2. Human Problem Solving, Prentice-Hall, 1972. See especially section 4.

3. See the section "Intelligent Tutoring Systems," in Artificial Intelligence and Education, Vol. 1.

4. See Minsky (1975, 1988) and Sussman (1975).

5. The following summary is reported in greater detail in primary sources, "The Articulation of Complementary Roles," (Lawler, 1985) and "Consider the Particular Case" (Lawler, 1996), both online now at NLCSA.net as well as in print sources.

6. Undertaken with the guidance of Oliver Selfridge (1993) and some programming help by Bud Frawley at GTE's Fundamental Research Laboratory.

7. From "The Articulation of Complimentary Roles," at http://nlcsa.net/lc2b-tis-2/lc2b-analyses/lc2ba4/

8. REO's preferences are those common in tactical play: first, win if possible; next block at need; finally choose a free cell, preferring the center cell first, and then any corner cell and finally a side cell. See Human Problem Solving, Newell and Simon (1972).

9. Subject to limitations based on rotational symmetry and the strategies adopted by the psychological subject, the generation of possible games was exhaustive. The analysis focused on won-games in which SLIM moved first in cell 1. See figure 1. The focus on corner opening play is based on the behavior of the subject and the relative variety of strategies such openings permit.

10. This focus of the models is precisely where the egocentricity of naive thought and cognitive self-construction of the psychological subject are embodied. The models are "egocentric" in the specific sense that no consideration of the opponent is taken unless and until the current plan is blocked. The psychological subject played this way. When a plan is blocked, SLIM drops from strategy driven play into tactical play based on preferences for cells valued by type (center, corner) and not by relation to others.

11. This form of learning by modifying the last term of a plan is one of two sorts; the other involves generating two possible plans based on deletion of the second term of a prototype plan. We know the forks achieved by plans [1 9 3] and [1 9 7] are symmetrical. SLIM has no knowledge of symmetry and no way of knowing that the forks are related other than through descent, i.e., the derivation of the second from the first. This issue is discussed in the longer versions of this text. See "On the Merits of the Particular Case."

12. These are detailed in "On the Merits of the Particular Case," in Case Study and Computing.

13. See Wikipedia general article on Rubik's Cube: http://en.wikipedia.org/wiki/Rubik%27s_Cube

14. See Wikipedia "Rubik's Cube in Popular Culture": http://en.wikipedia.org/wiki/Rubik%27s_Cube_in_popular_culture

15. I follow the booklet in choosing green to be the bottom layer, later as the "down" face. (The choice is arbitrary; it is easier to do the usual thing, if following a known solution.)

16. See Wikipedia articles on "Mnemonic" and "The Art of Memory": http://en.wikipedia.org/wiki/Mnemonic, http://en.wikipedia.org/wiki/Art_of_memory

17. The second case study, LC2, at NLCSA, contains a public Binet Test Summary; it

was summarized as an appendix in Computer Experience and Cognitive Development. An Analysis of Detail Data for the subject (at 6;1;17) exists under password protection at NLCSA.

18. Greek Lyrics, Richmond Lattimore, U. Chicago. 1960.

19. These comments, from a letter to a former student, show the wisdom of a man whose scientific brilliance is unquestioned. See "What Problems to Solve, by Richard Feynman" at http://genius.cat-v.org/richard-feynman/writtings/letters/problems ["writtings" (sic) in the web address.]

20. One might also take seriously how rigorous was Feynman's notion of what it means to really SOLVE a problem; see his discussion of the experiments of "Mr. Young" in the legendary 1974 Caltech Commencement Address, "Cargo Cult Science" (1986).

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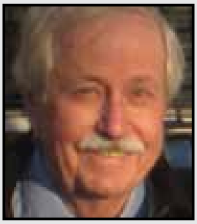

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Supporting Climate Science Research With 21st Century Technologies and a Virtual Student Conference for Upper Elementary to High School Students

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ABSTRACT

Engaging young science learners today requires a plethora of tools that oftentimes leverages technology in novel ways. This paper describes the use of several 21st century technologies to engage science learners in locally relevant climate science research projects and the presentation of these projects in an entirely online virtual student conference. Case studies demonstrating the use of and effectiveness of 21st century technologies and GLOBE protocols are also included. Through technology, students were able to find out more about distant locations and their own environments, talk to scientists, and make studying climate science personally relevant. Finally, the implementation and structure of the GLOBE Virtual Student Conference is described.

Introduction

Engaging science learners today is challenging and there is a continued push to develop Science Technology Engineering and Math (STEM) curricula that meaningfully integrate technology into as many curricular layers as possible (National Research Council, 2012). Of the many challenges teaching science, engaging learners oftentimes requires deepening the connection to the science through tangible concepts that address contemporary issues demonstrating the scientific phenomenon at hand (Hodson, 2003). Doing this requires tools that bring the learner successfully into the science, and climatology is an excellent vehicle to do that in many important ways. First, there are many open, freely available datasets that can be utilized to examine long-term climate trends. These may provide excellent opportunities for learners to immerse themselves in a particular aspect of a problem of interest. Second, since both the data and the problems being studied are often of high complexity, breaking them down into smaller, more manageable problems provides excellent opportunities to develop self-contained research questions that can be supported with effective pedagogy and collaboration (Fleming, 2010). Finally, many climate phenomenon can be observed directly, allowing young learners to get first-hand access to the scientific processes at hand as well as empirical data collection that can be experienced as much as it can be analyzed.

Another key challenge in the classroom is bringing technology to the learner, in ways that they are easily able to make productive use of technology to solve problems. With the multitude of technology platforms available (e.g., social media, online educational tools, online data repositories), and the increasingly distributed nature of communications, this paper will present a use of YouTube, Adobe Connect and Skype online video communications to provide learners direct control over technology while sharing their work with a distributed network of peers working on similar scientific concepts. This achieves two goals: the first technological, the second, pedagogical. On the technological side, students learn to increase their mastery of tools they may already be aware of, but may or may not already be using in the context of their own educational endeavors. While the consumption of technology remains high among learners today (Lenhart, Purcell, Smith, & Zickuhr, 2010), continuing to utilize these technologies in productive and creative ways remains a goal, especially within educational contexts, where other distractions may be reducing students' educational interests around technology use. On the pedagogical side, as learners engaged with other learners doing the same science in geographically and climatically diverse areas, they are able to connect the science concepts being learned in their own local environments with those across geography, and through carefully constructed exercises and discussions, reinforce the science even further. Thus, the central research question of this paper peers into both of these goals by positing: What are engaging ways to use collaborative, 21st century technologies to encourage students to learn about and share their understandings of climate science?

None of the gains in science understanding and technology use can be effective without appropriate teacher training and support (Fleming, 2010), particularly when considering the inquiry-based instruction practices that are becoming commonplace in science curricula today. While most science teachers are receiving some form of ongoing professional development, several dimensions of effective professional development in inquiry-based instruction have been identified including (but not limited to) extended support, authentic experience, reflection, content knowledge, enhanced knowledge, and change in teacher beliefs (Capps, Crawford, & Constas, 2012). Furthermore, Garet, Porter, Desimone, Birman, and Yoon (2001) and Penuel, Fishman, Yamaguchi, and Gallagher (2007) suggest that effective inquiry-based professional development focus on content knowledge and integration of activities into the classroom, while Darling-Hammond and McLaughlin (1995) and Loucks-Horsley, Hewson, Love, and Stiles (1998) suggest that professional development foster communities that value and support continuous learning, among other things. Though this paper will only briefly describe the teacher supports used within this project, several important features of the teacher training that was provided are: (1) teachers engaged in an online community of professional peers where they were in contact regularly, (2) participating teachers were encouraged to engage in bi-weekly webinars that provided a professional community platform for them to extend their content knowledge and share their experiences with one another, and (3) a focused curriculum was developed that centered around climate science that provided access to relevant content knowledge and sustained conceptual exposure that helped teachers develop throughout the course of the school year.

This paper is divided into three segments. The first segment will describe The GLOBE Program, its purpose, benefits, and use within this project. Furthermore, the first segment will lay out the rationale of the climate change curriculum used in this project—From Learning to Research (L2R)—and its intended goals and challenges. The second segment will describe three case studies of the use of the GLOBE From Learning to Research program and the resulting use of technology to engage learners in the production of outcomes resulting from applying science concepts directly from the curriculum. The third segment of this paper will reflect on the successes of the case studies and suggest a few ways that technology can be applied within the classroom to improve student engagement and learning. The final segment will reflect on and describe the implementation of the GLOBE Virtual Student Conference and how students can share and view research projects regardless of physical location.

Julie S. Malmberg and Keith E. Maull

The GLOBE Program and From Learning to Research Curriculum

The GLOBE Program

The GLOBE (Global Learning and Observations to Benefit the Environment) Program, sponsored by NASA, NOAA, and NSF, is a worldwide science and education program designed to encourage and support educators, students, and scientists in collaborative, inquiry-based Earth system scientific investigations. With over 112 countries, 24,000 schools and 1.5 million students having participated in the GLOBE program, the GLOBE database has over 23 million measurements that are being used in inquiry-based classroom lectures, discussions, and projects. With such a large network of participants, The GLOBE Program provides unique learning opportunities and collaborations among schools, teachers, students, and scientists.

From Learning to Research

One program that supports GLOBE's efforts is the From Learning To Research (L2R) program. Designed to help engage learners in the scientific process, while at the same time develop their knowledge and understanding of Earth systems processes, the L2R program is focused on three areas. The first is to provide the necessary supports and curriculum to teachers to effectively engage their learners in climate science concepts. The second is to expose students to climate science research with experts to facilitate closing the gap between climate science concepts and real-world scientific applicability of those concepts. This is primarily done by providing students access to climate science experts (meteorologists, climatologists, and other field experts) at various points through the curriculum. The third is to utilize 21st century technologies to encourage collaboration, distributed learning, and to facilitate building connections between students' local climate phenomenon and those of their geographically distributed collaborators. By actively engaging learners in scientific concepts and inquiry-driven activities, while also allowing students to gain access to climate scientists, students begin to learn how the science concepts they are learning are directly applied to solve problems that they may be observing first-hand in their classroom learning and data collection activities, while also engaging in the actual science around their learning materials. Furthermore, they are able to see how local climate phenomenon, supported by data collection and scientific analyses, are similar (or different) from those of their distributed peers.

From Learning to Research: Goals

Funded as an NSF Innovative Technology Experiences for Students and Teachers (ITEST) project, the L2R project seeks to develop a model for teacher-student-scientist collaborations leveraging 21st century technologies. The L2R team consists of educators (both former K-12 teachers and professors in STEM education), technology facilitators, researchers in educational communication, and technology and physical scientists. The primary goals of L2R are:

1. To provide teachers with the knowledge, skills, strategies, and confidence to engage middle and secondary students in authentic Earth System Science research on local, regional, and global scales

2. To expose teachers and students to careers in the Earth Sciences

3. To allow students to experience Earth System Science research by interacting with scientists from around the world

From Learning to Research: Implementation

In order to develop a successful collaboration model using 21st century technologies, teachers were recruited from geographically diverse areas. These included rural areas (some of the represented towns had either no or one stoplight), suburban and urban areas. Teachers were also recruited from diverse socioeconomic communities ranging from inner-city public schools to private schools. The 75 recruited teachers represented 22 states plus Puerto Rico and taught over 5,500 students in grades 5-12, including traditional schools as well as alternative schools. The teachers represented demographically diverse school settings and taught mainly science courses, including Advanced Placement Environmental Science, Earth Science, Biology, and general science, but some of the teachers taught math, technology, or geography. It was also preferred that teachers had three or more years of teaching experience to improve the stability of the project goals. Furthermore, in order to participate, teachers had to get a letter of support signed by their administrators.

Fig. 1: A map showing geographic distribution of teachers involved in L2R

The outcome of participating in L2R is a student research project about a locally relevant climate or environmental issue while using 21st century technologies and collaboration skills. To achieve this, the teachers participated in extensive professional development throughout the entire school year. This started with a weeklong summer institute held in Tyler, Texas in 2011 and Boulder, Colorado in 2012. The summer institute included presentations about project-based and inquiry-based learning, Next Generation Science Standards, a climate science overview, climate and climate change education, misconceptions and controversies in climate science, teaching in the 21st century (including skills and technologies), and two days of fieldwork. The teachers left the summer institute with concrete plans for collaboration, uses of technology, and a research project.

During the school year, teachers participated in webinars every two weeks, fall and spring status updates, and teacher updates on the student research projects. The webinars consisted of general announcements and interesting finds (e.g., useful technology tools or web pages), project updates, and career speakers from a variety of STEM fields. Each portion of the webinar was relatively short (10-12 minutes in length), so teachers shared the career speaker videos with their students in order to expose the students to many career options in STEM fields. Additionally, students communicated with other classrooms, the L2R staff and scientists via Skype, Adobe Connect, and email. Examples of student-to-student collaborations included sharing how to use a particular scientific instrument, updates about the class projects via Adobe Connect, and Q&A times about the schools' local communities and climate. Students communicated with scientists via Skype, webinars, and email. Additionally, after the students watched the Adobe Connect recordings of STEM career speakers, the teachers and students emailed or posted questions to a discussion forum hosted on http://www.globe.gov.

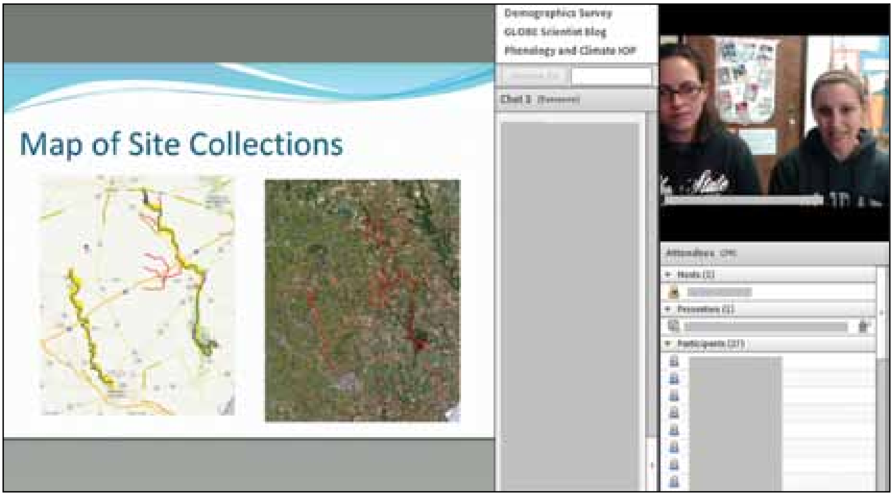

Fig. 2: An example of a project update via Adobe Connect. The presentation area is on the left—this can show PowerPoints, Prezis, web pages, or other documents, useful links and a chat window in the middle, and a webcam and participants on the right.

L2R Project Case Studies

Even with the training, teachers' use of technology in the classroom may vary greatly, and often with time and experience, teachers and students alike can get into effective and productive patterns of technology use. With the L2R project, two technologies, Skype and video recording, were widely encouraged to facilitate communication and collaboration. In this section, we will highlight three cases that demonstrate how these technologies helped students and teachers engage in climate science research across geographic boundaries, to enable deep learning experiences that would otherwise not be possible. We will also highlight the use of video technology through the "Student Virtual Conference" (described in more detail in the next section), and show how students became more engaged and excited about the science, through the connections they formed with others via these technologies. Note that any identifying information has been changed.

Case I: Martha

Martha is from a rural, politically conservative US town and had been a science teacher at a middle school for over a decade. She was very hesitant about teaching climate and climate change due to personal disbelief and concerns about negative responses from her community. She was encouraged by her administrators to participate in L2R, but during the first half of the year, Martha was not engaged in the program. However, after further push from her administrator, Martha began working more closely with L2R team member Amelia to explore potential locally relevant climate projects. Martha ended up choosing to work on phenology (the study of living organisms' responses to seasonal changes in their environment) in her area and agreed upon applying the green-up protocol. This GLOBE protocol is a relatively simple and inexpensive way to study the environment during which students monitor leaf buds in the spring. Her students selected several trees and started monitoring these trees for budburst and green-up. Martha, who had very little experience with climate science curricula, also worked closely with GLOBE staff to arrange Skype chat sessions between her students and climate scientists from different regions around the world. In these sessions, the scientists guided the students' research question, data collection and analysis, and presentation activities.

The students were so enthusiastic about studying phenology and climate, and talking to students and scientists in distant locations, that Martha became much more engaged in L2R and her students started investigating other research areas using GLOBE protocols in their community. These included looking at water quality (water temperature and transparency, dissolved oxygen, pH, nitrates, freshwater macroinvertebrates) near a poultry farm, investigating how their collected precipitation data compared to normals (it was a drought year), and looking at long-term air temperature datasets.

Martha's students presented their research project at the 2012 Virtual Student Conference and were active participants in the online conference activities, asking other students questions about their projects and inquiring about the science that emerged from others' projects. At the conclusion of the first year of L2R, not only did Martha and her students expand their science knowledge and technology use, but several students have also gained international recognition from their work since the completion of their project. One of the more powerful aspects of the L2R experience is summarized by one of Martha's students who said, "…it's been really interesting getting to be a part of it…it's neat to think that students in a small town of about 1,300 people get to interact with people from around the world because of a research project." Some of Martha's students continue to collaborate with other students and scientists from around the world.

Using technology, Martha and her students were able to explore opportunities that would otherwise be unavailable to them. They had access to some of the forefront scientists in the field and were able to see what other students around the country were exploring. Martha may not have had the skillset or confidence to study phenology and climate on her own, but with the support of other schools, scientists, and L2R staff, she was able to bring new opportunities to her students.

Case II: Jack

Jack, a 5th grade teacher in a rural US town, had been teaching for over 15 years. He had been involved with The GLOBE Program for over a decade and consistently sought out unique and engaging science opportunities (including climate science) for his students as well as professional development workshops and experiences for his own enrichment. When he saw the call for L2R recruitment, he immediately applied, and while Jack's students were already very active in collecting and analyzing data for local climate science projects, the technology component was both new and intriguing for Jack and his students. During the school year, Jack and his students started Skyping with students and scientists from around the world to share and learn more about their local environments. Through these Skype sessions Jack's students began to develop personal relationships and even began referring to other students they had been collaborating with as their "friends."

For the online Virtual Student Conference, Jack's students submitted a dramatic video rendition of their research project covering all elements of the scientific method. Most notably, Jack's students realized that not all research questions end up with definitive answers—an insight that even much older students struggle to realize and cope with. Jack and his students were later invited to participate in an international science competition to further present their research, which received both formal recognition and praise from the judges and other competition participants.

To show the importance of how distributed communications technologies helped his students to learn more science and gain valuable and authentic experiences, Jack pointed out in an interview:

> One of my favorite examples of how my students gained better conceptual understanding is the connection that became obvious with other schools in the USA as well as in the world. Quite often I would hear my students refer to other GLOBE schools as their friends. Finding and comparing surface temperature, snow, cloud data from schools in a different hemisphere, and viewing land cover photos from other locations, has helped my students to begin to understand the value in working together as a world-wide community to address climate and environmental issues.

Clearly, with these technologies available to Jack's students, building the connections between the scientific observations of their local climate and those of their online distributed peers, the importance and relevance of the science they were learning became much more meaningful.

Case III: Melody

Melody, a middle school science teacher in a geographically isolated location in the US, had been teaching for over 20 years, after switching careers from a corporate job earlier in her work history. Melody was concerned because her students were isolated from other regions of the country and worried that they would not become "citizens of the world." Many of the families in this location treated the area as a temporary home (even though they had lived there for ten years or more) and did not treat this area like a place they might stay for generations. The students were indifferent about recycling, keeping their areas clean, and embracing the local ecological features.

When she saw the announcement for the L2R professional development training that included collaboration via technology, Melody thought this would be an ideal opportunity for her students. After the summer teacher training, Melody started actively pursuing Skype relationships with schools around the world. Melody tapped into GLOBE's international database and contacted GLOBE schools from different regions, but due to the extreme isolation of her school, the Internet connection was substantially degraded for the bandwidth required to meaningfully participate. She consequently purchased a wireless hot spot to improve conductivity for her students, which then allowed her students to begin Skyping weekly with students from quite a few countries. Melody would even host lock-ins at the school to allow students to Skype very late at night with schools from distant locations at convenient times for those students.

After Skyping with others from a variety of locations, Melody's students became interested in improving their local community. Her students began to take greater notice of some of the unique ecological features of their hometown and pursued conversations with scientists specializing in these features. For their L2R research project, the students explored ways to improve their environment through a revitalization project while carefully documenting their progress. By using GLOBE protocols to collect and visualize their data, the students were able to see how modifying aspects of their environment helped to improve water quality. For the Virtual Student Conference, Melody's students showed before and after pictures of their community and explained how their research led to them improving their local environment.

Through technology, Melody's students not only learned about other environments, but also began to appreciate their own environment. And, even though Melody's students were in a very isolated location, they were able to connect with schools from a wide variety of locations. Rather than just reading about a distant location in a textbook, Melody's students were able to virtually see and discuss far-off environments with the students who lived in these locations.

Fig. 3: Students showing their scientific instruments during a Skype session

Synthesis

These three case studies illustrate how 21st century technologies allowed students to learn about their environments in new ways. While collaboration with geographically distant scientists, teachers, and students was possible before Skyping, webinars, and social web pages, these advancements have made collaboration much more accessible for teachers—particularly since all the schools were doing GLOBE protocols for data collection, which are consistent regardless of location. Martha's students got to learn about a topic that might not have been otherwise taught.

And, they were able to communicate with the scientists currently researching that science topic. Jack's students were able to compare and discuss their data with other schools' data. The students developed personal relationships with students in distant locations and were able to see how their research was important. Finally, through technology, Melody's students learned to appreciate the uniqueness of their own environment while learning about other cultures and environments as well. While we only presented three case studies, each teacher involved in L2R and his or her students were able to make connections, explore new topics, and learn more about the world via 21st century technologies.

The L2R 2012 Virtual Conference

The culminating event of L2R was for students to participate in the GLOBE Virtual Student Conference. Due to geographic, financial, and time constraints, a virtual conference was the best way for students to share their research with other classrooms. Despite these constraints, video technology was chosen as the primary tool for conducting the conference for several reasons. First, students were able to show details of their research projects, and in some cases this allowed for deeper capture and expression of the local qualities of their climate. Second, while students may already be familiar with online video through their own personal and academic use, they may not have used video to produce anything meaningful for the purposes of sharing with others, and more importantly, in the context of their own learning. Not only did this allow students to become full participants in their own projects, but also provided exposure to the ways technologies can be used to capture, record, and share their own educational knowledge and understanding with others. Finally, and perhaps more importantly, video technologies allow students to see firsthand the experiences of others engaging in activities similar to their own. With this medium, students are able to more intimately connect with the ideas (and science) of their peers. Also, with a push towards a more environmentally conscious world, a virtual conference has the added benefit of being "greener" than an in-person conference.

Virtual Conference: Structure and Implementation

To closely emulate the authentic structure of academic scientific conferences, students were asked to submit an abstract, a video documenting their local climate project, and a science report. The video portion was left open-ended, allowing students to create their video presentation in any style they liked. This yielded a variety of creative submission styles from narrated PowerPoints, videoblog-style reports, videos of the students in front of their science posters, to songs about the student projects. All the videos submitted were shared in two ways. First, they were uploaded to YouTube and embedded into a YouTube "channel," and second, for teachers that had school-imposed restricted access to YouTube, a video was also made available via download from a GLOBE server. YouTube was chosen primarily because of the readily available access to YouTube by the majority of the teachers, as well as the ease with which it allows videos to be shared, embedded, and viewed. Once submitted, the student projects were arranged into "rooms" (child pages of the conference web page) based upon themes, which included general atmosphere and climate, hydrology and climate, phenology and climate, and land cover and climate. Student projects were assigned a number and could be cross-listed in more than one theme.

The first GLOBE Virtual Student Conference was "open" for one day. During this day, teachers and students were encouraged to watch the videos, read the abstracts, and ask the other students questions about their projects via a commenting tool on the web page. GLOBE Scientists and community members also asked questions and made comments. Several of the schools spent significant portions of the school day watching the videos and invited administrators and other classes to watch with them. Students also Skyped other L2R schools and watched and discussed the projects together. The students answered the questions and responded to the comments during this virtual conference day. Since not all students were able to log in to the virtual conference on the same day, teachers and students were encouraged to check their projects for questions and comments for the following few weeks.

Fig. 4: Students viewing the virtual conference

Virtual Conference: Summary

All in all, the conference was a success. The student research reports demonstrated the goals of L2R. First, a majority of the projects illustrated collaboration via technology. For example, students from Puerto Rico and Alaska worked together to compare their local climates using GLOBE protocols and other schools referenced conversations with scientists from around the world. Second, all of the student projects demonstrated authentic Earth System Science research ranging from local to global scales. The quality of the projects varied, but they all illustrated a scientific research project from hypothesis to conclusion. Additionally, the students had a common space to see similar types of research and compare their local environments to other environments around the country.

Reflection

With one year of the Virtual Student Conference complete, the L2R staff came to several realizations. First, having a one-day conference was too short. For the next virtual conference, the open window will be three weeks. (Note: The next GLOBE Virtual Student Conference takes place May 6-31, 2013 and projects will be viewable any time after May 6, 2013.) This will allow for more meaningful discussions to occur between the students, scientists, and GLOBE community. This will also allow flexibility for scheduled field trips, school activities, and testing. Second, the virtual conference will be open to the GLOBE community. Students will be able to see student research projects from other parts of the world, as well as other L2R schools. Third, rather than just limiting the comments to GLOBE scientists and L2R teachers and students, the comments will be open to the entire GLOBE community. A more diverse population viewing and commenting on the projects should lead to more interesting conversations. Finally, projects will be scored by scientists from the GLOBE International Scientist Network using a modified Intel Science Fair scoring sheet. Scoring is modified to include points for entering data into the GLOBE database, which then makes it available for students and the public to utilize this data.

As for working with the teachers, several changes were implemented in the elements of the professional development from the first to the second cohort. First, more time was spent covering the scientific research process and how to develop a researchable question during the summer workshop. Second, the new technologies were practiced repeatedly during the workshop. Before the teachers left, each had to successfully Skype, use Adobe Connect, and enter test data into the GLOBE database.

Third, each teacher completed a project plan that included plans for collecting data, finding climate data sources, and plans for how to collaborate with other schools and scientists. GLOBE scientists and L2R staff worked through the project plans with each teacher. While the second student virtual conference has not yet happened, the teacher updates already indicate these additional steps are helping to shape more collaborative and scientifically sound research projects.

In conclusion, several aspects were found to be the most effective in helping engage students in scientific research. First, using technology and finding new ways for using technology interested the students. Second, forming connections with other students, schools and scientists made learning about distant locations more meaningful. Third, finding locally relevant and personally significant science topics helped keep the students motivated to explore their research questions. Finally, the L2R staff worked closely with the teachers to provide support and assistance. Overall, everyone involved in working with the students and teachers in some way was impressed with the students' interest and passion about climate issues.

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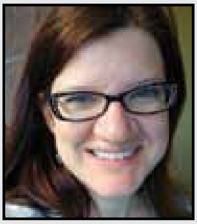

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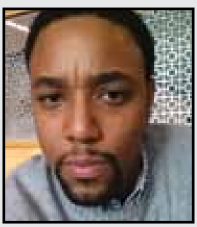

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Teaching With Electronic Portfolios to Develop 21st Century Literacies

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ABSTRACT
This article introduces an electronic portfolio, ePEARL, and how it has been used in classrooms to promote 21st century literacies. Using NCTE's 21st Century Literacies framework, the authors provide examples of student work and classroom assignments to demonstrate how an electronic portfolio can support teachers integrating this framework and developing these skills in pedagogically meaningful ways.

Today the grade four students were working on a group science project: the design of an "Insulating Machine." To prepare for this lesson using electronic portfolios, the teacher had taken digital photos of the machines each group had already built and saved them on a USB key. A technology consultant was working with the teacher in class this day, so the consultant spent time with each group showing the students how to download the image files, and then upload them to the correct location in their ePortfolio. As the students waited for their turns with the USB key, they worked in groups inputting the text describing this project in their ePortfolios. One person was working in their portfolio and once the data was fully entered they were able to "share" the artifact with their group members for inclusion in their own ePortfolios.

Before creating their insulating machines, the students completed paper-and-pencil planning sheets that included: a description of the assignment, the group's goals, and specific strategies they had planned to use to successfully satisfy the criteria for the project (Figure 1). The groups referred to their planning sheets as they entered the text into each corresponding field of their ePortfolios. The students then input the temperature data they had recorded earlier, discussed their findings, and attached the photos that showed the machine they had built (Figure 2). This lesson is just one of many examples of how elementary teachers are using ePortfolios to help promote 21st century literacies across the curriculum. This article provides detailed examples from three elementary classrooms of how the use of an electronic portfolio can help support teachers in their efforts to teach media literacy, information and computing technology (ICT), and related language arts skills that are often described as "21st Century Literacies."

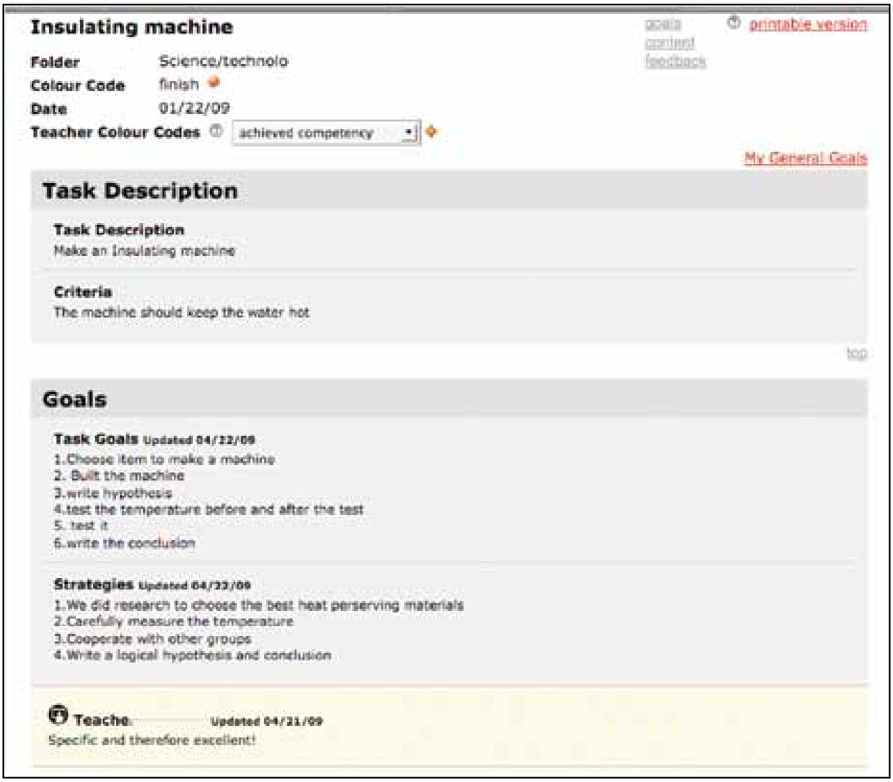

Fig. 1: Insulating machine project: planning

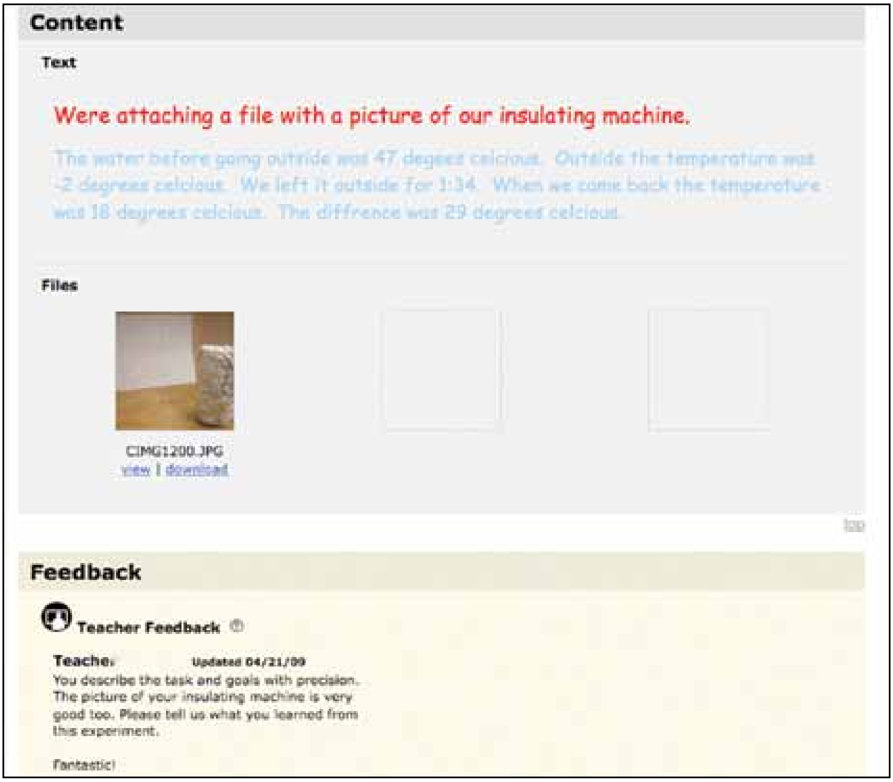

Fig. 2: Insulating machine project: content and teacher feedback

21st Century Literacies: Definitions and Framework

In 2008, the National Council of Teachers of English released a new framework for literacy education. This framework provides a working definition for 21st century literacies and how the evolving demands of new technologies and communications are able to inform new literacies education.

Literacy has always been a collection of cultural and communicative practices shared among members of particular groups. As society and technology change, so does literacy. Because technology has increased the intensity and complexity of literate environments, the twenty-first century demands that a literate person possess a wide range of abilities and competencies, many literacies. These literacies—from reading online newspapers to participating in virtual classrooms—are multiple, dynamic, and malleable. As in the past, they are inextricably linked with particular histories, life possibilities, and social trajectories of individuals and groups. Twenty-first century readers and writers need to:

- Develop proficiency with the tools of technology
- Build relationships with others to pose and solve problems collaboratively and cross-culturally
- Design and share information for global communities to meet a variety of purposes
- Manage, analyze, and synthesize multiple streams of simultaneous information
- Create, critique, analyze, and evaluate multimedia texts
- Attend to the ethical responsibilities required by these complex environments (NCTE, 2008)

This framework is written in such a way to help teachers "explore and implement 21st century skills," reflect on their practice, and begin conversations about the possibilities that this framework holds to best meet the evolving needs of students in schools today (Bass, Sibberson, Hayes, McGraw, & White, 2010, pp. 390–391). This article will present the work of three elementary school teachers who integrated an electronic portfolio, ePEARL, in their classrooms, and discuss how this tool facilitated the process of integrating 21st century literacy skills into their classroom practices.

An electronic portfolio (EP) is a digital container capable of storing visual and auditory content including text, images, video, and sound. EPs may also be learning tools not only because they organize content but also because they are designed to support a variety of pedagogical processes including reflecting on one's own learning and providing feedback to peers to stimulate their own reflections (Abrami & Barrett, 2005; Wade, Abrami, & Sclater, 2005). This reflection process is a key element in students' learning and effective communication between students is an important part of this process. EPs have three broad purposes: process, presentation, and assessment. For assessment purposes, EPs can be used to display examples of students' authentic activity and are especially useful for formative purposes, showing progress over time; while presentation portfolios are used to represent students' most important works—however the teacher and student choose to define "important." The focus of this article is on using EPs as process portfolios as they have great potential for supporting and demonstrating learning of the 21st century literacy skills mentioned above.

EPs may be designed as *process (or learning) portfolios* supporting how users learn through embedded structures and strategies. A process EP is a purposeful collection of student work that tells the story of a student's effort, progress and/or achievement in one or more areas (Arter & Spandel, 1992; MacIsaac & Jackson, 1994). Process portfolios are personal learning management tools. They are meant to encourage individual improvement, personal growth and development, and a commitment to lifelong learning.

Process EPs are gaining in popularity for multiple reasons. They provide multimedia display and assessment possibilities for school and work contexts allowing the use of a variety of tools to demonstrate and develop understanding—especially advantageous for at-risk children whose competencies may be better reflected through these authentic tasks. At the same time, by engaging these learners, their deficiencies in core competencies such as reading, writing, and general learning skills may be overcome. Process EPs scaffold attempts at knowledge construction by supporting planning, reflection, refinement, conferencing, and other processes of self-regulation, important skills for lifelong learning, and learning how to learn (Meyer, Abrami, Wade, Aslan, & Deault, 2010). They are superior for cataloguing and organizing learning materials, better illustrating the process of learner development. Many EPs are web-based, so they can also provide remote access encouraging anywhere, anytime learning and easier input from peers, parents, and educators, consolidating feedback through a single electronic container. In this regard, they may be used to foster communication between teacher-student, student-student, and child-parent throughout the learning process, which can support their abilities to "manage, analyze, and synthesize multiple streams of simultaneous information" as well as "build relationships with others to pose and solve problems collaboratively and cross-culturally" (NCTE, 2008).

Research Context and Methods

The research presented here represents a subset of a larger study. Participants in the full study were 21 teachers from elementary schools (grades 4-6), and their students (n = 483) from nine urban and rural English school boards in Quebec and Alberta who participated during the 2008-2009 school year which was the final year of a three-year study. All experimental teachers (n = 9) received at least a half-day of training on the use of ePEARL from the research centre's staff and follow-up support including lesson plans and job aids, an online discussion forum (in the form of a moderated wiki), as well as in-class observations and model lessons during the school year. In addition, multimedia scaffolding and support for teachers and students are embedded in the tool.

We worked actively with school principals and school board administrators to identify control teachers and their classrooms who would match as closely as possible the experimental teachers and their classrooms. All teachers needed to follow the language arts provincial curriculum requirements. Experimental teachers did so with the aid of ePEARL, while control teachers did not. All teachers were at liberty to decide how the provision of language arts instruction will unfold in their classrooms. There were no special language arts materials provided to either experimental or control teachers by the research team.

The design of the study was a two-group repeated measures design. Teacher and student pretest questionnaire data were collected in September-October of 2008. Teacher and student questionnaire post-test data were collected again in May-June of 2009 after ePEARL was used for some part of the school year ranging from 6 to 8 months. In addition to questionnaires, all students completed the constructed response of the Canadian Achievement Test (version 4) in both the fall and the spring to assess their reading and writing skills. This article reports on data collected in three classrooms (AS1, QH6, & QL9) from three different school districts, which demonstrated the highest levels of implementation of ePEARL based on an analysis of student portfolios, teacher interviews, and classroom observations. These classrooms were chosen in order to illustrate the multiple ways that elementary teachers can integrate instruction based in the 21st century literacies paradigm with the support of an electronic portfolio.

ePEARL: An Example of an e-Portfolio Tool

The Centre for the Study of Learning and Performance (CSLP) based at Concordia University in Montreal in collaboration with their partner LEARN (http://www.learnquebec.ca/), developed a web-based, student-centred electronic portfolio software, entitled ePEARL, electronic Portfolio Encouraging Active Reflective Learning, (http://grover.concordia.ca/epearl) that is designed to develop self-regulated learning (Zimmerman, 1989, 2000; Zimmerman & Tsikalas, 2005), along with improved literacy skills in students. Three levels of ePEARL have been designed for use in early elementary (Level 1), late elementary (Level 2), secondary schools

(Level 3), and post-secondary education (Level 4). In ePEARL students can: personalize their portfolios; set long- and short-term goals; create new work through use of a text editor and audio recorder, or link to digital files created outside of the tool; reflect on work; share work with classmates; provide and receive feedback from teachers, peers, and parents; edit work; save work under multiple versions and send work to a presentation portfolio. The artifacts index page offers students and teachers an easy way to store, organize, and track the progress of assignments (Figure 3).

ePEARL is designed to promote a student's self-regulated process of learning. The learner-centered software prompts the creation of a home page that reflects each student's personality, interests, and general learning goals for a term or year. One teacher commented that this home page was a great tool to help introduce the new technology to her grade four students. She noted that, "working on their home page was a great way to start off because it involved visuals and it was all about them and setting up a general goal and it was easy, but fun and so that was a nice initiation into the project" (QH6). For each project students also set task goals (G); reflect on works in progress or completed works (R); and give and receive peer, parent, and teacher feedback (C) on the portfolio or on a specific artifact. Teachers may also provide feedback on the student's goal setting and reflection that has occurred within the portfolio. The ePEARL environment guides students through the creation process. The software also offers the ability to attach work completed using other software (A), so it can accommodate any kind of digital work a student creates, including podcasts, videos, PowerPoint files, scanned images, or photographs of three-dimensional work.

Before work is created, students are encouraged to set their goals for the assignment, and may attach learning logs, evaluation rubrics, and study plans to keep track of their learning process as it takes place. After the creation of work, sharing with peers or teachers is encouraged so that students may solicit feedback on drafts of work. Students may also reflect on their performance and strategies, and use these to adjust their goals for the next work. Sharing with peers is prompted in the reflection screen (Figure 4). Once students have completed a version of an assignment they are asked if they would like to share this piece with classmates to obtain feedback. Teachers have automatic access to view and enter feedback in all of their students' ePs. This unique feature helps promote collaboration as well as evaluation and feedback skills. It also enables students to view each other's goals, strategies, and completed assignments, which provides additional modeling and scaffolding to their own learning processes.

The Presentation folder within ePEARL is where students collect selected important artifacts. This provides a cumulative area where artifacts are carried over to the next level of the software and acts as an archive of stored work during a student's educational career. The selection process allows students to reflect on why they feel an artifact belongs in their presentation folder, its relationship to other work, and on their own advancements.

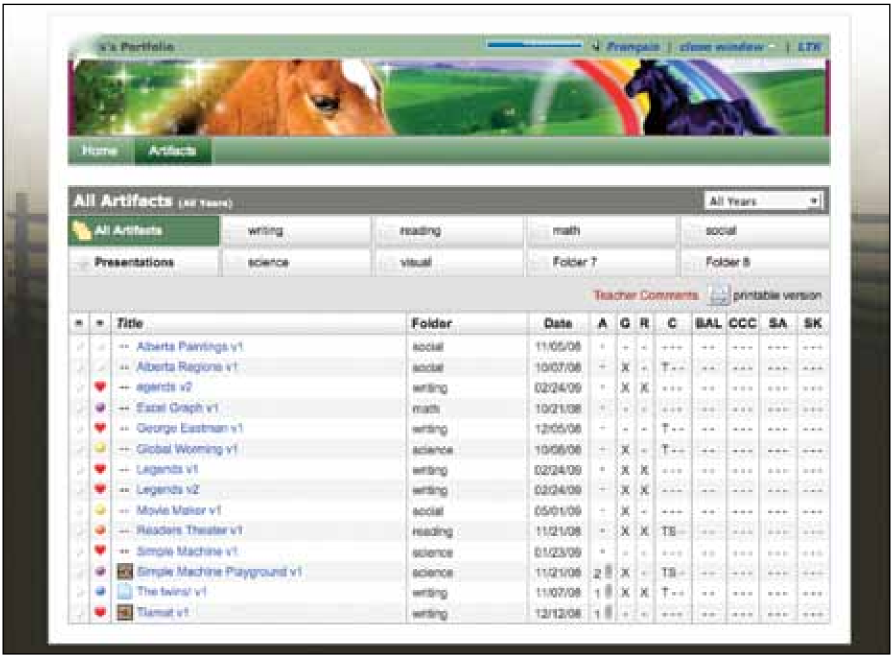

Fig. 3: Artifacts index page

Fig. 4: Reflection screen: sharing

Scaffolding the Development of New Literacies With ePortfolios

An EP, by definition, is a way to externalize an individual's thought processes and progressions. When beginning an ePEARL entry, the student is walked through a creation process that models a certain level of expert practice of forethought, performance, and self-reflection. Some cognitive scaffolding is made explicit at this stage, enabling students to easily address aspects or initiate practices that they may not realize are necessary or beneficial to their learning process such as reflecting on both the final content and the process. As these skills and practices are adopted and internalized by the learner, this guided step-by-step scaffolding may be turned off. ePEARL is designed to give the individual student an overview of his/her own progress. By the end of the guided process, and possibly after several drafts, the learner is ready to make a selection of works he/she would like to display by copying them to the Presentations folder.

Reflection is also actively encouraged at this point by urging learners to consider the merits of the final work, of the process, and of the contribution made to the student's awareness of him/herself as a learner. These structured processes help individual students to "develop proficiency with the tools of technology" as well as "manage, analyze, and synthesize multiple streams of simultaneous information" (NCTE, 2008). One grade four teacher commented on how working with ePEARL really helped improve her students' computer literacy skills: "The kids like using computers, so it's great in terms of computer skills. The kids had to download pictures and they had to make attachments and stuff, so it's great in terms of computer technology" (QH6). A second teacher explained how the ePortfolio helped her teach technology competencies through writing assignments:

> I think their technology competencies were more of the goal than the actual writing competency, because we do a lot of writing also in class. So the kids are able to learn how to attach files, learn how to save files, learn how to go and search for things, how to go back and peer edit and use the technology as more of the tool. (QL9)

A third teacher used a readers' theatre project to help students work on their writing skills, as well as reading fluency and expression. In addition to providing a place for students to demonstrate the basic technical skills necessary to type, edit, and save a Word document, attach a file, and complete an audio recording, ePEARL helps students set goals for a new work by breaking down the task and the criteria so students can focus on the various steps involved in writing a script and presenting it to the class (Figure 5).

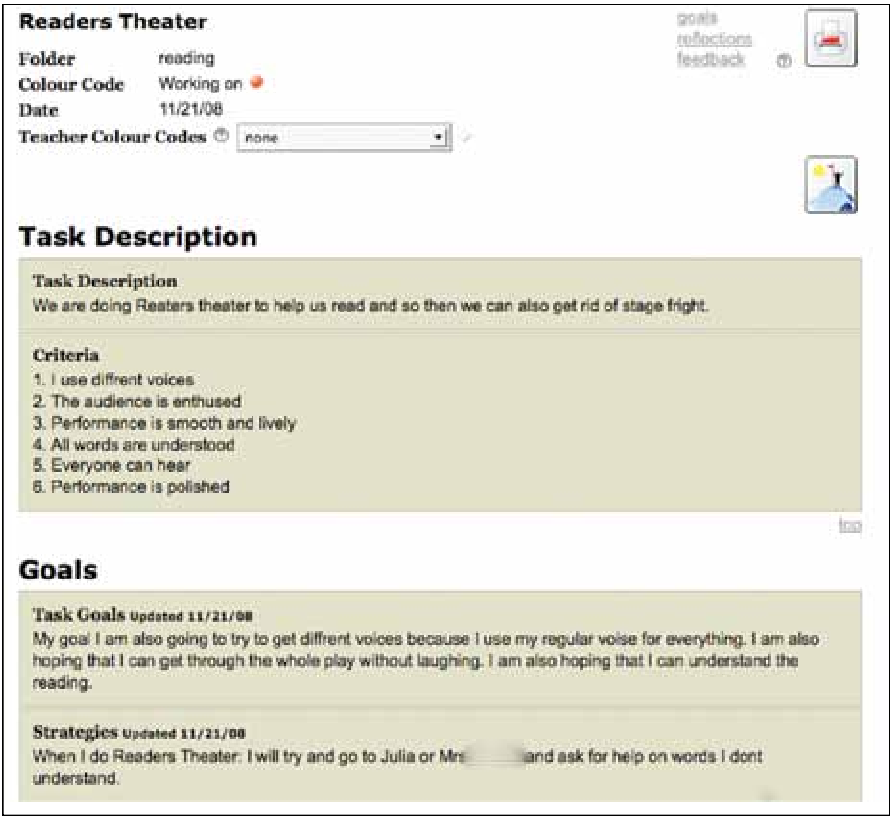

Fig. 5: Reader's theatre: planning

Particular features in ePEARL are designed to facilitate communication between individuals. The software allows students in the same class or school or across schools within a district, to comment on works in each other's portfolios. Students receiving the comments are encouraged to revise their work, incorporating those comments they feel are most helpful. Teachers are also able to comment on goals and strategies selected by the student, and thus help monitor and adjust individual student progress and understanding. Apart from facilitating the communication between teacher and students, this feature also pedagogically supports the teacher by clearly identifying where a teacher's comment may be inserted to provide the greatest help. We have provided a sample of teacher and student feedback on the readers' theatre project below (Figure 6).

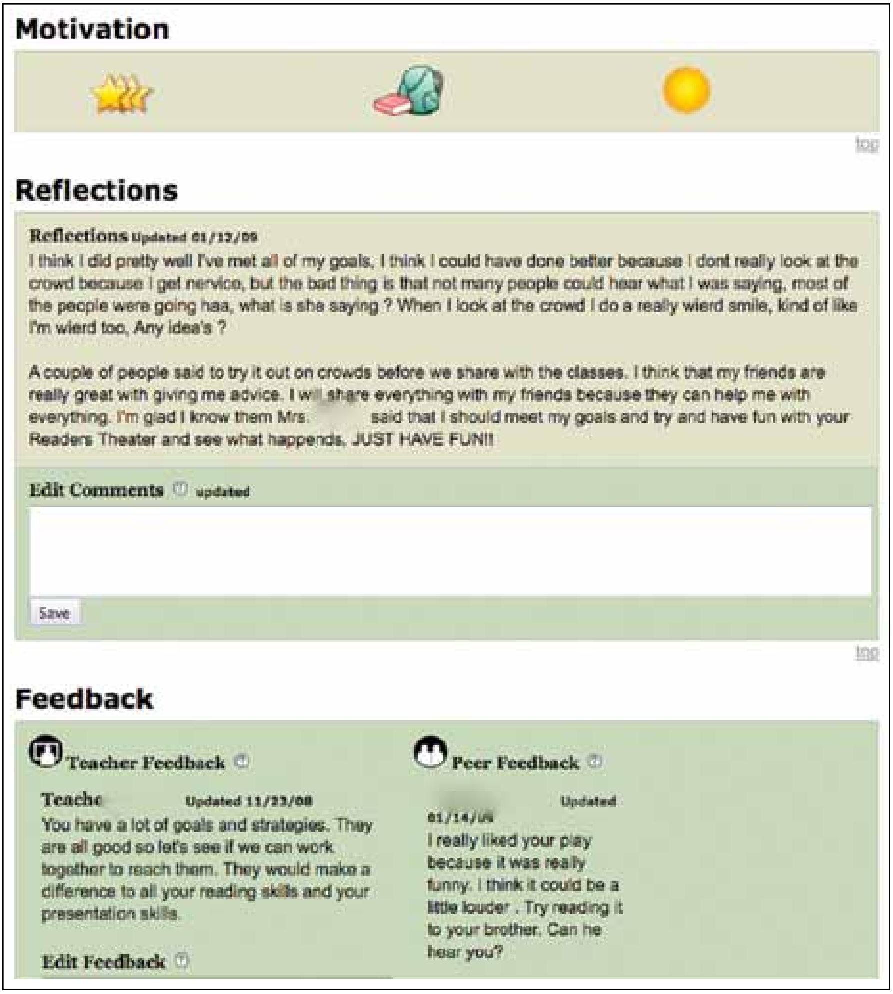

Fig. 6: Reader's theatre: reflecting and feedback

In this feedback, the teacher acknowledges the effort made by the student and provides encouragement and support as well as specific guidance as to how what they have learned in this assignment can translate into other literacy and communication activities. The peer feedback is also positive and encouraging regarding the oral presentation but offers very specific advice about the volume of the presenter's voice. The student providing feedback even offers the idea of reading aloud to a family member to ensure that the presenter is speaking loudly enough. Getting multiple perspectives on one's work is valuable as it allows students to synthesize various perspectives and decide which ones are most helpful for them to work on in future projects.

ePEARL was also designed to encourage scholastic communication between students and their parents. Given that the learning environment is not limited to the classroom, practices at home are central to a student's academic success. The ePEARL software encourages parents to participate in their child's learning process by commenting on individual work as well as on the portfolio as a whole. There is also a group work component that allows students to plan, create, and reflect on projects that they have collaborated on. In addition to saving all of the group's planning steps and products, individuals are also prompted to reflect on their own contributions to the project, as well as the skills they have developed. These features help students to "build relationships with others to pose and solve problems collaboratively and cross-culturally" (NCTE, 2008). One Grade 5/6 teacher reflected on how the feedback feature helped her build a better sense of community in her classroom:

> I do see that the students are able to [give] peer feedback more and accept each other a little bit better and keep their respect. There was a little bit of that bullying issue that was going on. I think that's something that we addressed because of the tool. So…how do we live in a community and respect each other are very important because it is part of our school community, [and] the ePEARL project. (QL9)

Improving Teaching and Learning With ePEARL

The teachers in this research project all commented on how working with ePEARL helped them better understand their students as learners and improved their instructional and assessment practices. One teacher noted that, "there's something about the program that really works…I think because [the students] have to be creative in terms of the writing skills but also in terms of making it visually presentable" (QH6). A second teacher reflected on how her instructional and assessment practices have improved since using ePEARL:

> It just made me so aware… starting in September: here are the steps that I need to be teaching. Here are things that I need to watch for, here's the understanding I need to check on—and assessment changing so much. I like to think I was doing a fairly good job, but assessment has really changed—it is more assessment of learning, for learning, to learn…So it goes hand in hand with what we've been doing in the [school district], but it was just at the right time and I think it truly has changed my assessment practices. (AS1)

A third teacher who worked with grades five and six talked about how she spent more time teaching her students how to provide useful feedback: "We did a lot of lessons on positive feedback, negative feedback, what is a good way to help a friend, what you find as useful feedback when someone writes you something" (QL9). The feedback and sharing feature was a popular motivational factor for many students and teachers. A grade four teacher talked about how this aspect helped improve student engagement in writing activities. She explained, "It gives them an audience to write for other than the teacher. They like sharing the work, so that's great—it motivates the kids that are sometimes really reticent about writing and I just love it" (QH6). These comments illustrate how teachers are shifting their practices in ways that engage students more effectively and promote new literacy skills. Our research team has already reported elsewhere that students who used ePEARL made significantly greater gains compared to control students in writing skills as assessed on a standardized literacy measure (Canadian Achievement Test, 4th ed.) (Meyer et al., 2010; Abrami, Venkatesh, Idan, Meyer, & Wade, in press).

We found that teachers who used ePEARL were more likely to use technology for creative, evaluative, and informative purposes (Meyer et al., 2010). One teacher reported that she was pleased to see a change in her students' awareness of the various purposes of technology. She reported having a student tell her, "I've really realized that computers are a lot more than just a thing to go on and research." She reflected on this by adding, "I thought, wow, because we haven't really talked about that and there he is coming up with: 'this is a way for me to keep all my stuff together and watch what I'm doing' " (AS1). These data offer encouraging evidence that electronic portfolios such as ePEARL provide valuable instructional support for teachers as well as pedagogical support for students as they work to develop their 21st century literacy skills.

These teachers all demonstrated a great deal of creativity and cross-curricular approaches in their teaching. The projects that students included in their portfolios show that although teachers did primarily emphasize reading and writing activities, they also included diverse content area and media to help promote deeper and more complex understandings of the world. Some of the assignments and projects included in the EPs from these three classes are presented in Table 1 as a matrix to indicate how the various portfolio entries supported specific elements of the NCTE 21st century literacies framework.

Table 1: ***Sample ePEARL Assignments and Links to NCTE's 21st Century Literacy Skills***

ASSIGNMENT	DEVELOP PROFICIENCY W/ TECHNOLOGY	BUILD RELATIONSHIPS	DESIGN AND SHARE INFORMATION	MANAGE MULTIPLE STREAMS OF INFO	CREATE/ CRITIQUE MULTIMEDIA TEXTS	ATTEND TO ETHICAL RESPONSIBILITIES
Papier mâché masks: story	●	●	●		●	
Collaborative story writing	●	●	●	●	●	
Insulating Machine	●	●	●	●		
Oral reading	●		●		●	
Group PPT presentations: environment	●	●	●	●	●	●
Biographies	●		●	●	●	
Readers' Theatre	●	●	●	●	●	●
First Nations village	●	●	●	●	●	
Response to Dove "real beauty" Video	●		●	●	●	●
Response to PBS website on ads for kids	●		●	●	●	●
Create warning about stereotypes in TV shows	●		●	●	●	●
Excel graphs	●		●	●		
Simple machine playground	●	●	●			

As this table demonstrates, the assignments include content from Science, History, Reading, Writing, Art, Media Literacy, Math, and Computer Technology. With each of these assignments students were developing the computer technology skills as well as at least one other area identified in the 21st century literacy program. Students were reading and critiquing various forms of media as well as creating their own texts and artifacts in individual and group projects. One teacher explained how working with ePEARL allowed students to showcase their strengths and problem-solving skills,

> …they were able to do so much more: "miss, I figured out how to paste it in" or sometimes we just saw them go ahead and try, and they figured out ways to do it even before I had showed them. Which is great. They're learning from each other and they're teaching me some new stuff, too. (QL9)

The ePortfolio provides a unique medium in which students and teachers can collect, reflect, and extend on these skills. In the absence of such a rich central storage point that provides detailed information about the learning process, it would be quite difficult to show and measure student growth in these areas over time.

Lessons Learned

During this three-year research project the researchers and teachers developed new approaches to and understandings of how to best integrate the new technologies and new pedagogies associated with integrating an electronic portfolio in the elementary classroom. Some of the key lessons we have learned from this study are:

1. ePortfolios can promote creative and pedagogically sound ways to integrate new technologies in the classroom

2. Teachers reported that ePEARL improved their instructional and assessment practices

3. Teachers reported seeing positive impacts on student motivation and engagement while using ePEARL

4. ePortfolios can effectively promote each of the six elements of the 21st Century Literacies framework

The strengths that we have observed while working with ePEARL in classrooms for the past seven years are many. We do believe in the effectiveness of an electronic portfolio to help students and teachers better understand creative and learning processes. Web 2.0 tools such as this can also help students, teachers, and families communicate and collaborate more effectively across distance and time. However, we do not claim that ePortfolios are the only way for teachers to meet the objectives outlined in the 21st Century Literacies framework. We recognize that many educators have their own creative and innovative ways of integrating various technological tools into their praxis. We also acknowledge the presence of many other exciting educational technologies. However, we are aware that many elementary teachers continue to struggle with the evolving demands of teaching these newer literacy and technology skills. ePEARL was designed in such a way as to require little technical training and the CSLP provides direct pedagogical support to the students, teachers, and school communities who have chosen to work with this tool.

Our research has demonstrated that this tool can have multiple positive impacts in classrooms, but as with any new technology in the classroom we have also documented some challenges (Meyer, Abrami, Wade, & Scherzer, 2011). As with many technologies, teachers did experience technical issues including: computers freezing, servers crashing, limited time with and access to computers, and the need to incorporate instructional time to teach basic keyboarding skills. However, in spite of these challenges, the teachers who regularly used ePEARL were pleased with their own professional growth as well as the progress their students made. The ePEARL research and development project has resulted in the design of an effective, powerful bilingual (French-English) tool that is available at no cost to the educational community. Hopefully these success stories may inspire others to slowly integrate some new approaches to fostering 21st century literacy skills. As one teacher reported,

> I'm learning so much about technology just using ePEARL, which is important. We're in a world where technology is at the front of everything, so for me, improving and learning more about it so that I can help the students is definitely my main goal. (QL9)

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Don't Give Up: A Case Study on Girls and Video Game Design

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ABSTRACT

This case study examines the experience of two sixth grade girls who participated in a game-design class in a class taken by all students at their school. Questions were: How do the experiences observed demonstrate engagement with a story drawn from the participants' own lives?; and: How does the experience observed reflect experiences leading to competency, perseverance and science, technology, engineering and math (STEM) self-efficacy and the development of interest in STEM careers? Findings were that the students were highly engaged with the chosen topic and demonstrated growth in the attribute of perseverance and self-efficacy in STEM skills.

Introduction

According to a US Bureau of Labor report, approximately one in six employed Latinos, aged 25 and over, have completed a bachelor's degree, less than half the proportion of employed Whites, indicating an education equity gap. Between 2000 and 2011, this gap grew from 17.6 percentage points to 20.1 percentage points. In addition, Latino/as employed in professional, scientific, and technical fields made up just 7.1% of the workforce in 2011. Looking at both gender and ethnicity together presents an even starker picture: the percentage of computing occupations held by Latinas was 1.5% in 2009. Meanwhile, computing has been identified as one of the fastest growing professions, with a projection of 800,000 positions to be filled by 2018 (Bureau of Labor Statistics, 2012). As educational inequality and professional opportunity gaps widen, the need to reach Latinos, and young Latinas in particular, with more targeted and effective opportunities for advancement is clear.

The Globaloria program is a game design intervention that aims to introduce students to game design and social media by putting them in the role of a game designer and developer, offering one approach to mitigating these gaps. The program embodies the theoretical instructional design principles of Constructionism and distributed cognition (Harel & Papert, 1991; Salomon, 1997), and is being implemented in middle and high schools serving economically disadvantaged students in several U.S. states. Participating students engage in collaborative game design within a formal, in-school elective game design class offered for credit and a grade. Students in many participating classes create a social issue game that also includes some academic content such as math or science. The primary goal from the students' perspective is to create a functioning interactive web game by the end of the school year, which can teach other students about their chosen social-impact topic. To complete a game, students participate in several integrated technology-supported activities such as inquiry and collaboration in teams to meet a range of instructional objectives towards achievement of "constructionist digital literacy" (Reynolds & Harel Caperton, 2009).

In this case study impact report, we meet a team of two sixth grade girls who call themselves the "Blue Flowers," and are part of Globaloria as it is being implemented at a charter middle school in East Austin, Texas. The team consisted of students who were both English Language Learners from a high poverty neighborhood. At this school, the 6, 7, and 8th grade students take the game-design class across all three years of middle school and many will also continue throughout high school. Our report focuses on ways in which the team's identification with the main content of their game design project (connected closely to the team members' personal lives) appears to have supported their acquisition of the Constructionist digital literacy learning objectives. The study draws upon Social Cognitive Theory (SCT) to examine the connections between the student-centered game design experience and the development of students' STEM related self-efficacy. Theoretically, it may be that for some students, creating games about a social issue to which they have a personal connection leads to greater affective identification with the activities themselves, which may in turn cultivate their interests in careers in the STEM disciplines.

Literature Review

The game design intervention employed by the students in this case study, called Globaloria, was influenced by previous research on Constructionism, which is a philosophy and framework for learning and educative action (diSessa & Cobb, 2004) developed by Seymour Papert and colleagues at the MIT Media Lab (Papert, 1980). Constructionism builds on Piaget's theory of constructivism, in which learners are young scientists and inventors whose active creative work in theory building and testing develops their knowledge of how the world works. Consistent with sociocultural theory perspectives, learners benefit from social interactions and sharing throughout the process of creating a computational artifact often involving programming, in which the artifact expresses conceptual knowledge in a dynamic way. Within Constructionism, educators act as expert mentors and facilitators, and peers also guide each other, operating within a workshop-based environment. The mentoring and collaborative peer relationships also serve to provide the social support and vicarious modeling for the development of stronger STEM self-efficacy (Zeldin & Pajares, 2000).

The game-design program places young learners in the role of game designers who model the behaviors of professionals, such as computer scientists and engineers. Bandura's Social Cognitive Theory holds that individuals can develop self-efficacy in a given domain through modeling and having positive affective experiences in the domain. Self-efficacy is a core concept in (SCT) (Bandura, 1977). Bandura (1995) defines self-efficacy as: "beliefs about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives" (p. 11). He writes,

> People with high assurance in their capabilities approach difficult tasks as challenges to be mastered rather than as threats to be avoided. Such an efficacious outlook fosters intrinsic interest and deep engrossment in activities. They set themselves challenging goals and maintain strong commitment to them. (p. 11)

Several studies have concluded that interventions involving successful experiences increase STEM self-efficacy (e.g., Betz & Schifano, 2000; Luzzo, Hasper, Albert, Bibby, & Martinelli, 1999). We expect that engagement in the game design program we investigate has the potential to cultivate positive affective experiences in the STEM game design activities in which students participate.

Further, in a chapter entitled *Social Cognitive Career Theory*, in the book *Career Choice and Development*, Lent, Brown, and Hackett (2002) describe "a complex interplay among goals, self-efficacy, and outcome expectations in the self-regulation of behavior" (p. 263) as it relates to development of *career interests*. Social Cognitive Career Theory (SCCT) posits that personal goals are driven by one's self-efficacy beliefs about the goals themselves, and activities related to the goal. Self-efficacy beliefs influence ongoing development of one's outcome expectations, adding to a process of career interest development. Since the Globaloria program and the charter school addressed here both hold common objectives to offer interventions that prepare students to enter the STEM field, formation of STEM career interests and goals is a focus for investigation. Self-efficacy forms the initial basis for the longer-term formation of career interests. Our research considers apparent changes in students' self-efficacy.

The introduction of students to programming through a meaningful context of computational media production has been found to provide new pathways for underrepresented students and groups to enter into Computer Science (CS) disciplines and appropriate technical expertise (Forte & Guzdial, 2005). Rich, Perry, and Guzdial (2004) found that a CS course emphasizing relevance, collaboration, and creativity provided a pathway for more CS interest, particularly among women. Eisenhart and Edwards (2004) conducted research with younger minority girls in a technology afterschool program. Their findings were that the girls' level of interest and sustained engagement was stronger when they created a project using a topic that was meaningful for them. Such studies support introduction of STEM content through computational media production as is done in Globaloria, particularly with underrepresented populations.

Research indicates that computational media production can be further supported when students identify with the subject matter of their project. Kelleher, Pauscher, and Kiesler (2007) found that girls who used Storytelling Alice, a 3D computer programming environment in which they created stories depicting relationships and ideas from their own lives, had more signs of engagement with programming than those who used a similar tool without support for storytelling. The girls who used the storytelling tool spent 42% more time on programming and expressed stronger interest in future use of the tool than users of the version without storytelling support. The investigation also found a relationship between interest in using the programs and interest in pursuing computer science. This is compatible with the SCCT interest model, which holds that "self-efficacy and outcome expectations regarding activity involvement exert an important, direct effect on the formation of career interests" (Lent, Brown, & Hackett, 2002, p. 265). In this model, people form a lasting interest in an activity in which they believe they have competence and which will lead to a positive outcome. Minnigerode (2012) reported results of a previous survey study investigating interest development among students in the Texas school of focus here, indicating that many students who started the sixth grade year with no interest in pursuing a STEM career became interested over the course of the sixth grade year.

The literature on students and particularly girls using stories from their own lives as content for a digital artifact indicates that identifying with the subject matter is a motivating factor for engagement in computational media production. The literatures on SCT, SCCT, and other cognitive theories connect competence and success in STEM to the development of enduring interest. The successful experiences, also called mastery experiences, provided by working with technology and engineering skills while also drawing on material relevant to students' lives, may interact to provide a particularly effective potential pathway to STEM career interest development.

In this case study, we investigate the following questions:

1. In what ways do two high-performing middle school female team members demonstrate engagement in game design around a story drawn from their own lives?
2. In what ways do two high-performing middle school female team members demonstrate engagement in game design that appears to lead to perseverance, STEM self-efficacy, competency, and the formation of interest in STEM careers?
3. In what ways does the use of the stories from the girls' lives in game design appear to contribute to their perseverance, STEM self-efficacy, competency, and the formation of interest in STEM careers?

Methods

This initial case study is inductive and exploratory, drawing on an eclectic range of sources. We chose a single high-performing team of focus in the present study and review data from individuals within the team, and the team as a whole.

Participants

Teachers and the parents of the students have given signed consent to participate in this research project, in accordance with IRB from Rutgers University. The students and their parents gave full informed consent for participation in this study. The students' names are changed per Institutional Review Board requirements.

School.

The school is designed for and attended by students who are mainly from the surrounding economically disadvantaged community. The enrolled students are Latino (80%) and African American (20%). Approximately 40% of students are classified as English Language Learners. The school's mission is to address the need for the educational attainment in Latino/a students and improve the employment picture in East Austin by providing an innovative STEM education experience. The mission of the school indicates a recognition of some the unique needs of their student population in light of the U.S. Bureau of Labor Statistics data cited above, and works to address the gap in support of academic and career goals, in part by requiring all middle school students to participate in the class.

Team.

The case study participants are two female eleven-year-old sixth grade students, Marissa and Benita, who were new to middle school in the year of focus (2010-11). This team was selected as the subject of the case study because its project represents an example of students working with a highly relevant topic that pertains to their local cultural experience, reflecting personal meaning-making, one of the aims of the project. Thus, this case might be considered a "success story." Early in the year, each of the students related to the teacher stories about how she had struggled with reading and English-language arts in elementary school.

In the previous year, both team members attended traditional non-charter elementary schools that maintained a strong focus on drill and practice, in preparation for standardized assessments. Both girls express a lot of interest in technology. Early in the school year, Marissa writes on her blog: *I also want to tell my parents what I have accomplished with using the computers. My parents wanted me to learn about computers so I can teach them.*

The girls became a team called Blue Flowers; formed because of their mutual interest in the topic of drop-out prevention. They began to conduct topical research and at the same time worked with online tutorials and game design topics before they started to work on the game idea for a drop-out prevention game.

Intervention

The students learn to write code in the ActionScript language using Adobe Flash software. ActionScript is the programming language used by the Flash software. Adobe Flash is a multimedia software platform used for authoring animation, audio, and graphics, and is frequently used to add animation to web pages (TechTerms, 2013). In the class, the teacher provides some direct instruction in writing code and guides students to online tutorials that provide step-by-step instructions for implementing the code. The students' game-making process also includes researching a social issue topic of their own choosing using a variety of materials, writing a blog, keeping an online learning log, and collaborating on a design document on a course wiki or site developed collaboratively by users. The students work in teams and each team member posts his or her work in this shared environment. The student teams also give feedback on other teams' projects at several points along the game development cycle.

Analysis

This research uses an inductive case study method, drawing on data sources that include classroom observation of student teams in situ, interviews with students, students' written reflections, survey responses on student self-efficacy related to STEM, teacher interviews, and students' game artifacts. The primary focus of observation is the students' attributes of efficacious behavior in the learning environment as the team learns to develop games. Teacher interviews addressed student behavior and interactions that demonstrated attributes related to problem-solving and efficacious behavior. We examine student reflections about their work in blog entries and posts to the wiki. Students wrote on a blog throughout the year, and these blog posts were analyzed for evidence of the themes of student interest in the topic and perseverance in game design and programming work. Midway through the year, students were asked to write about their aspirations for the future in response to a blog prompt. Student interviews addressed their chosen research topic and the nature of their connection to it. All students are also asked to describe a goal for their future on a pre- and post-program survey.

Variables measured in pre/post-survey tests of difference.

Students also took two sets of surveys associated with the formative and summative evaluation of the program. In addition, all students participating in the program took a self-efficacy survey four times throughout the year. The instrument was derived from Bandura's work with adolescents (Bandura, 2005). In the survey, students are asked to respond to a series of questions in three domains of self-efficacy:

STEM learning, enlisting social resources for learning, and self-regulation for learning. The survey contained 11 items. The students responded to items that described a specific task within the game-design class, and asked students to rate their confidence that they could complete the task with a number along a scale of 1-100. The instrument was developed based on Bandura's work measuring self-efficacy in adolescents (Bandura, 2005) and comprises three study-specific domains of self-efficacy, (a) *learning STEM content,* i.e., student confidence that they can learn the technical content in the Globaloria course, (b) *enlisting social resources for learning*, i.e., student confidence that they can enlist their support teachers and peers as needed, and (c) self-regulation for learning, i.e., student confidence that they can regulate their own learning and persist when the work is challenging. Four items addressed domains (a) and (b) and three items addressed domain (c). It should be noted that this instrument has been studied and revised since the time of this case study. See Appendix 2 for the survey. More information about the instrument and the qualitative analyses conducted with the data collected can be found in a paper entitled *Self-Efficacy in Economically Disadvantaged and English Language Learner Middle School Students Learning Game Design* (Minnigerode & Malerba, 2012)

Results

On the whole, the team members demonstrated high levels of engagement with their chosen topic of drop-out prevention, illustrated by their behavior, final accomplishment, and an analysis of their game. Specifically, analysis of their reflections in writing revealed recurring themes of strong commitment to achieving challenging goals during the tasks of computational and design problem solving. Analysis of the team's game *Don't Give Up*, the game they created, reveals use of advanced features that are not typically implemented by beginning game programmers. The game was playable and challenging, making it popular for repeated use as observed among the other students at the school. The responses the students gave on surveys also demonstrated growth in their self-efficacy related to programming and game design skills and demonstrated development of goals of pursuing STEM careers.

STEM Skills and Perseverance

The students demonstrated improved STEM skills across time, moving from hesitance to self-confidence with the subject matter. For instance, Marissa and Benita worked to create a "type your name" feature for their game even though this content was not available in the curriculum. This feature was part of the original design for their game as seen in the Paper Prototype of *Don't Give Up* (Figure 1, below). Their classroom teacher reported that in order to carry out their design, the students researched on their own how to develop the feature, and they were successful in developing the feature they had envisioned where a player would choose a gender, and then enter a name. Their final product is shown in Figure 2, below. These results demonstrate mastery of the STEM skills, and commitment to achievement of a goal often described as efficacious behavior.

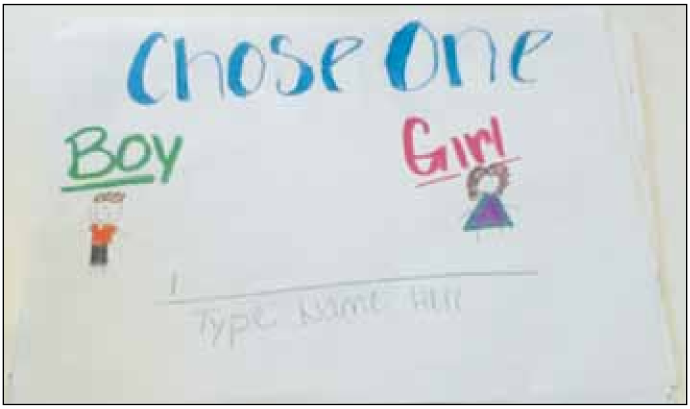


Fig. 1: Paper prototype page with "Type your name" feature

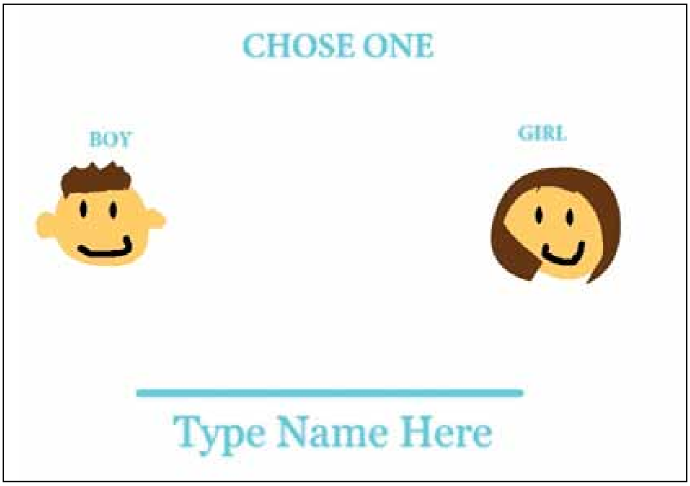


Fig. 2: Implementation of "type your name" feature

Engagement with topic.

The case study students chose the topic for their project because they were very connected to the issue of dropping out, after observing people in their lives who have dropped out of school. The name of their game was *Don't Give Up*. It was so named because, in the words of Marissa, "dropping out means giving up." As Benita writes: *I want them [the players] to understand that if you drop out of school you are gonna have troubles finding a job. And most chances that you are gonna regret that you drop out of school.*

The students' motivation for making the game was a desire to make a difference and the team members maintained a connection with the mission throughout the time they worked on their project. The transcript excerpted in Table 1, below, provides detail about the students' experience.

Table 1:
Interview With Students About Game Topic

MARISSA:	BENITA:
"We should show kids, because nowadays kids are dropping out of school. My cousins dropped out. …. At first I thought it was good because they were going to take care of their kids, but then I saw it was bad because they have to pay the bills and it's hard for them. And my cousin… she doesn't have time to take care of her baby. Because she is working."	"I also have a cousin like that. She works more hours because she needs the money. …Like… if you get a GED you get to choose. Any job that you get, they pay more. But if you don't get one, you have to work in McDonald's and they don't pay you that much. So you have to work extra hours."

The students wrote on their blogs about their goals for the game, describing what they wanted the people who played their game to learn. The blog posts, from February 2011, are included below.

Feb 16, 2011 Blog Post, Marissa:

The topic of my game is that I want players to learn about the importance of staying into school. I want my game to teach the players what the barriers to

> *college are. I want my game to teach people what they have to prevent when they are their way to college. The main theme of my game is to teach them how hard it is when you do not go to college. My game would have stages where you need to avoid the reasons you dropout of school.*

Feb 16, 2011 Blog Post, Benita:

> *The learning goal for my game is about why kids dropout. And I want the people that are going to play to learn that you should not drop out.*

Efficacious behavior and perseverance.

During the course of the year, the researcher observed in the classroom weekly, and followed students' blog posts. From review of their writing, it was clear that the students had a lot of thoughts about perseverance and "not giving up." The students demonstrated these qualities and also sought to communicate about them in their game. For example, Benita writes,

> *Last class we watched a movie called 'The Pact' and it was a really good movie. In the beginning it said that EDUCATION could save ur life and i do agree with him because if you have education you have a chance that you mite have a better life. And another thing i heard from the video/movie that you should never give up.*

Marissa writes,

> *The topic of my game is that I want players to learn about the importance of staying into school. I want my game to teach the players what the barriers to college are. The main theme of my game is to teach them how hard it is when you do not go to college.*

Both of the above comments demonstrate the theme of not dropping out, which the girls embody in their work style and interactions. The examples below describe the girls' commitment to achieving their own goal of making a game.

The team discovered that some of the elements they included in their game design plan required them to go beyond what was available in the class curriculum. They began to figure things out on their own. The girls remained very focused on this task, working until they were able to successfully implement features for type-your-name and scorekeeping.

The following vignette is drawn from a teacher interview to illustrate the students' strong commitment to achieving this goal:

Teacher:

The girls came in after school many times, because they were having a hard time figuring out how to implement the hit-test in their maze game [when an object runs into another object, it triggers a score or other event]. Each section of their maze was a separate object and they had them all pieced together. Eventually Marissa was able to figure that out on her own after school.

Benita reflected on her experience and blogged,

I learned how to make a life [in ActionScript], how to make points and also how to make a button and how to make the barriers move. It was reaaly hard. I am so happy that I was nominated in the Globey Awards like we are so awesome—me and my partner worked so hard to find how to make the points. We took weeks to find out.

Both students attended more than one afterschool work session, and also came to the school on a special weekend workday to spend more time finishing their game. After the game was finished, Marissa wrote: *I was really surprised that I finished my game because I almost wanted to give up but I didn't. This is an awesome experience because I enjoyed to make my game. I liked to find where the codes are*.

The girls' design employed their perceived barriers to high school graduation and success: drugs and getting pregnant and represented them as literal obstacles within the game. In the game, the player must dodge cigarettes and babies and move through a maze while also collecting "lives" and books. The game became one of three finalists in the sixth grade social issue game category of the school's year-end awards, called the Globey Awards competition. See game screen in Figure 3, below.

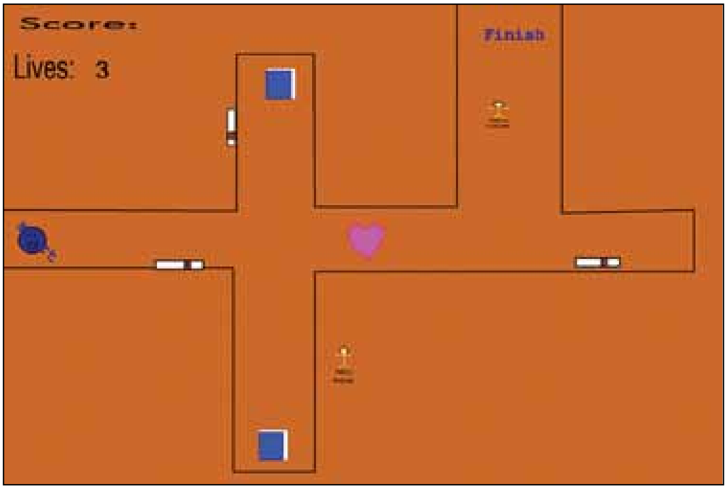


Fig. 3: Level one from the game *Don't Give Up*

The school's end-of-year competition recognized students in categories including Best Programmer, Most Improved and Best Blogger. Best Programmer finalists were selected based on the following rubric:

- Cool use of Flash skills
- Helped others and improved skills outside of class
- Used problem-solving skills

Both Marissa and Benita were nominated and became finalists in the category of Best Sixth Grade Programmer, along with one other sixth grade student. Marissa was selected as the winner of this award, and honored at the end-of-school year awards ceremony. This illustrates that both students achieved a measure of success as STEM learners and problem solvers.

STEM Self-efficacy

All students at the school took a survey designed to measure self-efficacy in the game-design classroom. Three domains of self-efficacy were examined: STEM skills, self-directed learning, and enlisting social resources. For the 6th and 7th grades participating in the project, for the variables connected to all three domains, there were significant differences between average ratings at time 1 and time 3, $t(345)$ 2.45, $p < .05$ and between time 1 and time 4, $t(330) = 2.32$, $p < .05$.

The case-study subject girls appeared to show growth in self-efficacy across all areas. See Appendix 2 of this report for a chart depicting some pre- and post student survey responses. Benita demonstrated the most change in self-confidence in the categories of (a) helping other students and getting help from other students while programming (enlisting social resources), and also in (b) self-confidence to express her thoughts clearly. These results match observations of Benita's behavior in the classroom. When she first began the class she was very reserved; by the end of the school year, she had helped many other teams in the class to implement the "Type-your-name" feature in their games.

Marissa began the year with higher self-confidence and so reported slightly less dramatic changes overall, but one exception was her growth in self-confidence in "figuring out what to do when stuck on something when programming." This finding matches the behavior we observed in class, where she persevered towards a solution; many times using time after school to continue to try to solve the problems she encountered, and finding success in doing so.

Career Goals

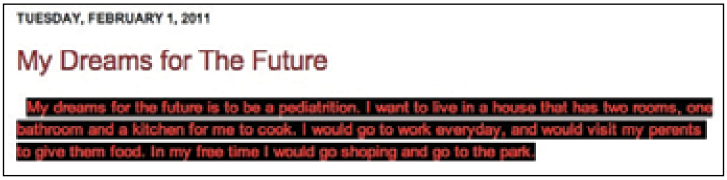
The team members, and all students in the school's Globaloria program, responded to an open-ended survey question with a possible career goal. This question appeared on a survey that they took 4 times during the year. The goals mentioned by Benita and Marissa are found in Table 2, below.

Table 2

Student Career Goals Across the Year of 6th Grade

CAREER GOALS	TIME 1 (PRE)	TIME 2 (MID)	TIME 3 (POST)
Marissa	Fashion Designer	Pediatrician	Teacher
Benita	Marine Biologist	Marine Biologist	Forensic Scientist

At the mid-point of the year, students were asked to write an extended reflection about their dreams for the future on their blogs. Benita wrote about her future career choice: working as a marine biologist with sea animals. Marissa wrote about her dream of being a pediatrician and living in a house with two rooms. Please see her blog post, below.


TUESDAY, FEBRUARY 1, 2011

My Dreams for The Future

My dreams for the future is to be a pediatrition. I want to live in a house that has two rooms, one bathroom and a kitchen for me to cook. I would go to work everyday, and would visit my parents to give them food. In my free time I would go shoping and go to the park.

Fig. 4: Marissa's blog post regarding career goals

Discussion

In this case study, we saw evidence of the project-based game design class as support for the development of students' STEM skills and perseverance, STEM self-efficacy in areas related to problem solving with computer programming, and career goal development during and after their participation in the classroom. It is possible that these experiences were mediated by the students' engagement with the game topic that was drawn from relationships in their lives. At the end of the year, both students in the case study demonstrated very strong engagement in game-design project, and report high levels of self-efficacy. In addition, both have shown some interest in STEM career fields.

It appears that the students' use of stories from their own lives as content of the digital media project, in this case a game, supports their level of engagement, and may also support changes in affect. In this case study, the students are highly engaged in the subject matter, and have a mission of improving the lives of the players who play their game by using its content and mechanics to impart a message. They participate actively in the game design class and create a working final product. At the end of the project, they are recognized for their performance and achievement. In the future, we can test this case study result further in larger survey datasets by including questions on student affinity for the game subject, and investigate the relationship between such affinity, affective shifts, and learning outcomes. A further question for future study is how student engagement in this program contributes to development of a lasting interest in STEM as a potential career goal.

Findings from the Girl Scout Research Institute (GSRI) indicate a strong desire among middle and high school aged girls to "make a difference in the world" and to help people (GSRI, 2012; GSRI, 2008), with the desire to make a difference in the world most frequently cited by girls in the study as an important reason for their career choices. In the current study, we saw that the team members were highly engaged and developed both STEM skills and improved self-efficacy for some of the STEM skill areas. During this time period, the team members expressed the STEM field career goals of forensic scientist, marine biologist, and pediatrician. It may be that offering girls the experience to build games on such aspirational themes contributes to their interest and engagement. While the students in this case study demonstrated a personal connection to the mission of their game, and sustained interest in the mission. Projected across a year, it should also be noted that the activities of digital game design and programming may provide substantial interest as well, thereby interacting in its effects with the nature of the thematic content of the game.

This case study found that girls in this technology and game design classroom became very engaged and developed STEM self-efficacy across the year. The longitudinal nature of the school's game design program, with classes offered throughout the middle school years, will allow for continued and multi-factored examination into changes in the girls' engagement, STEM skill self-efficacy, outcome expectations and career goals, and the decisions they make as a result. In the future we will conduct a comparative case study of multiple teams, examining how distinctly dissimilar cases can exploit the variability among cases and thus facilitate discovery of appropriate explanations and hypothesis generation (Firestone, 1993). While selecting a high performing team for the case is a limitation, the aim is to highlight *what is possible to be achieved by some students*, and elicit further refined research questions. Future comparative work will investigate the fuller ranges of student experiences. In concert with future research mentioned, additional study of the experiences of students who participate in this game design program will seek to illuminate possible links between the use of stories from the game designers' lives, thematic content, and the potential to make a difference in the world through engagement, and ties to development of career interest in STEM fields using the skills developed in game-design class.

Appendix 1:
Self-efficacy for Learning Engineering Instrument

Components and item text of the Self-efficacy for Learning Engineering Instrument

Component of self-efficacy for learning engineering	**Item number**	**For each of the following questions, we are going to use a scale of 1-100. Numbers close to 1 are connected with a low confidence and numbers close to 100 are connected with complete confidence. Numbers around 50 are connected with a medium level of confidence. (Please choose a number from 1-100)**
Self-regulation of learning	Item 1	How confident are you that you can finish assignments on time in Globaloria?
Self-regulation of learning	Item 2	How confident are you that you can always concentrate on school subjects during Globaloria class?
Self-regulation of learning	Item 3	How confident are you that you can remember information presented in Globaloria class?
Learning new engineering skills	Item 4	How confident are you that you can figure out new things about editing the wiki?
Enlisting social resources for learning	Item 5	How confident are you that you can get help from another student when you get stuck on something in Globaloria?
Enlisting social resources for learning	Item 6	How confident are you that you can get help from a teacher when you get stuck on something in Globaloria?
Enlisting social resources for learning	Item 7	How confident are you that you can help other students who are stuck on something in Globaloria?
Self-regulation of learning	Item 8	How confident are you that you can participate in class discussions in Globaloria?
Learning new engineering skills	Item 9	How confident are you that you can put your thoughts and ideas into words that are easy for people to understand on your blog?
Learning new engineering skills	Item 10	How confident are you that you can figure out what to do when you get stuck on something doing Flash?
Learning new engineering skills	Item 11	How confident are you that you can search on the Internet to find help when you get stuck on something?

Note. The instrument was designed to measure three components of self-efficacy for learning engineering: self-regulation of learning, enlisting social resources for learning, and learning new engineering skills.

Appendix 2

Some pre- and post-results on self-efficacy measures

How confident are you that you can figure out new things about editing the wiki?

	Pre	Post
Benita	60/100	90/100
Marissa	90/100	100/100

How confident are you that you can get help from another student when you get stuck on something in Globaloria?

	Pre	Post
Benita	30/100	90/100
Marissa	50/100	90/100

How confident are you that you can help other students who are stuck on something in Globaloria?

	Pre	Post
Benita	32/100	90/100
Marissa	90/100	99/100

How confident are you that you can put your thoughts and ideas into words that are easy for people to understand on your blog?

	Pre	Post
Benita	30/100	90/100
Marissa	69/100	90/100

How confident are you that you can figure out what to do when you get stuck on something doing Flash in Globaloria?

	Pre	Post
Benita	50/100	90/100
Marissa	60/100	90/100

How confident are you that you can search on the Internet to find help when you get stuck on something in Globaloria?

	Pre	Post
Benita	60/100	90/100
Marissa	50/100	100/100

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Text-to-Speech Technology as Inclusive Reading Practice: Changing Perspectives, Overcoming Barriers

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ABSTRACT

Many students struggle to read well enough to support learning in various areas of the curriculum. Drawing on an eight-month inquiry, with 28 grade five students, this article discusses text-to-speech technology as an inclusive reading practice that allows students entry into their literacy communities, access to a variety of texts, and enhanced meaning making. It seeks to illuminate concerns and questions teachers, students, and parents might have with regard to the use of text-to-speech technology.

> Everyday, children come to school unable to read despite the best efforts of their teachers. They are slow to recognize the letters of the alphabet and have great difficulty learning the sounds each letter makes. Their knowledge of sight words is minimal. They have limited interest looking at books or listening to stories. By the time they reach fourth grade, their reading skills have advanced to a level equivalent of a mid-year first-grade student. Year after year, these children, their parents, and teachers have tried new instructional approaches; used a variety of instructional materials; devoted extra time to reading activities; engaged peer readers to work with them; and used a host of motivational techniques to model, reward, and even coerce them to read. Despite everyone's best efforts, these children have not developed the reading skills that allow them to derive meaning from text with adequate speed, fluency, and comprehension. (adapted from Edyburn, 2007, p. 146)

The Dilemma

> If a child repeatedly fails to read and to understand printed text, how much data documenting this failure needs to be gathered before we have enough evidence that the child can't perform the task? (Edyburn, 2006) When do we intervene? And what do we do? (Edyburn, 2007, p. 149)

The reading research has long investigated reader differences, why readers struggle, what happens when readers struggle, how best to intervene, and how best to support. Traditional reading interventions (Dolan, Hall, Banerjee, Chun, & Strangman, 2005; Rose & Meyer, 2000) are often designed to support readers' ability to decode and make the connection between the sounds heard and letters read. While systematic phonics instruction (Adams, 1994; National Reading Panel, 2000) benefits many children, there is a group of students who may never achieve a level of speed, fluency, and accuracy that supports their emotional, social, cognitive, and intellectual development. The problem is one of information processing: by the time they have successfully decoded the word, they have little to no energy or capacity left to solve the word, let alone make sense of it, and then do something with it (i.e., comprehend, respond) (Hirsch, 2003). As a result, many of these students enter into a vicious cycle of withdrawal from text, which widens the gap between those who read well and those who don't, referred to as the Matthew Effect (Stanovich, 1986).

Bypassing decoding issues, TTST may prevent the cycle of withdrawal often attributed to inaccessible curricula, low levels of motivation, lack of confidence, and/or reading deficits in phonemic and phonic awareness (Bryant & Bryant, 1998; Day & Edwards, 1996; Dolan et al., 2005; Hitchcock & Stahl, 2003; Hodge, 2003; Lewis, 1998; Kellner, 2004; Raskind & Higgins, 1998; Sipe, 1999). It may also reduce reliance on "human" supports in a variety of contexts, therefore enhancing independence (Cople & Ziviani, 2004; Labbo & Reinking, 1999; LDOnline, 1998; Pisano, 2002).

Despite this compelling research, parents and teachers continue to be plagued with questions of: *What do we do with students who struggle to read despite numerous interventions focused on decoding, speed, and fluency? Do we continue to teach decoding, or do we try something new? And in trying something new, how do we ensure that students who struggle to read the conventional/traditional way are not stigmatized, perceived by others as privileged, or accused of cheating?*

These are honest questions and real concerns discussed by many in the field—ones that I have encountered on multiple occasions. I often find myself defending and rationalizing in a way that supports these students and their rights to be readers…

Opening the Conversation

Regardless of whether I'm talking to teacher candidates, teachers in the field, parents, or even students, I begin with a conversation about fairness, accommodation, and sensitivity. I open with some simple yet insightful questions:

How do we learn best? How are you smart? How can we each be taught in a way that matches our strengths, needs, and interests?

Hands go up and discussions circle, but we come to a tentative agreement that each of us deserves to be taught in a way that is fair and equitable, responsive to our strengths, needs, and interests. We acknowledge that the best learning occurs when what is taught is what is needed in a way that is meaningful, relevant, and allows students to be part of their classroom communities.

Gradually I push the conversation toward reading, asking, *What do you remember about learning to read? What do you do when you come to a word you don't know? What happens when you don't read or can't read what is required? How can we, or do we, support students who struggle with reading?*

At this point, we discuss what happens when teachers have exhausted available interventions and specialized supports, and students are still not reading at an age, grade, even cognitively appropriate level. We talk about not reading well enough to access the texts that support learning. I know they know what I am talking about. I know that every single person in the room has either observed this frustration or experienced it somehow over the course of their lifetime. And I know that at times, they have felt every bit as powerless as I have or my students have…

They are ready, they are thinking, and I know that I am about to tread on thin ice, but out I skate…

I enter into a discussion of technology and the promise and possibility that text-to-speech offers students who struggle. If I close my eyes, I can already see not one but five hands about to go up. I know I have their attention, especially as we enter into the inevitable discussion of high interest, low vocabulary texts, the concept that we learn to read by reading, and the importance of access to their age, grade, and cognitive reference groups.

I can see some sitting there thinking, that was me… I never got to read the same as the others. And I can see some sitting there, those who never struggled, struggling now with the question of, *But how, if we give them a computer, will they ever learn to read?*

And I know that as sure as this question gets posed, I'll also hear, *But, when we take it away, they won't be able to read on their own. And here I ask: Why take it away? Would you take a guide dog from an individual with a visual impairment?*

I steel myself for the debate and conversation about to surface. I know that there are as many viewpoints in the room as there are individuals. And I am satisfied with the response. I know that it will not change overnight, but instead, it is far more important to get them thinking, encourage them to step outside their experience, and look at things from a different perspective. If I have disrupted what they have come to accept as commonplace—that it is not enough to simply modify the reading materials to the level students can read with 90-95% accuracy regardless of whether this is what interests them or not, regardless of whether this is age, grade, or cognitively appropriate—then I have done enough for today.

Ultimately though, what I want to share is that text-to-speech technology (TTST) offers a solution to this dilemma, particularly if it is viewed as an inclusive practice or way of reading. Now, this is not to recommend that TTST be used as a teaching reading program, nor that we bypass decoding issues in lieu of teaching decoding. Instead, I am suggesting that TTST may circumvent frustration and reader withdrawal due to inadequate decoding and fluency, freeing readers to do the real work of reading, which is making meaning. In this way, TTST supports the overall acquisition of literacy, and learning, as students continue to receive other forms of intervention such as systematic phonics instruction.

Unpacking TTST: What It Does and Does not Do

Text-to-speech technology (TTST) transforms print text into electronically read, computer synthesized text. Different than audio-texts, TTST allows any text, at any time, to be accessed (Anderson-Inman & Horney, 2007; Rose & Meyer, 2000) provided that a computer with scanning and TTST is available. The view inside a text reader (such as Kurzweil©) is the same as the view inside the print text, regardless of whether it is predominantly print, a website, or a text with multiple images and/or graphics (see Figure 1).

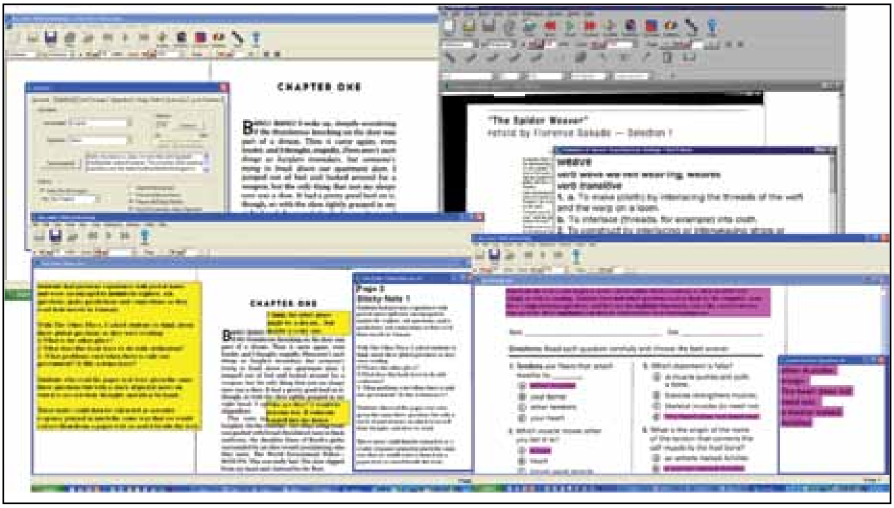

Fig. 1: The view inside Kurzweil©

TTST decodes for students with an accuracy and fluency that they cannot attain on their own: it does not think about text, make connections, or solve words. Take for example the following proverb, translated into very technical language:

CLICK SENTENCE BELOW TO HEAR TTST AUDIO FILE

Missiles of ligneous or petrous consistency have the potential of fracturing my osseous structure, but appellations will eternally remain innocuous.

Can you read it with a high level of accuracy? Understand it? Make sense of it? Apply it to your life? Now imagine reading it with a computer that is decoding the letters and sounds into words. Would that make a difference? Would you be able to understand it? Make sense of it? Apply it to your life? This is the task faced by readers who struggle, and often, it is not the meaning or even understanding of words that interfere. It is often the most basic level of letters and sounds that stops them dead in their tracks, not allowing them to go any further. They still have to think, to make sense of, to connect, to solve the puzzle of words. TTST cannot do any of this for them. TTST offers a similar level of support as read-alouds, but without expression of any nature. It is monotone, leaving the reader to bring what he/she feels is an appropriate level of expression to the text.

Traditionally, TTST was reserved for students with special needs but today's availability of technology, ranging from the free Adobe Reader© to the sophisticated

Kurzweil©, offers TTST possibilities to all readers both in and out of the classroom. This consideration of TTST as inclusive practice, however, raises many questions:

What are the implications of offering TTST as a text format to all readers? How does it fit in to what we already do? Will all readers want to use it? Will we have enough computers? Will reading the "decoding" way become a way of the past in the same way that we are seeing handwriting, even proper keyboarding, lose importance in favour of contemporary ways of being with technology? Will readers who can decode accurately and fluently on their own benefit from TTST; enhancing the gap instead of reducing it?

Research into the use of electronic text readers as support for reading consistently demonstrates that the effect is different for individual students. Studies that focus on word recognition, decoding, and sentence level awareness demonstrate some positive effect but are often limited due to factors such as lack of control group or limited length of study (e.g., three sessions to three weeks) (Farmer, Klein, & Bryson, 1992; Higgins & Raskind, 2000; Olson & Wise, 1992; Wise, 1992). The effect of TTST on reading comprehension varies depending on reading proficiency, with less proficient readers demonstrating elevated scores on reading comprehension and more proficient or confident readers showing depressed levels (Disseldorp & Chambers, 2002; Elkind, 1998; Elkind, Cohen, & Murray, 1993; Higgins & Raskind, 1997; Montali & Lewandowski, 1996). From a more general perspective, Hasselbring and Bausch (2005/2006) suggest that as a reading support, TTST helps students with learning disabilities access grade-level texts; as a reading intervention, it helps "students strengthen and improve their overall reading skills" (p. 73).

Although the research base appears to be ambiguous on which students benefit most from TTST, it underscores what we know about readers, particularly those who struggle—each learner presents with a unique set of behaviours and characteristics in diverse contexts, and therefore must be considered on a case-by-case basis (Disseldorp & Chambers, 2002; Montali & Lewandowski, 1996; Balajthy, 2005; Garrison, 2009; Hitchcock, Meyer, Rose, & Jackson, 2002; MacArthur, Ferretti, Okolo, & Cavalier, 2001; Zabala, 2000). While TTST may not produce generalized effects on reading, it is critical to determine which students benefit, in which contexts, for what purposes (Hirsch, 2003). The voices of students described below provide evidence that TTST positively influences the motivation, confidence, and self-efficacy of those who struggle most; in fact, TTST enables students to struggle with success instead of withdrawing from the task of reading.

Student Voices: What Works Best?

For many years, I heard from struggling readers, "But I don't want to be different," or from confident readers, "Why don't I get to use the computer?" From parents and teachers, I often heard, "But if you give them a computer, they will never learn to read. I don't want him/her to have a privilege that others don't have." My counterargument was, and is, "If you don't allow them to read with a computer, they may never learn to read in a way that supports their overall development. Others are privileged in the sense that they can read independently. Without TTST, some may never have this privilege." When TTST is offered as inclusive practice, as simply one more way to access text in the regular classroom, it is not overused but instead becomes a matter of choice, self-efficacy, and self-advocacy, as demonstrated by the following vignettes derived from an eight-month ethnographic inquiry, based on the implementation of TTST as a level of support, in a regular Grade 5 classroom with 28 students. Indeed what these students had to say was more than interesting.

Mackenzie — A confident reader, a justifiably confident refuser of TTST.

I'm using the computer to my benefit.

*I made the technology work for me, but …
I felt Kurzweil© was controlling reading for me, and I like to be in control of my reading…
I think it is a good program, just not for me.*

~letter to Kurzweil©

It interferes with the voices in my head.

Fig. 2: Mackenzie's voice

Mackenzie is an internally motivated reader who recognizes the benefits of reading; he believes that reading is valuable, embraces its goals, and believes that he reads well (See Figure 2 for direct quotes and images of Mackenzie). He approaches challenging texts with the expectation that he will master them (Guthrie & Humenick, 2004). Confident readers, like Mackenzie, have fluent and accurate decoding, strong oral reading, and diverse reading interests, often reflecting "the rich get richer" end of the Matthew Effect (Stanovich, 1986). While willing to suspend judgment and give TTST a chance, these readers find comfort in what they have learned, but prefer to read without it. Their primary complaint with TTST is that the computer voice interferes with the voices in their head, thus interfering with comprehension and disrupting engagement. It is unlikely that these students will use TTST as a way to access print; some even prefer the notion of audio-texts as they feel there is far more expression of voice offered. TTST, in their opinion, requires them to do more work than they were doing on their own.

James — A contextual chooser.

Everybody should have a chance to try it.

James' cohort:
James asked, "*Can I change to a book?*"
Ryan turned and said incredulously, "*You want to change*?"
James responded, "*Yeah, [do you] want to change*?"
Ryan: "*No. Why are you changing?*"
James: "*I don't know. I just want to try it out.*"

~Fieldnote

Fig. 3: James' voice

Contextual choosers, like James, read when they need to read (See Figure 3 for direct quotes and images of James). These students are often characterized by low levels of internal motivation, self-efficacy, and reader engagement (Guthrie & Humenick, 2004; Smith, 1988), which can be offset by legitimate opportunities to interact, collaborate, and make decisions. For contextual choosers, TTST is not necessarily a support for accuracy and fluency but instead acts as a scaffold, a motivator, and a regulator that maintains focus, enhances concentration, and supports engagement. It is one more way to familiarize themselves with author, genre, and text difficulty (Edyburn, 2007). TTST may alleviate the initial stages to the Matthew Effect (Stanovich, 1986) by allowing access in various ways to multi-level texts and appropriate literacy communities. Perhaps most important to this group is choice and control: Use of TTST is a decision they feel entitled to make—an issue of privilege and social justice. They no longer believe that the computer does "all the work" for them and understand that TTST simply reads the decoding way.

Jacqueline — An enabled user.

I can't read it on my own, you know!

I don't like to read, because it is too hard.

~reading inventory

I think now is the best time to learn text-to-speech. If you learn text-to-speech, it will help you to read. It is better to get the kids who know Kurzweil© to teach the other kids about it.

~ scribed response

Fig. 4: Jacqueline's voice

With TTST, Jacqueline possesses both self-efficacy and self-advocacy as a reader (Guthrie & Humenick, 2004). She believes that she is reading, realizes its benefits, and has learned to use TTST effectively as a support system (See Figure 4 for direct quotes and images of Jacqueline). Without TTST, students like Jacqueline would be denied access to age, grade, and cognitively appropriate texts that allow them to learn at the same rate as their peers. With the exception of one student in 28 (Jacqueline), the enabled users in this inquiry could decode at grade level with 95% accuracy, but decoding is so slow and capacity demanding that comprehension suffers, energy to engage fully in the reading process is drained, and as a result, they often withdraw from the text. TTST helps students like Jacqueline sustain access to texts of their choice, ultimately enhancing engagement with content, dialogue, and independent response. Without TTST, these students will likely suffer from reduced exposure to print and the deleterious effects of the Matthew Effect (Stanovich, 1986). For readers who need it, TTST will never be just a reading tool: it will be an enabling tool, likely for the rest of their lives (Elkind, 2005).

Those who benefit most.

Students for whom TTST is most beneficial may be characterized by one or all of the following: a) slow or inaccurate decoding that does not correlate to their cognitive and intellectual potential (i.e., less than 90% accuracy); b) lower levels of fluency, typically 24 to 92 words per minute; c) high levels of listening comprehension that can be activated by TTST; d) low levels of confidence and/or internal motivation that lead to reader reluctance and withdrawal; e) pacing and attentional difficulties that can be regulated by TTST; and f) the need for multiple readings.

Conditions for the Successful Implementation of TTST

Mackenzie, James, and Jacqueline demonstrate that decisions about technology need to be made on a case-by-case basis, considering individual strengths and needs, environmental and contextual demands placed on a student, and demands of the task (Zabala, 2000). In traditional frameworks, the basis for this decision making often lies within the control of the teacher or the instructional team. These students, however, demonstrate that they are more than capable of participating in this decision.

Allowing students legitimate choice and control with regard to the use of technology builds student interest, motivation, and engagement, all of which are especially important for students like Jacqueline who may otherwise become reluctant readers (Reinking, 2005). TTST allows students to customize viewing, interacting, and pacing with text (See Figure 5), all of which enhance student engagement and motivation (Strangman & Dalton, 2006).

- TTST gives you more choice over what is read. With the computer, you can read everything, but the computer can't do it all. It can't do the thinking for me. I still have to think about the words, but the computer becomes my eyes.
- TTST allows you to read all of a book without help; you can slow it down and speed it up when you want to.
- If you don't know a word, you can stop, try to figure it out on your own. If it is a hard word, you can right click on it, and Kurzweil© will give the definition.
- TTST helps us read, write, proofread, download… it just helps us read.

Fig. 5: Student reflections about the purposes and functions of TTST (Source: Parr, 2012, p. 1425)

Offering TTST as one more text format reduces the risk that is often inherent in specialized supports, where we often hear of students who refuse the supports because they do not want to appear different than their peers. When given the option to explore, students accept TTST as another form of support in the regular classroom; it is not overused but instead fits within reading practices they already use.

Fitting TTST Into Existing Reading Practices

TTST easily fits within a balanced literacy framework grounded in multiple intelligences, multi-modalities, multiple literacies, and universal design for learning. In a regular classroom, readers have control over such things as genre and author; just as they will move in and out of authors and genres, so, too, do many move in and out of TTST. Listening to the computer read or simply viewing material on a computer screen does not bring "about superior reading skill: the electronic medium, however does offer unique opportunities to reformat and enhance the text in ways that can support reading comprehension" (Anderson-Inman & Horney, 2007; MacArthur, Ferretti, Okolo, & Cavalier, 2001 in Berkely & Lindstrom, 2011). Similar to shared reading, students are encouraged to join in and read along when they feel comfortable, bringing appropriate intonation and expression to the text. Texts mediated by TTST can be read and reread just as with a human reader, thus tapping into the notion of repeated readings designed to improve student engagement and comprehension (Samuels, 2002), fluency, and accuracy. Viewing and hearing words spoken within the context of a passage helps to build word recognition and vocabulary without disturbing the flow of comprehension (Silver-Pacuilla, Ruedel, & Mistrett, 2004). Most importantly, TTST supports decoding, which frees the listener to focus on the meaning of the text (Wise, Ring, & Olson, 2000), in turn facilitating student dialogue and collaboration, access to content area texts, and spontaneous written responses.

TTST as support for student dialogue and collaboration.

Despite the fact that students wear earphones to read with the computer, this does not isolate students nor does it interfere with the collaborative sense-making and spontaneous dialogue about texts. Students in this inquiry discovered that if they dropped one earphone, they could keep one ear (and two eyes) on the text as it was being read with the computer, and the other ear on the conversation occurring within their group. Recognizing the role of collaboration in the reading process (Guthrie & Humenick, 2004), these students adapted TTST to suit their purposes and ensure that they did miss out on dialogue due to their engagement with TTST. For example, one literature circle elected to discuss *The Other Place* by Monica Hughes, a novel that deals with a family moved to a penal colony in a not-so distant future. As they read with both TTST and the paper text, three students were observed trying to understand what some of the less common phrases meant and how this connected to what they had been learning (see Figure 6). John and Taylor were reading a print text, where Eric was reading with TTST; without TTST, Eric would have been prevented access to this text, this particularly rich conversation about government and democracy, and the opportunity to engage in collaborative sense-making.

Eric*:	What does this mean? [referring to crimes of subversion]
Mackenzie:	When you're spreading messages and you're trying to get into someone's head, without actually telling them what you are doing.
John:	Oh, like a newspaper. Oh, I think that's why he's going to prison. Because of the articles he wrote . . . I wonder what they said.
Eric*:	What's a penal colony? Oh, I think it's like a prison. Why would they say, "Long live the world government organization?" Does that mean that one government rules the world? That's like democracy. This is getting more interesting!
*Eric was reading with TTST.	

Fig. 6: Collaborative sense-making with TTST (Source: Parr & Campbell, 2012, p. 47)

TTST as access to grade-appropriate content area texts.

Access to content area print texts can be facilitated through TTST, regardless of whether it is a periodical, a textbook, or a website. TTST allows students to struggle, persist, and succeed appropriately with content as opposed to being limited by their ability to crack the letter-sound codes of print texts. While TTST provides a different way of accessing and travelling through content, students are still in control of their thinking, learning, and creating. While some students were more than content to refuse TTST for content texts, they did agree that it was a great way to encounter content, where intonation and expression have less of an effect on meaning.

Engaged in a unit on the human body, students were invited to choose whether they wanted to access content about muscles and the way our body moves through a print text or through TTST. The snippets of content learned by students (presented in Figure 7) demonstrate that there is no difference in the acquisition of content between students who accessed the traditional print text and those who accessed the content through TTST. The processes required to acquire and recall content do not differ in relation to the way the text is presented.

Edward*:	I learned that it takes 40 muscles to frown and 17 muscles to smile.
Jacqueline*:	When you bring your arm up and down like this, and ask someone to touch your muscle, you can tell that it has grown.
Noah:	I learned that the eyes are the muscles that move most often and that we blink more than 1000 times a day.
*students reading with TTST.	

Fig. 7: TTST as access to grade-appropriate content text

TTST as support for spontaneous written reader response.

TTST offers students opportunities to spontaneously respond in writing in much the same way they might with a paper text (See Figure 8). Built into TTST is the ability to record written sticky notes and/or voice notes. For the one student in 28, Jacqueline, whose decoding and encoding was prohibitive to written response, she independently recorded her voice notes that were later transcribed, helping her to make the connection between oral and written language. Without TTST, she would have been prohibited independent access to Black Beauty. With TTST, however, she was able to read, make sense of, and make connections without reliance on human supports. Jacqueline's responses are contrasted with those offered by Diana, a confident reader, while reading Peter Pan. In Diana's response, we see more in-depth discussion about the author's choice of words and the computer's ability to replace a word that she felt was inappropriate to be read out loud (with paper, she felt she could ignore it; with TTST, she wanted the same option, but because the computer said the word, she didn't have that option).

Jacqueline's Written Response

I like everything and what's going to happen next is that the horse is going to get buried and the other horses are going to feel bad for the black horse named Charlie.

I don't like this story very much because a horse died. Next I think Black Beauty is going to die.

Diana's Written Response

I don't like it when Tinker Bell said or called Peter a silly a**. But I did like when Wendy gave Peter Pan a kiss, a very polite kiss and Peter Pan gave Wendy a thimble kiss or a real kiss but I don't really know what he gave her but I'm pretty sure he gave her a thimble Kiss!

Today, I liked when Peter Pan got to Neverland safely with Wendy, John, and Michael… and that Tinkerbell didn't say you silly a** to Peter Pan.

Fig. 8: Spontaneous written responses (Source: Parr, 2012, p. 1424)

Extending the Conversation

Many teachers, students, and parents are unaware of the potential of text-to-speech technology (TTST), to empower students struggling to read/work independently at their age, grade, and cognitively appropriate levels (Hasselbring & Bausch, 2005/2006; Johnson, 2009). Lack of awareness, traditional conceptualizations of reading, attitude, and perception need to be addressed in systematic and respectful ways, with both students and teachers, in order to maximize the potential of students who struggle to read the conventional/traditional way. What I learned about developing awareness, broadening conceptualizations of reading, challenging attitudes, and changing perspectives from the enabled users like Jacqueline, I now use when discussing TTST with diverse populations.

I often find myself drawn back into that initial conversation about text-to-speech technology and how *they* will ever learn to read if they read with a computer… I find that today, I am better situated to answer some of the outstanding questions and alleviate some of the concerns left unaddressed. Here I offer what I feel might be an extended conversation, as part of a hands-on workshop for those participants interested in learning about text-to-speech technology. This represents insights that I have gained along the way, conversations I continue to have, and philosophies that have now become part of who I am and part of the story that I now tell.

But how, if we give them a computer, will they ever learn to read?

Offering students a computer with text-to-speech technology does not mean that they don't have to be skilled readers. It means that the computer has become their decoding eyes. They still have to add expression, reread with fluency, create pictures in their mind, make connections, and make sense of it all. The computer works best for those students who have decoding or fluency needs. As a matter of fact, students who have strong decoding skills and high fluency opt out of the technology because they feel that it slows them down.

I often begin with a simulation of what it means to read with a computer, large group or individually, exploring specific functions and characteristics of TTST (See Author, 2011 for a detailed implementation plan for inclusive classrooms). When I ask, *How is this reading?* I hear responses similar to, *It's not reading. It's listening. And if the computer reads to you, it's kind of cheating*. These responses stem from traditional conceptualizations or experiences of reading as decoding. Here, I find it important to review contemporary conceptualizations that view reading, or more globally literacy, as a complex negotiation of the following tasks and processes: understanding the codes of diverse texts (experiential, print, multimedia, digital, etc.); making sense of texts in multiple contexts, from multiple perspectives, for different purposes; critical thinking and analysis of the purposes and functions of texts; and transformational practices related to the creation of new texts (Freebody & Luke, 1990; Luke, 2000; Luke & Freebody, 1999; Parr, 2012; Parr & Campbell, 2012). I quote research and literacy documents that state that *struggling readers should not be limited to low-level activities focused on decoding and literal comprehension* (Ontario Expert Panel on Literacy in Grades 4 to 6, 2004). I proceed by deconstructing exactly what the computer does—decode—one tiny component of reading.

We then consider the use of TTST in independent reading and discuss why being read to by a human is not the same as reading independently. Here, I also point out that many academic and work institutions have accepted this view: TTST is an acceptable accommodation on standardized tests for students who struggle to read and are formally identified as a student with a reading exceptionality; TTST is an accommodation that must be offered in the workplace when necessary. While I still encounter resistance, I see an increasing acceptance that decoding does not a reader make, that reading with TTST is not listening or cheating, and that TTST just provides a different way of decoding letters and sounds.

As we near the end of our discussion, I still hear some participants sitting back asking that philosophical question:

But how is this real reading? How will they ever learn to read if we give them a computer that reads to them? And, what happens when we take it away?

Well, the goal is to have each student reading on his or her own, but we must also recognize that not all students are going to be able to read with a high level of fluency. Most of the students with whom I worked could decode with between 90 and 95% accuracy, but their fluency rates were incredibly low—some of them were reading at 32 words a minute in order to decode with 95% accuracy. When they got to the task of meaning-making and comprehension, they had no energy left. They could not remember what they had read. So it's not always that these kids can't read, but instead the amount of time it takes them to read and then the amount of energy they have left over for something else. Long term, these students will be able to read what they need on a daily basis (e.g., prescription bottles, directions, menus, etc.), but in terms of long-term learning, they have far greater potential if offered the support of TTST.

CLICK SENTENCE BELOW TO HEAR TTST AUDIO FILE

We must remember that TTST is a support, a tool, a scaffold for pre-reading, a way to gain familiarity with such things as text structures and author styles, and a way to access the texts of their peer groups—the students with whom I have worked will tell you this. They will tell you that one or two chapters read with text-to-speech technology gives them enough confidence and independence to continue on their own. It sets them up for success. And when we provide access to all students, we are eliminating the stigma attached to text-to-speech technology, the privilege of text-to-speech attributed by others, and we are simply adding one more text format to our repertoire. In this case, we are providing supports that will foster student ownership over the reading process and we are allowing students to choose what works best in a given situation. "Ultimately, adaptive technology [can be] responsible for two paramount outcomes; it encourages independence and enhances self-confidence" (Hunt, 2003, p. 1). Students "failed [or restricted] by conventional schooling, and thus who have limited engagement and accumulated reading resources, could be offered by new technologies new ways back into school as a context for learning experiences" (Freebody & Hornibrook, 2005, p. 373).

We circle back to this question of "Would you ever take a guide dog from an individual with a visual impairment?" and I offer that it is not our role to take something away, especially if it is enabling student engagement and self-efficacy. It is the readers' role to self-advocate, to identify their own strengths and needs, and to retain ownership over their reading processes. If this means that they need TTST to keep up with the demands of their schooling, so be it… we need to provide the tools needed to be successful.

So, would you ever take a guide dog from an individual with a visual impairment? We would never take it away, but there may be times when a guide dog is no longer necessary; there may be times when the individual has a great enough support system that he or she chooses to let the dog rest… it is all about choice, self-efficacy, and self-advocacy. Your lifelong users will help you to understand fully this technology.

As readers, it is tough for us to fully understand, but if you introduce it, if you encourage it, and if you see the promise, you'll be amazed at just how far your students can go...

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Developing Interactive Andragogical Online Content for Nursing Students

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ABSTRACT

There is currently a shortage of registered nurses. This situation is further complicated by increased demands for nurses who are baccalaureate or masters' prepared. Online education can facilitate degree completion for working adults. Nursing faculty, however, are not always adequately prepared to teach online. The purpose of this article is to describe the results of a qualitative research study and thematic analysis of methods utilized by nursing faculty currently involved in teaching online courses. Moreover, the article presents the experiences of nursing faculty who discovered creative methods to develop engaging online content based on relevant clinical experiences, and their transformation from teachers to facilitators of adult learning.

Introduction

Nurses, according to the American Association of Colleges of Nursing (AACN), are the individuals who are most directly responsible for patient care at the most vulnerable points in their lives (American Association of Colleges of Nursing [AACN], 2011). Unfortunately, the current shortage of registered nurses (RNs) throughout the U.S. has placed patient safety at risk. A study of hospitals by Aiken, Clarke, Cheung, Sloane, and Silber (2003) demonstrated that with each new patient added to an RN's workload, chances of patient death after surgery increased by 7%.

One method to help alleviate these current RN shortages has been to concentrate funding on graduating nurses more quickly through two-year, associate degree of science programs offered at vocational and community colleges. However, this solution does not focus on the long term. Procedures and protocols have and continue to evolve mandating that the bedside nurse must also become a much more sophisticated, savvy user of technology in addition to competence in continually updated nursing skills. Consequently, evidence has shown that patient safety and outcomes are compromised when a greater majority of the RN population is not baccalaureate prepared (Aiken et al., 2003; American Association of Colleges of Nursing [AACN], 2011; Maltby & Andrusyszyn, 1997; Tourangeau et al., 2007; Van den Heede et al., 2009). Thus, national (U.S.-based) organizations, such as the Institute of Medicine (IOM), have called for a more educated nursing workforce to improve patient safety and enhance nursing care (Institute of Medicine, 2010).

This recommendation was based in part on a landmark study by Aiken and colleagues who examined 168 hospitals and found that with every 10% increase of baccalaureate-prepared nurses, there was a 5% reduction in patient deaths (Aiken et al., 2003). Aiken and team looked at 133 patient health outcome variables to determine patients' risk of death and even taking all these other variables into account, nurse education level still showed that a greater proportion of nurses with baccalaureate degrees are associated with a decline in patient mortality. This work was corroborated by other researchers both in the U.S. and internationally (Aiken et al., 2011; Maltby & Andrusyszyn, 1997; McHugh et al., 2013; Tourangeau et al., 2007; Van den Heede et al., 2009). These studies led to the Institute of Medicine report on the future of nursing that recommended that all hospitals be staffed at 80% by baccalaureate-prepared RNs by 2020 and to encourage all RNs to seek even higher levels of education, thereby increasing the number of graduate-prepared nurses (Institute of Medicine, 2010).

In order to increase access to education, online registered nursing to bachelor (RN-to-BS) as well as graduate nursing programs have been instituted by many colleges and universities, and have resulted in increased student enrollment (Kozlowski, 2004; Ostrow & DiMaria-Ghalili, 2005). Unlike pre-licensed nursing programs (students who do not have their RN license as yet), these programs consist of very little hands-on training or closely supervised clinical education. Ali, Hodson-Carlton, Ryan, Flowers, Rose, and Wayda (2005) state that the phenomenal growth of online education for nurses may help meet the growing need for qualified professional RNs.

Steiner (2001) reported that in the five years prior to a 2001 study there was a 500% increase in distance education courses for nursing. Many courses are web-based. Others are delivered through video conferencing, television, audio/video methods, or by faculty members who travel to multiple locations (Steiner, 2001). Teaching online requires an integrated knowledge of content, technology, and pedagogy beyond that expected of faculty members who teach only live classes (Anderson, 2008; Koehler & Mishra, 2005). Many faculty, however, are unfamiliar with tools and online teaching methods that can be utilized effectively in online education (Hulkari & Mahlamaki-Kultanen, 2008).

Despite critics' concerns of online educational quality, studies have demonstrated equal if not superior learning in some aspects (Donavant, 2009; McKeown, 2012). For example, online students have been shown to employ broader reading strategies and adapt more easily to instructional strategies that focus on acquisition of lifelong learning skills (Dykman & Davis, 2008; National Survey of Student Engagement, 2012). Online teaching strategies are key in enabling students to learn how to locate information on their own to foster self-directed learning and continue providing professional skills throughout their careers (Anderson, 2008; Dzubinski, Hentz, Davis, & Nicolaides, 2012; Hussain, 2013).

Providing quality as well as authentic learning experiences to nursing students is a concern of faculty charged with transitioning nursing programs to a web-based curriculum (Smith, Passmore, & Faught, 2009). This lack of authenticity and relevance to real-life situations has been frequently cited by nursing students as a reason for withdrawal from online programs (Perry, Boman, Care, Edwards, & Park, 2008). Teachers of practicing nurses, often with families and jobs, need to look towards methods that engage adult and lifelong learning, and understand the theories and concepts about how adults actually learn.

Andragogical Theory

Students in RN-to-BS and graduate nursing programs are generally older and more experienced than the typical college-age student (Duff, 1989) and can usually be identified as adults, that is persons mature enough to be held responsible for their own actions (Mezirow & Associates, 1990). Knowles (1978) says that in regards to learning, we become adults when we accept responsibility for our learning and are self-directed. Therefore, in that RN-to-BS and graduate nursing students can be categorized as adult learners, it is important that nursing educators understand adult learners and what it means for them to be online learners (Anderson, 2008; Dzubinski et al., 2012; Hussain, 2013).

One method for accomplishing this objective is to incorporate andragogical theory into the design and development of online courses to increase their effectiveness (Henning, 2012; Williams, 2002). The term andragogy was introduced in 1968 by Malcolm Knowles (Merriam & Caffarella, 1991), who defined it as "the art and science of helping adults learn" (Knowles, 1978, p. 52) as contrasted with pedagogy which is associated with how children learn. Adult education is cooperative by nature and the teacher's role is more that of facilitator of learning rather than absolute expert. Mezirow and Associates (1990) described adult education as a method for adult learners to foster understanding of the meaning of their experiences, and consequently take action on the resulting insight.

Andragogy is based on six assumptions: 1) adult learners need a reason for learning something; 2) adult learners are self-directed; 3) adult learners bring more and different experiences than children to educational experiences; 4) adult learners learn more readily when confronted with real-life situations that require them to attain knowledge in order to cope; 5) adult learners are task-oriented; and 6) adult learners are intrinsically motivated to learn (Knowles, 1989).

These assumptions can provide faculty with a framework for designing and delivering online education. For example, knowing that adults need reasons for learning a particular subject, faculty understand that adult learners are less likely than younger students to participate in activities that are marginal to the course goals such as icebreakers, or activities to foster community without an understanding that these activities provide any direct educational benefits (Anderson, 2008). Andragogical-based courses offer flexibility to learners, and enable some control over their own learning as well as opportunities to apply content to real-life situations (Anderson, 2008; Dzubinski et al., 2012). Additionally, course content and activities should draw to some extent on adult learners' prior experiences, in order for them to contextualize how new information can be integrated into their current knowledge and environment (Anderson, 2008; Arbaugh, 2010; Donavant, 2009; Henderson & Bradey, 2008). This study examined how nurse educators developed online learning content and integrated activities that addressed adult learning principles.

Methods

A phenomenological method was used to explore 16 nursing faculty members' experiences in developing online education. Through one-on-one, open-ended interviews, faculty members were asked to describe how they converted their course material into an online environment. Criteria for inclusion was that nursing faculty: 1) must have taught in an online nursing program for at least one year, 2) began their teaching career in a live venue, and 3) currently taught on a full-time basis in a public university. Adjunct faculty were excluded from this study, since often they do not receive the same type of institutional support and development as full-time faculty (Biro, 2005) and, therefore, may not have similar experiences.

From three to five participants were recruited from four public university colleges of nursing within the same state. One face-to-face interview at the participant's university was scheduled for each individual, and they were provided with a written description of an interview guide prior to the appointment. Each individual was asked to sign a statement of informed consent and verbally affirm his or her consent to be audiotaped. Interviews took approximately one to two hours. Member checking was accomplished through provision of an interview transcription to all participants for the opportunity of removing or clarifying information. Each transcribed interview was examined utilizing Atlas.TI to highlight and track thematic content within the interview and provide a data trail correlating themes with illustrative quotations. Steps for analysis as identified by Moustakas (1994) were incorporated to analyze the data. These analysis steps involved: 1) searching for statements that described the experience, 2) grouping statements by meaning and writing a description, 3) describing how the phenomenon was experienced, 4) constructing a description of the meaning for each individual, and 5) constructing an overall meaning of the phenomenon. Institutional review board (IRB) approval was obtained from all participating universities.

Participant Description

For this study, 16 nursing faculty members from four major state universities were interviewed. All faculty who participated were registered nurses (RNs) and had experience in patient care prior to beginning their teaching careers. Thirteen of the participants had a doctorate degree but all had at least a master's degree in nursing. All taught online in either an RN-to-BS or graduate program. Some also taught in traditional face-to-face and clinical courses. In order to preserve anonymity, each of the participants was given a pseudonym; this pseudonym along with the type of degree received, location, and the year each participant graduated from nursing school is included in Table 1 along with length of online teaching experience. The last column in Table 1 describes how each participant reported being prepared to teach online.

Table 1:
Participant Description

UNIVERSITY	PSEUDONYM	YEAR GRADUATED FROM NURSING SCHOOL/ DEGREES	# YEARS TAUGHT ONLINE	TYPE OF PREPARATION TO TEACH ONLINE
SU1†	Terry	1974 / BSN, MSN, MEd	11	Mandatory formal training
SU1	Leslie	1970 / BS, MA, PhD	5	Mandatory formal training
SU1	Pat	1972 / BSN, MEd, MSN, PhD	7	Mentored*, research project*, mandatory formal training
SU1	Gerry	1988 / BSN, MSN, PhD	5	Mentored*, research project*, mandatory formal training
SU1	Jesse	1970 / BS, MA, MSN, EdD	2	Mandatory formal training
SU2	Ronnie	1967 / Diploma, BSN, MSN, DSN	5	Sent to workshops by administration
SU2	Faye	1973 / BSN, MSN, DSN	1	Reviewed existing courses, asked peers
SU2	Joey	N/A / BSN, MSN, DSN	8	Self-taught, workshops
SU3	Casey	N/A / AS, BS, DN	5	Self-taught, workshops
SU3	Morgan	1970 / BSN, MS, PhD	3	Existing course, 1-on-1 training, workshops
SU3	Stacey	1977 / ASN, BSN, MSN	1	Reviewed existing course, peers, hybrid classes, workshops
SU3	Chris	1970 / ASN, BSN, MSN	3	Existing course, peers, hybrid classes, workshops
SU4	Ray	1978 / BSN, MSN, PhD	6	Certificate in Online Teaching, vendor technical training
SU4	Tony	1976 / AA, BSN, MSN, PhD	5	Peers
SU4	Tyler	1964 / AAS, BHS, MSN, PhD	4	Reviewed existing courses, vendor technical training
SU4	Dale	1976 / BSN, MSN, PhD	3	Post-graduate certificate in distance teaching, vendor technical training

SU=State University * Training received at a previous university

As shown in Table 1, faculty had various levels of support and experience to prepare them for online teaching. All SU1 faculty members were required to participate in a semester-long mandatory formal education process that requires them to build the first two lessons of their online course under the guidance of an instructional designer. No other universities within the state provide such intensive, formalized training.

At SU2, Ronnie was one of the first nursing faculty to teach online and, consequently, was provided opportunities to attend seminars and workshops to prepare her for this venue. Faye, also from SU2, had no formal or informal training and began teaching by adapting existing courses and relying on peers for informal mentoring. Casey and Joey reported being self-taught as well, though both attended occasional workshops offered by their university to enhance technology and instructional design skills. Morgan began teaching by adapting existing courses but reported that the university provided one-on-one training with the technical support staff as well as instructional design workshops. Stacey and Chris worked offsite at a satellite campus and began their online experience by developing and teaching hybrid classes. Faculty who taught at satellite campuses, such as Stacey and Chris, reported they were often at a disadvantage for workshop attendance due to lengthy drives. All SU4 faculty members receive technical training provided by the learning management system vendor but then relied on colleagues for ongoing mentoring. Both Ray and Dale earned graduate certificates in online teaching from institutions other than their own.

Preparation and training for teaching online varied from mandatory semester-long classes to occasional workshops that were optional and frequently difficult to access due to location. Mentoring of new online teachers was also sporadic, and mostly facilitated through an informal network of colleagues willing to assist their peers. The bulk of these training and educational opportunities related to technology or instructional design principles, with little emphasis on educational principles, and theories such as andragogy.

Educating Nurses Online: Using an Andragogical Model

Despite their initial lack of preparation, particularly from a theoretical perspective, most of the faculty genuinely wanted to develop online learning experiences that were authentic, relevant to nursing students, and required critical thinking. In order to describe how nursing faculty accomplished these goals, we have analyzed, grouped, and provided a textural description of their statements within the framework of Knowles' assumptions. This section describes how these assumptions were addressed through content, activities, or awareness by the faculty as they reflected on their online course development experiences.

Recognizing That Adults Need a Reason for Learning

The first assumption of andragogy is that adults need a reason for learning. In this study, we reviewed educators of registered nurses (RNs) who had gone back to school to complete a baccalaureate degree or advanced education at the graduate level. In 2013, there is significant political and economic pressure for RNs to further their education. First, there is the move to employ only baccalaureate-prepared nurses in order to comply with the goals of the Institute of Medicine (Institute of Medicine, 2010). Additionally, the need for primary health care providers is greater than ever and advanced registered nurse practitioners (ARNPs) are positioned to fill the void created by a shortage of primary care medical doctors (PR Newswire, 2012). Finding qualified programs for all these students, however, can be problematic. Online education is one way to enable working nurses to return to school for advanced degrees as Dale describes her beliefs regarding this process.

> *It's not the be all end all but as nurses we really do need to embrace it. We're going to get people into nursing and progress their careers within nurse education or lead them from undergraduate to RN to BSN to graduate even RN to PhD. We really do need to embrace these methods I believe. (Dale/3-30-2010)*

RNs who return to school understand their reasons for obtaining higher levels of education. However, it is the responsibility of the nursing faculty to provide learning experiences that will meet the students' needs as they progress in their nursing careers.

Adult Learners Are Self-Directed

In order to enhance the online learning experience, faculty often included activities and assignments that enabled students to pursue their own interests. Ray described that after teaching online for a few semesters, she realized the online class needed more interaction than the lectures and PowerPoint presentations she had recorded from her live classes. Consequently, she redid online content to increase interaction, requiring students to research information relevant to their individual educational goals. Gerry, who teaches statistics, required students to apply the principles they learn in class to research articles of their own choosing, and post their conclusions to the discussion board.

> *If I made them read my articles they were dead. I had lost them. But if I said read your article, at least they're interested in the content and they tended to be a little bit more involved in the discussion and the research. What did that mean for me? A lot of reading and no right answer. No right answer you know, I had 50 students, 50 different articles. There's not a right answer for me to look for in the discussion posting. So I got them involved, expanded their horizons a little bit because they had to read some postings by other topics. (Gerry/4-1-10)*

Adult Learners Bring More and Different Experiences

Many of the faculty in this study described early versions of their online classes as "page-turners" that involved PowerPoint presentations left over from live classes or pages of text uploaded to websites. As they began to feel more comfortable with the online medium, faculty began adding interactive lessons and activities that relied on their adult students' own experiences and knowledge.

Tyler, who taught about cultural differences, wanted to create a group experience that required students to think about different cultures they had encountered as nurses and how these cultures were portrayed in the media. Therefore, she created a group assignment called movie and popcorn.

> *I gave them a list of movies, but they could go find other ones that clearly depicted cultural, you know cultural phenomenon, and then they would discuss it in their groups... So they have the fun of an experience. (Tyler/4-14-2010)*

Other faculty reported relying on student knowledge and experiences, that the faculty themselves may not have. Ray, for example, required that all assignments be submitted to the discussion board to obtain feedback from class peers, relying on their varying nursing practices to provide a broader area of feedback to the student.

> *The other students are reading it and saying I don't understand what you're trying to say here or what about this or what about that or, where I work… because lots of our students are practicing nurses… it's much more of that kind of peer collegiality sort of interaction. (Ray/4-14-2010)*

Many of the faculty utilized discussion boards which enabled students to share individual expertise with their peers. After finding that whenever she made a post all conversation stopped in order to follow her direction, Tony began appointing class leaders to facilitate the discussions. Faye also relied on student discussion leaders by organizing individuals in discussion groups according to their area of nursing specialization.

> *And they have more knowledge, like if it's acute care I know basic acute care but I'm not an expert at acute care nursing, but they are already in the acute care setting working there so they can be more supportive than I can with the nitty gritty details about what's going on there. (Faye/4-13-09)*

Adult nursing students have experience and knowledge that in some instances may go beyond those of the faculty. Faculty described in this study often relied on these students to share their experiences, and thereby enhance learning for other students. Faculty also attempted to create activities that enabled students to focus on their individual interests and learning goals.

Providing Real-Life Learning Situations and Related Tasks

Providing actual clinical situations to students in an online venue was challenging to faculty, but also encouraged them to cultivate creative methods that added value to live as well as online classes. Casey, a nurse practitioner as well as faculty, had previously used case studies in classroom situations and consequently, preferring them as a learning strategy, utilized technology to create them for an online venue.

> *I like to do a lot of case studies. Actual cases. I actually carry a digital camera to clinical with me. I still practice. And over the years I've taken many hundreds of patients not identifying kinds of pictures, and I like to use those and kind of work through cases… in my online when I'm providing them materials, because they can't interact with me. (Casey/4-9-2010)*

Additionally, Casey described creating audio files from patients that students could use to learn about heart conditions.

> *I put these audio files and I make little folders and I'll have actual tapes of the different murmurs, that I've recorded with an electronic stethoscope in clinic over the years. So they'll have the murmur they can hear the murmur and they click*

on another audio file and they hear me talking about the murmur. So they can kind of go back and forth between those. (Casey/4-9-2010)

Ray encouraged students who are studying nursing research to apply the research principles acquired in class to their own work experience when completing class assignments.

We added a project from their clinical sites. We grounded them in ascertaining and thinking about what is the problem in their own clinical settings. We talked about problems, and we learned how to do a review of literature. And then they learned how to critique about 4 or 5 studies, and what is the status of the evidence. Was there enough information to make a clinical change based on what was in the literature? (Ray/4-14-2010)

Terry teaches students about managing health by having them create a plan based on their own personal needs. Working with her IT department she developed a tool that helps students analyze their current fitness needs.

They do their own personal physical plan and hone in on two of their lowest scores based on this survey and they have to set up a personal action plan on how they are going to change. Maybe for instance they have a problem with physical fitness. They have to set up an action plan and then at the end we evaluate it...So it's women and nutrition, each week once again they have a little module to do then they have an assignment, and they have an assessment here for nutrition. They take this assessment and it scores them where they are. They have too much fat, too much whatever in their diet, discuss your score and dietary in your personal action plan. So I tie these personal assessments to their assignment that they will turn in. (Terry/3-30-10)

Field trips were a means of encouraging students to interact with the community, rather than limiting their educational experiences, to sitting in front of a computer. Terry described several field trips she required for a women's health class.

During the contraceptive module they all have to go to a local drug store and they have to bring back information on three different contraceptives sold over the counter. What did they encounter? What did people around them … how did they feel when they walked in? And they have to bring prices and they discuss this and they have to analyze their experiences. Many of them, this is the first time they ever thought about contraceptives besides condoms; and when *they see the women's condoms and you know they say I didn't know they were so expensive. So I engage them in field trips. They have two in women's health. They have to go to an agency that has women's services. It can be an abortion clinic, a fertility clinic, an ob/gyn, a health dept, they have to go physically face to face, have an interview, and they have to have it dripping with adjectives. (Terry/3-30-10)*

Ronnie, who taught nursing leadership, also assigned student field trips in her course. Students were required to interview nursing managers and compare actual medical staff organizational charts to nursing organizational charts, and draw some conclusions on how the different professions operate within a health care institution.

So that didn't come out of web per se, but I felt the need to do that. More so with web than when I had them… If I had them in a live classroom I could put them in a group, I could observe behaviors, we did games, and I couldn't do that on the web so it forced me to be innovative. I think it was just a different way, not better or worse, it made the web three-dimensional. (Ronnie/4-13-10)

Elliott reported that discussion boards provided a rich supplement to students in community clinical courses. The nursing students, who had been making home health care visits, participated in online discussions regarding their experiences, enabling them to review the differences in value and culture that they encountered.

And it's sort of like a process course. Or what I would call a validation course. You're validating your nursing process from your original education. The discussion boards complement the visits. So when they go in and they do their discussion board it's more information about their home visit. So it's kind of an extension. (Elliott/4-14-10)

These faculty found various methods for ensuring that learning experiences were reflective of real-life situations and engaging to online students. Additionally, assignments were often related to the nursing students' work environment or real-life experiences, increasing the relevancy of the content. For faculty who may not have some of the multimedia resources described here, the Internet provides a vast source of information such as sites that include heart sounds (http://depts.washington.edu/physdx/heart/demo.html) or sites like www.MERLOT.org that offer a host of audio/video resources for nursing and other health care fields.

Facilitating Lifelong Learning

Ray explained another key element of online education often overlooked by students and faculty. Nursing, like many other professions, requires lifelong learning in order to maintain competencies and knowledge within the field. By engaging in learning on the Internet, students will develop skills to enhance their ability to gather and evaluate relevant information.

> *The things we can teach a student today in whatever format in this building, when they graduate in six months and get out in practice, you know there's a new IV pump. There's a different medication. Things change so fast in probably any profession that you always have to be learning new things. You need those basics. But that's ongoing learning, and I think that's one thing you can do more so with the online course. Not relying on a textbook. (Ray/4-14-2010)*

Primarily because of their mission to encourage lifelong, self-directed learning among their students, many of the faculty participating in this study discovered that online teaching had somewhat changed their role as teacher and they often found themselves as facilitators of learning. Elliott talks about the struggle to discern when to facilitate versus when to teach.

> *Facilitation versus the teaching moment is a biggie. I think you need to learn how to really hear for what they're asking you. Probably no different than listening orally when people are talking to you what are they really saying, rather than just reacting. But I need to be very thoughtful in my responses to students. So if I was telling somebody new that's what I think I would try to help them to see. You don't just react to everything, give an answer. (Elliott/4-14-09)*

Another participant, Dale, described the transformation process that she experienced as an online teacher.

> *Which is, you do not see yourself as the sage on the stage. You are a facilitator of active learning. So when you see it that way, you see that the students have that much more responsibility in their learning and you must create that environment, and that community of learners. (Dale/3-30-2010)*

Leslie discussed how she tries to emphasize that students are in charge of their learning, particularly the graduate students. She describes herself as a facilitator and explains to her students that she is there to help them learn, but they are professionals and ultimately responsible for their own learning. Pat also described herself as a resource to students and a facilitator of learning in her research course. She believes that students in her online class fared better than live classroom students because they had to search for their own answers. She indicated that live classroom students listened to lectures but often failed to read assignments, whereas online students were better prepared to study research on their own due to the self-directed nature of online learning. Because of the differences necessitated in online teaching, Morgan revealed that her method of teaching all types of classes has irrevocably changed.

> *It's changed my whole way that I think and approach students in the classroom. Completely changed. Because I virtually forced myself at first, say you're going to design this face-to-face course and you're not going to lecture. You're not going to lecture anymore. So how are you going to do it? I think the distance learning has changed the way I teach face to face. I think it's had a big difference. (Morgan/3-30-10)*

These faculty revealed that they had reconsidered the evolution of their role as traditional faculty to facilitators of learning. This was in part due to the need to foster self-directed, lifelong learning habits in their students. Faculty assured students of their availability as guide and resource but emphasized students' need to take control of their own learning.

Discussion and Implications

Online education offers an alternative to traditional face-to-face programs for nursing students who are unable to attend live classes due to geographical challenges, or employment and family demands. This study described how nursing faculty who transitioned from live to online teaching found ways to create interactive, engaging content that addressed the adult learning needs of their students, including relevance and application of prior knowledge. Activities made use of technology, such as digital photos and audio, documenting health conditions in actual patients, or relied on low-tech solutions such as "field trips" that placed students in the community. Even more significant was the emphasis faculty placed on providing learning experiences and skills that would facilitate lifelong learning competencies, which are vital for nursing career progression.

Developing interactive content appropriate to online adult learners requires that faculty understand not only the functionality and capability of the technology at their disposal, but that they also understand andragogical learning principles in order to ensure engagement of their online adult students as well as provide quality learning experiences. Faculty, as well as students, often do not think of themselves as being involved in adult education, and both can easily adopt behaviors with which they are more familiar, such as pedagogical approaches or dependence on faculty to control the learning experience (Dzubinski et al., 2012).

Faculty must make a paradigm shift when they move to online teaching (Henning, 2012). In this study, most of the participants came to realize that traditional methods of teaching (i.e., lecturing, "sage on the stage") should be supplemented, or even replaced, with participatory learning strategies that give at least some control of learning to their adult students. Significantly, several faculty reported adopting andragogical methods within their traditional live classrooms, acknowledging not only the significance of student life experiences but also the importance of fostering lifelong learning among their students.

The participants in this study all taught in large, public universities and were given the opportunity to develop their own course content rather than reliance on publisher- or university-mandated curriculum. However, most faculty are not introduced to andragogical theory prior to teaching online; instead they are often rushed through technology orientations that attempt to prepare them on how to use the technology without understanding the principles that guide its use in developing adult-oriented content (Johnson, Wisniewski, Kuhlemeyer, Isaacs, & Krzykowski, 2012). If online nursing programs are to successfully prepare the workforce of the future, they must ensure that faculty are prepared technically as well as theoretically and given opportunities to develop content that is relevant to adult nursing students. Successful online nursing programs require a well-thought-out infrastructure in order to meet both student and faculty needs (Cornelius & Glasgow, 2007). The faculty whose experiences were documented in this article were mostly enthusiastic about the opportunity to develop these activities. Recommendations to facilitate collaboration of ideas among nursing faculty include peer-to-peer mentoring programs that would enable faculty, who have developed methods for effectively teaching online, to share their experiences with faculty new to this environment. Collaboration could be done efficiently through listservs or informal workshops, live or online, where faculty present and discuss methods they have utilized, thereby developing a community of practice (Reilly, Vandenhouten, Gallagher-Lepak, & Ralston-Berg, 2012). Finding a way to share effective and innovative online teaching methods among nursing faculty could provide a means of aiding faculty in the development of online courses, and should be a priority amongst educators of one of our most treasured and increasingly scarce resources, nurses.

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Teaching With Portals: the Intersection of Video Games and Physics Education

Cameron Pittman, LEAD Academy

ABSTRACT

The author, a high school physics teacher, describes the process of teaching with the commercial video game *Portal 2*. He gives his story from inception, through setbacks, to eventually teaching a semester of laboratories using the *Portal 2* Puzzle Maker, a tool which allows for the easy conception and construction of levels. He describes how his students used the Puzzle Maker as a laboratory tool to build and analyze virtual experiments that followed real-world laws of physics. Finally, he concludes with a discussion on the current and future status of video games in education.

Introduction

In June of 2012 I interviewed for my current teaching position at LEAD Academy, a charter high school in Nashville, Tennessee. During my interview, I made it clear that I wanted to teach physics using video games as part of the curriculum. Well before I had even heard of LEAD or sent in a resume and cover letter, I had planned a semester of laboratories set inside the virtual world of Valve Software's commercial video game, *Portal 2*. During the interview I told the principal that I fully intended to use a video game in a way that no other teacher had ever considered; I wanted to use *Portal 2* as a laboratory setting.

It seems self-evident. Video game realism, simulation ability, and availability have vastly improved in recent years. Video games showcase how realistically they resemble the world, both graphically and interactively. It seemed like a natural jump to take physics education to a readily available and flexible medium. To this day, I am still surprised that the idea had not taken root elsewhere. There are a few educators who have, in similar fashion, turned video games into physics laboratories. But none were high school teachers, and none had taken it to the same scale I wanted.

Fortunately, the principal supported my crazy idea and hired me.

Background Information

Students come to us with the built-in capability to become fully immersed inside game worlds. They spend upwards of hundreds of hours poring over every mission and detail of games. Why not use the same skills and game worlds to teach them? If we can reroute their attention from killing each other (an all-too-common video game theme) to productive, educational activities, then video games become a huge asset to educators. The leap is small and surmountable, especially with *Portal 2*, which is essentially a series of physics puzzles, one after another (Portal 2 [Computer software], 2011).

In the *Portal* series, consisting of the original *Portal* and *Portal 2*, the player takes on the role of a test subject from the first-person perspective who has to navigate through a series of increasingly challenging experiments known as "test chambers." These experiments generally consist of modular rooms with an entrance and an exit. Upon entering a room, the player must find, open, and reach an exit. Sometimes the challenges are simple, such as placing a cube on a button to open a door.

Fig. 1: Cube and button mechanics opening a door

Other times the challenges are more difficult and may require the use of one or more elements, such as automated (and apparently sentient) gun turrets, spring-loaded launchers (called aerial faith plates), lasers and laser receptors (called thermal discouragement beams), tractor beams (called excursion funnels), and gels that change the elasticity of surfaces or the rate at which objects accelerate on surfaces.

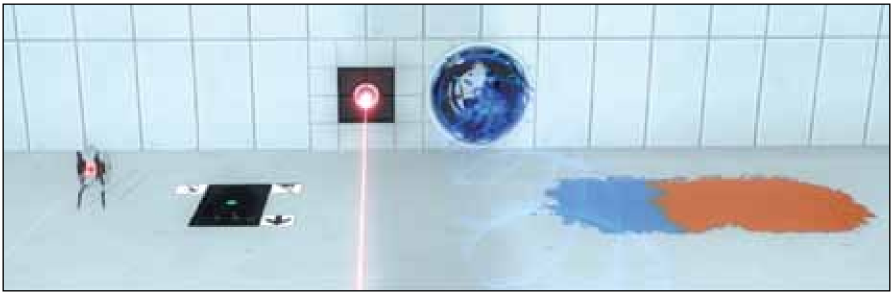

Fig. 2: From left to right: a turret, an aerial faith plate, a laser, a tractor beam, bounce gel, and speed gel

The only tool available to the player is the portal gun, formally known as the Aperture Science Handheld Portal Device (so named by Aperture Science, the fictional corporation holding the player hostage and hosting the experiments). The portal gun allows players to connect two surfaces with a wormhole, which they can use to traverse distant points instantaneously. Furthermore, any speed an object has upon entering one portal is conserved as it exits the other. Combined with the various game elements, the player has to rethink geometry and physics to move about rooms in ways that are impossible in real life.

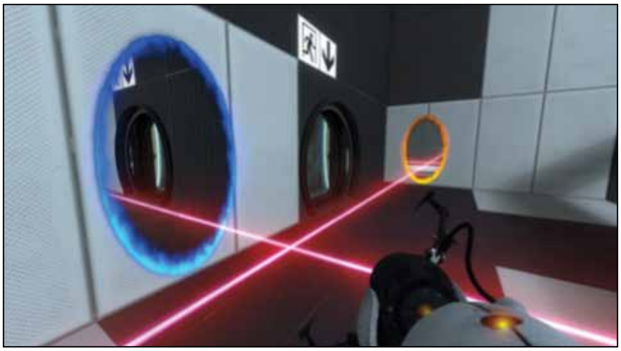

Fig. 3: A laser going into the orange portal and exiting the blue portal. Also, notice the portal gun in the foreground.

One basic gameplay technique is called the momentum fling, which requires portals on two surfaces, one being horizontal (such as a floor) and the other vertical (such as a wall). A typical momentum fling will require the player to place one portal well below her current position, usually in some type of pit or below a ledge, and the other high on a wall or similar surface. The player then falls down towards the low portal, accelerating under the influence of gravity. As she enters the low portal and exits the high portal, she maintains her high speed and is flung across whatever room or challenge that must be crossed (see Figure 4).

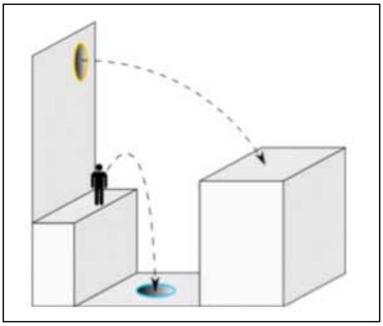

Fig. 4: A diagram of a momentum fling (Portal, n.d.)

Game developers have recognized that the easiest way to make ultra-realistic games is to engineer game worlds that follow the laws of physics (Bourg, 2002, p. ix). Physics engines handle background physical laws, serving as a sort of underlying matrix governing properties of objects and their interactions inside the game world.

There are numerous examples of physics engines in use by modern games, one of which is Valve's Source engine. *Portal 2* runs on Source (Portal 2 [Computer software], 2011). While Source does not significantly stand apart from other modern physics engines in terms of technological capabilities, Valve has added features that inadvertently make it the perfect solution for classroom physics simulation.

Building content with the tools game developers use is a tedious and time-consuming process for good reason. Games are meticulously designed to include all the nuances developers need to create an immersive and believable experience (Bourg, 2002). It takes a significant amount of time for a novice to learn how to create a basic room with four walls, a ceiling, and a floor using a program called Hammer, Valve's world-creation tool for Source. A new level designer faces a steep learning curve and tedious work to create simple levels due to the amount of freedom afforded to the user. However in May 2012, Valve released the *Portal 2* Puzzle Maker, which simplifies the level design process into a point-and-click venture (compare Figures 5 and 6). What the Puzzle Maker lacks in terms of level of detail compared to Hammer, it more than makes up for in terms of ease and intuitiveness (Vic, 2012).

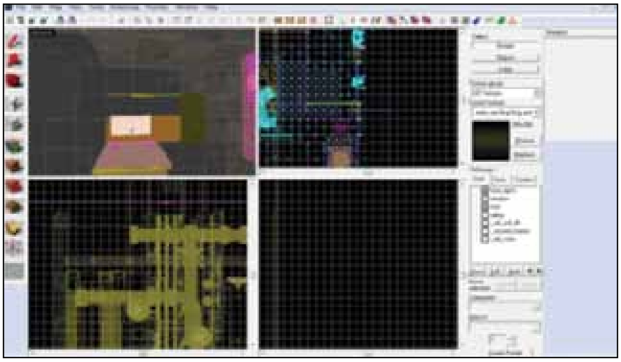

Fig. 5: A typical Hammer workstation

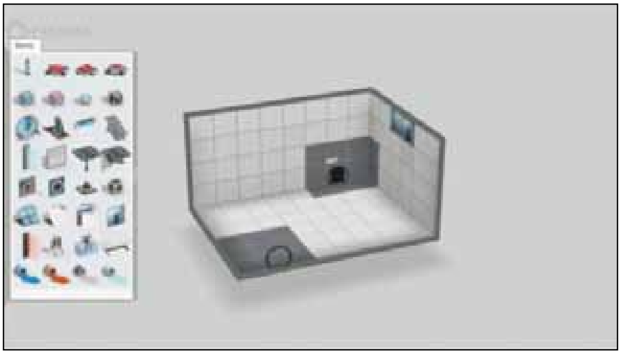

Fig. 6: How all Puzzle Maker levels start

The *Portal* series is incredibly successful in terms of critical reception and sales, with more than 8 million units sold in total (Caoili, 2012) and garnering scores of 90 and 95 out of 100 for the original and sequel respectively on Metacritic (CBS Interactive, 2013a/b). Soon after the original game's release, Valve realized that its customers wanted more puzzles than they could reasonably deliver (Valve Software, 2012). The single player campaign lasts on average around nine hours (GameLengths, 2013). Valve released the Puzzle Maker under the title "Perpetual Testing Initiative," indicating the ease with which the gamer community could contribute an essentially limitless reservoir of challenges (Wilde, 2012).

Teaching History

As I was finishing my second year of teaching in 2011, I reevaluated my methods. Had my students participated in enough labs? Did their problem-solving skills improve throughout the year? I realized that I wanted a better laboratory situation.

My school, like many other high-needs high schools, suffered from a severe lack of funding. The laboratory equipment I inherited was in disrepair, while other much-needed tools were missing altogether. Ordering equipment was a painfully slow and frustrating endeavor. I wanted a fast, dynamic, and easy way for my students to interact with concepts from their lessons and solve problems. Without readily available physical laboratory supplies, I turned to digital learning.

I tried illustrating difficult concepts with basic flash game simulations such as those found at Colorado University's PhET.[1] While they entertained students as diversions from usual lessons, student results were still disappointing, whether due to the flash games' inherent lack of utility in the classroom or my inexperience as a teacher, I could not determine. And I was unhappy using simple flash games. Physics, and science as a whole, are connected experiences. No idea exists in isolation; all of the laws of physics we currently understand branch from the same four fundamental forces (which may well be consolidated further, but that is a discussion for a completely different journal) (Weisstein, 2007). Presenting ideas in science in single-serving packages ignores the underlying connections that make science the beautiful, cohesive fabric of the universe we want our students to appreciate. So, I thought bigger.

I realized that I wanted to teach with a physics simulator, a world in which my students could interact with as many laws of physics as possible. It quickly dawned on me that a modern video game, with all of its physics engine flexibility, would provide the perfect platform. I thought of the original *Portal*. By the end of the summer, I had written a full set of laboratory lesson plans using *Portal*'s test chambers.

I initiated contact with Valve in the summer of 2011. In my first email, I gave them a copy of my *Portal* lesson plans and asked for feedback, requested a class set of copies of *Portal*, and asked how my students might be able to export position and time data of different objects in the game world to make for easy calculations. Valve soon replied with a demonstrated interest in education and supported me as I tried to teach with *Portal* and later *Portal 2*.

At the start of the 2011-2012 school year, I began preparing for *Portal 2* physics lessons. I suspected that *Portal 2* could run on the school's laptops, but I could never test my hypothesis because they were under strict control. Software installation required administrator access, and there was never more than one IT administrator in our building at any given time. And when he was there, his attention was split between the hundreds of computers, printers, projectors, and luddites in the building.

Administrator access was a secondary concern to the real issue: the school's locked-down network. In order to install *Portal 2* in the first place, a computer must have access to Valve's content distribution program, Steam. Steam communicates with Valve's servers to download and activate software through a range of network ports, which were unfortunately blocked.

Over the course of the school year, I fought to open the ports. My previous principal fought on my behalf too, but we collided with a bureaucratic mess in the district office. Promises were made to open the ports but the district failed to follow through.

I was just as disappointed as my students that we were never able to make *Portal 2* a laboratory setting in the 2011-2012 school year. But, I did not want to waste all of my efforts. To compensate for unavailable classroom resources, I instead brought my personal desktop computer to school to allow students to run through lessons on a trial basis. I pulled students aside one at a time during independent work and allowed them to work their way through some sample levels. As they got more familiar with the game, I encouraged students to start building simple experiments in the Puzzle Maker.

I noticed the Puzzle Maker's power early in the sample lessons. One student, with problematic communication skills but exceptional problem-solving capabilities, wanted to build a level. After a few minutes of playing with *Portal 2* he concocted a level design. He tried but ultimately failed to verbally explain it to me. However, after five minutes of work with the Puzzle Maker, he managed to build a complicated system of linked buttons and cubes to make a set of six excursion funnels which cyclically switch directions at regular intervals.

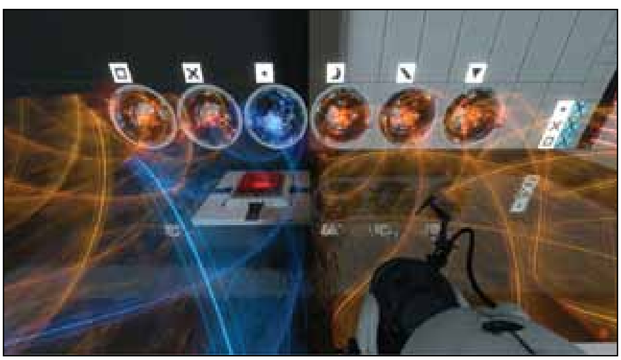

Fig. 7: My student's cyclical excursion funnel level. The colors of the excursion funnels represent their direction. About every second, the blue funnel turns to orange and the orange funnel to the right turns blue.

While this student's verbal communication lacked clarity, he obviously had a clear understanding of the game's internal logic. This was a tangible example of how the freeform aspects of the Puzzle Maker empower students to express themselves and work in a way that no other tool can replicate with the same ease and broad applicability.

Current School Year and Selected Laboratory Overview

Following the release of the Puzzle Maker, I started creating a set of physics lessons in which students explicitly conceptualize, build, and analyze experiments within the Puzzle Maker.[2] Topics covered included velocity, acceleration, friction, gravity, forces, momentum, energy, and projectile motion. The power of the Puzzle Maker lies in the ease with which it allows users to create content, making students masters of their own design who can quickly create and manipulate worlds to try new ideas and draw conclusions.

The 2012-2013 school year began in sharp contrast to my previous three years as a teacher. For testing purposes, my new school has a classroom set of recent model MacBook Pros. And because of our charter, we have full control over our resources, including network ports. Two weeks in the 2012-2013 school year, I had successfully installed *Portal 2* on a class set of laptops and was prepared to start *Portal 2* laboratories.

Portal 2 lessons began with a preview of sorts in which students were encouraged to independently explore the game's campaign and sample levels to gain comfort and confidence. From there, we used the Puzzle Maker in the natural progression of laboratories that would typically be found in a first semester high school physics class.

In their first official *Portal 2* lesson, students studied the time it takes a falling object to reach the ground. Students were instructed to build a level that would allow them to easily observe the entirety of a falling object's path. They had to predict how long it would take the object to hit the ground using the same laws of physics that dictate motion in the physical world. The primary goal of the lab was to help the students develop an implicit trust in the game's physics engine. I wanted them to see, in a very easy way, that the game world accurately simulates the real world. As a secondary goal, I also observed the ease with which students interacted with the game. Unsurprisingly, they demonstrated a range of abilities. Some students were exceptionally adept with *Portal 2* with likely extensive video game experience, while others struggled navigating through the menus.

Portal 2 succeeds as a physics laboratory simulator because students can collect accurate data inside the game world. *Portal 2*'s utilitarian and futuristic laboratory motif naturally leads itself to mathematically precise architecture. Square panels permeate the game's floors and walls, creating perfect metrics for measuring distance (see Figure 8).

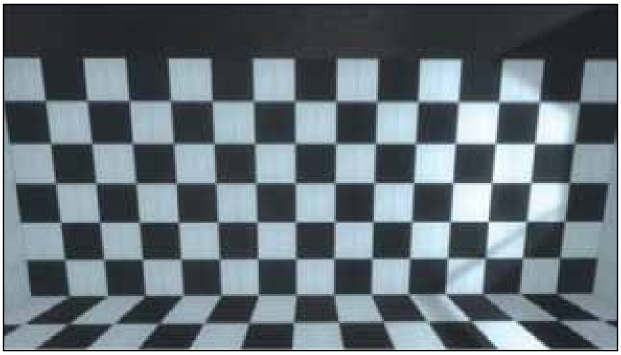

Fig. 8: A checkered wall and floor to illustrate the all-pervasive square-shaped panels in the Puzzle Maker.

Motion is, in effect, the study of how and why displacement changes over time. Counting panels gives us displacement. To complete the time component of motion, the educational version of *Portal 2* features a built-in stopwatch.

In the second laboratory, students worked backwards from the first lab to calculate the strength of gravity. They built ledges at known heights from which they could drop and time objects falling to the ground. Students knew what answer to expect ahead of time because they had been given the strength of gravity in the game world in the previous session.

Even with the work I had done to create the labs, I still had to justify using a video game to teach all of the Tennessee state standards for physics, including the math and laboratory skills standards (Metropolitan Nashville Public Schools, 2013). Students performed data collection and analysis on every experiment, including this one. Students had to time multiple object drops from each height and take the average for their calculations. Quantitative error analysis was beyond my students' skill sets at this point, but we still discussed the reasoning for taking multiple measurements. Students performed the laboratory with objects falling from different heights to ensure the strength of gravity is independent of altitude or other quirkiness in the game world.

From their work with basic concepts in motion, we moved on to forces. The *Portal* games offer the unique ability to create infinite loops, whereby an object falls into one portal with the exit portal directly above (see Figure 9). In this scenario, the object falls indefinitely through the portals while accelerating under the influence of gravity. Eventually, it appears to reach some type of terminal velocity.

Fig. 9: A cube falling through an infinite loop. Note the position of the two portals.

In the terminal velocity laboratory, I challenged my students to determine terminal velocity by simply measuring the distance between two horizontal portals placed directly on top of one another and recording the amount of time it takes to make five falls through their portals. Students allowed themselves to fall for a moment to ensure they had reached terminal velocity before starting the timer.

My students learned their first physics quirk of *Portal 2*: portals have a speed limit. In most infinite falls, the player never reaches a terminal velocity because the game itself imposes a maximum speed with which a player can exit a portal. Though subtle, many of my students noticed that portals slowed them like speed bumps as they fell.

The data supported their claims. Students realized that falls from different heights (e.g., where portals are at varying distances apart) led to different terminal velocity measurements, which runs counter to expectations in the real world. They found that greater vertical distances between the two portals produced higher measured terminal velocities. This lesson stuck with students. On their next quiz, I asked them about the cause of terminal velocity in the real world and received a few responses about the speed limit portals impose. I am always happy to see students remembering classroom experiences but it goes to show the power careless teaching can have. Playing with video games is especially like playing with fire; students remember what happens in them, so teachers have to carefully filter information.

From lessons on terminal velocity and forces, we moved on to collisions and momentum. In this laboratory, students launched objects of different masses and velocities at each other with aerial faith plates (see Figure 10). We ran into some technical difficulties. In the early days of *Portal 2* lessons, my students used the normal version of *Portal 2* distributed with Steam for Schools, only called the *Portal 2* Educational Build at the time because it limited online features. Later that semester, Valve released new features for the Educational Build that introduced, among other items, contraption cubes with variable mass, friction, and elasticity. Contraption cubes would have been a tremendous asset for the collision experiment because cubes were the easiest objects to successfully and cleanly collide (and not to mention, variable elasticity opens up additional experiments). Without contraption cubes of customizable masses, my students used turrets and spheres (otherwise known as "edgeless safety cubes") because of their varied masses: cubes have a mass of 40 kg, turrets have a mass of 85 kg, and spheres have a mass of 100 kg. My students found that spheres and turrets tend to rotate or shift either before launch or in midair causing glancing rather than head-on collisions.

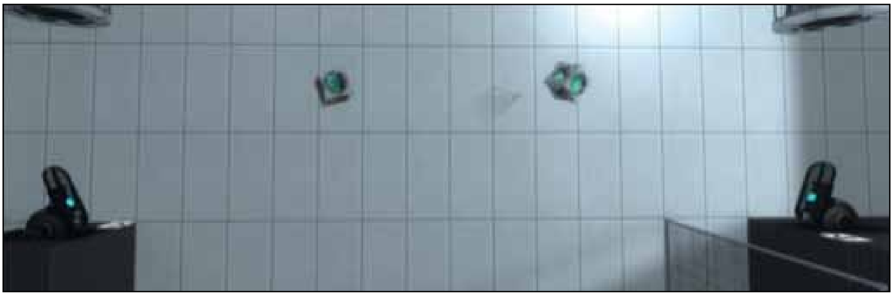

Fig. 10: A typical test of the law of conservation of momentum. The cubes are flying directly at one another.

Though the Source engine handles momentum and collisions extremely well, glancing blows with turrets and spheres frustrated students. Some drew incorrect conclusions because they failed to see successful head-on collisions, which I had to later correct in class.

The new version of the Educational Build includes the on-the-fly ability to alter the rate at which time passes for in-game objects (not including the player). But prior to the release of the new version, my students still needed to slow down time to capture the velocity of moving objects at the instant of launch or immediately after. I taught them how to use the developer console, which is a command line interface for altering the game world. Students enacted console commands to slow down time and pull information about moving objects directly from the physics engine. They took to the console surprisingly well, but the educational build's new time variables hastened data collection.

In the next laboratory, students built off their knowledge of independent velocity vectors to predict where launched objects would land. *Portal 2* handles projectile motion accurately. While their experiments succeeded and students related launch angle, launch velocity, and distanced traveled, I saw a surprising number of students simply copy the demonstration level I made. There are numerous ways to launch objects in *Portal 2*, such as by using momentum flings, aerial faith plates, repulsion gel (which causes objects to bounce), propulsion gel (which causes the player to accelerate more than normal) and ramps, or simply running and jumping off a ledge. I used an aerial faith plate in my example and most of my students followed suit. Had students spent more time exploring the game on their own before entering the world of laboratory lessons, I believe my copycat issue would have been mostly mitigated. Part of the draw of using the Puzzle Maker is the ease with which students can realize their own creations; I wanted to see my students create unique contraptions, not rehashed designs (more on this in the **Issues**, **Setbacks**, and **Lessons** section).

The last major addition to the Educational Build worth noting is the more accurate aerial faith plate design. In the vanilla build of the Puzzle Maker, players predetermine the landing spot for the aerial faith plate simply by placing a target. Regardless of mass, objects land in the same place.

Fig. 11: Aerial faith plate "impulse" options in the Puzzle Maker

The Educational Build adds "impulses" which ostensibly allow you to alter the angle, measured in degrees, and force, measured in Newtons, of aerial faith plates. With locked forces, objects of different masses accelerate differently upon launch and land in different places. When I first saw "impulses," the forces listed caught my eye. The force of the aerial faith plate can be slid between 1 and 99 Newtons.

I knew immediately that aerial faith plates represented "impulses" incorrectly. I continue to use quotation marks because the "impulse" listed is actually a force. An impulse is a force over time and has units of Newton-seconds. So, I designed a laboratory exercise where students investigate the inaccurate nature of aerial faith plates. Students observed that aerial faith plates appear to launch objects for a split second but calculated that aerial faith plates would have to accelerate objects for more than 400 seconds to achieve the same effect. They quickly identified that something was amiss.

When students examined their data, they asked with apprehension if their calculations were accurate. "Yes," I told them, "but what does that say about the way aerial faith plates work in the game?" Students compared their results to what they expected, one of Tennessee's embedded inquiry standards, and quickly found the game world failed to realistically represent all aspects of the real world. Though physical inaccuracies may seem like a downfall, when students identify what aspects of the game are unrealistic, they apply their understanding of physics at a much deeper level.

For the essay portion of their semester exams, my students built levels in the Puzzle Maker that showcased multiple concepts learned throughout the semester. Students chose two or three concepts we covered and built levels demonstrating said concepts. They also wrote essays to describe the concepts in question and explain how their levels demonstrated them. Physics is incomplete without quantitative analysis; so all students also wrote their own physics problem and built an accurate representation of it in their level, which they then solved.

Some students produced polished, clean levels (see Figure 12). Other students produced impressive messes with extraneous features and unclear physics. In both cases, I graded students on their ability to describe the physics of their levels and some of the best scores came from poorly designed levels.

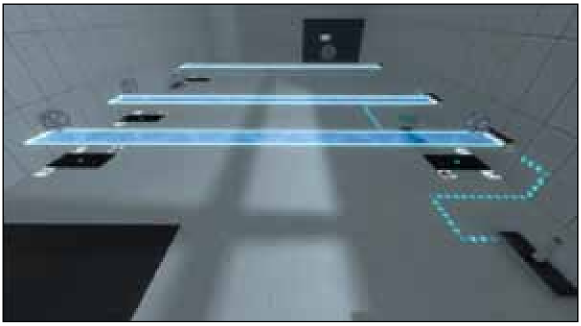

Fig. 12: An overview of a clean winter final level. Note the three tests in succession.

I analyzed my final exam for the accuracy with which students answered questions on topics we covered with the Puzzle Maker. Selected, non-normed results from the multiple-choice section are as follows in Table 1:

Table 1:
Topics Covered With Puzzle Maker

CONCEPT	QUESTIONS ANSWERED CORRECTLY
One Dimensional Motion	56%
Forces	40%
Momentum, Conservation of Momentum	91%
Conservation of Energy (including work)	50%
Projectile Motion	53%

My students performed admirably, but with ample room for improvement. My final was difficult and, as any physicist will tell you, multiple choice and physics mix like oil and water. In the essay section of the final, students earned an average of 63% of the points available. A significant portion of points were lost simply because students omitted essay sections; many of the essays that had been finished to completion featured impressive explanations of the physics demonstrations they created.

The data from the winter final is inconclusive. I feel comfortable stating that the Puzzle Maker improved my students' understanding of physics, but to what degree and with what success compared to the traditional lab is still to be determined.

Classroom Effects

Feedback from students indicated they enjoyed class. They said they looked forward to class and many of them told me they enjoyed physics more than they thought they would. Interest in physics spiked throughout the building as my students shared what was happening in class with their friends. Students from lower grade levels (and even some elementary aged siblings) asked me about next year's physics classes wondering if they could play video games in class.

While my students worked with *Portal 2*, classroom management issues were virtually nonexistent. Almost all students focused all of their time and energy on their work. Even the loudest and most obnoxious students actively participated for the entirety of each lesson. Students listened carefully to instructions, helped me troubleshoot a few technical difficulties, and produced high quality work. On numerous occasions, students took on tutorial roles unprompted. They worked until the end of class and, in fact, often complained that I ended lessons too early (usually to engage in post-laboratory discussions), which was a welcome change from usual classroom complaints.

Issues, Setbacks, and Lessons

Using technology without touchscreens, I watched my students flounder and flail trying to control their computers. They lacked basic skills, like keyboarding and mouse handling. Students demonstrated an aversion to using a physical mouse and almost universally preferred using the laptop touchpad to control the player's in-game view.

I found that student inexperience with video games in general, or first-person games specifically, created the biggest setbacks to learning with *Portal 2*.

A few students struggled to even grasp a sense of their position and view within the game world, which made simple tasks, like navigating a room, almost insurmountable obstacles.

Inexperience with specific gameplay mechanics and elements, such as the various tools and objects encountered in tests of *Portal 2*, led to unimaginative experiments. Like all classroom teachers, I have a finite amount of time to teach a large set of standards. Students enjoyed less than a single 90-minute period of free play before we began laboratory exercises, which was not enough. Granted, many of the first laboratories were written so that they would gain experience with the game, but they needed more time to feel comfortable with the often complex nature of *Portal 2*.

In each laboratory, I learned my expectations for student proficiency with the Puzzle Maker were too high and that my instructions were too short. I thought my students would immediately gravitate to the Puzzle Maker and demonstrate advanced world-building skills by the end of the semester. I was wrong. Students still advanced in both physics problem-solving ability and level design proficiency, but not to my expectations. If I teach with *Portal 2* or any other video game again, I will go out of my way to ensure students get more time to become familiar with the game before beginning graded lessons.

Conclusion

We waste valuable resources when we fail to harness our digital natives' seemingly innate ability to interact with technology and lose themselves in game worlds. Through careful planning, science teachers can create a classroom environment where students manipulate digital worlds to create measurable scientific experiments that run on laws of physics. It is a unique opportunity for educators. We can let students play, create and interact with worlds only limited by their imaginations. They can explore and analyze impossible yet physically accurate situations to uncover real physical laws. They can build virtual experiments as valid as their physical counterparts in less time and with less effort. Teaching physics with *Portal 2* is about encouraging students to actively build, explore, and apply laws of physics.

As a physicist and teacher, I think we have only just started to explore the range and depth of lessons that can be taught with video games. I see this past semester as a proof of concept—evidence that students can learn physics in a rigorous and realistic video game environment. I cannot overstate how much fun it is to give students a sandbox world that follows the laws of physics. The freedom of the Puzzle Maker for physics students is akin to the freedom of a pen and a pad of paper for English students. They have agency and ability to mold a world to their specifications, analyze it, share it, and ultimately learn from it in a way that no other tool can replicate.

In each of the ten laboratories, students explored the laws of physics using new tools that are only now available. The *Portal 2* Puzzle Maker represents a major step towards a symbiotic relationship between the video game world and education. Video games support education by providing a practical, flexible, and readily available medium for learning. *Portal 2* is just one example of a commercial video game finding applicability in a classroom. Other teachers have used games like *Minecraft* (Knapp, 2011), *World of Warcraft* (Whitcomb, 2008), the *Civilization* series (Alexander, 2010) and *SimCity* (Siddiqui, 2013) to teach topics as wide ranging as economics, history, and social sciences.

Entering the classroom gives video game developers the chance to hone their ability to create experiences that connect with all people, not just gamers. New audiences provide new challenges, which surely push developers to innovate. Education and video games both strive to create memorable experiences and leave lasting impressions on people's lives. The two disciplines have much to learn from each other.

I finished the semester feeling both invigorated and slightly daunted by the complex task facing future educators. We clearly have an impressive new technology that affords educators unique opportunities for reaching students, but we have yet to fully understand or utilize its capabilities. Video games are another medium for conveying information. They are neither inherently good nor evil, useful nor useless. The form and message of the information embedded in video games determines utility, which informs teachers how and when to apply them as effective classroom tools.

Successful classrooms of the future will mix teachers and video games seamlessly, where students will be led through virtual worlds by real teachers. These teachers will help students draw from their virtual experiences to better understand the real world. Educators and video game developers need to collaborate to innovatively intertwine video games and education. The process has already begun, with educators like Histrionix's Rick Brennan (Brennan, n.d.) and Arizona State University's

Sasha Barab (2009) working with developers to design games made specifically for the classroom that emphasize the teacher's input. They recognize that no educational software will succeed in a classroom if the teacher has not made it their own.

I successfully taught with *Portal 2* because I leveraged my intimate knowledge of the *Portal* universe and real-world physics to ensure that virtual experiences and physical applications complemented one another. In that sense, video games are not standalone educational tools; they are field trips, laboratories, and everyday experiences rolled into one, creating opportunities for students to draw connections and gain deeper understandings.

Accordingly, establishing the effectiveness of and improving educational video games should rely on metrics that measure game-classroom interactions rather than specific learning outcomes, which are too closely tied to individual teachers. Measuring a game's ability to retain attention, induce engagement, and apply to real-world lessons will prove invaluable as we better design and understand video games as educational experiences. Ultimately, large-scale quantitative analysis and comparative studies of learning outcomes between traditional and video game centric classrooms will ascertain the true utility of video games in education.

The nascent study and use of video games in education has indicated that video games have a profound ability to engage students and create memorable, teachable experiences. I suspect that as research continues, more educators will recognize video games as a valuable tool and my students' experiences with *Portal 2* will soon be commonplace in classrooms around the world.

Notes

1. Please see: http://phet.colorado.edu/

2. Available for download at www.teachwithportals.com

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Lest We Forget: Mixing Traditional and Digital Learning in the History Classroom

Matthew Russell, D'Arcy McGee High School

ABSTRACT

This paper presents an experience of integrating digital technology with traditional historical research in a grade 11 history classroom. Students researched First World War soldiers from western Quebec using online databases and archival sources and presented their research using a Wordpress blog and Google Earth. Students built their sense of historical consciousness by connecting to the past of their community and developing disciplinary skills such as using primary sources. Throughout the project, students were engaged in the authentic task. The success of the project indicates that teachers should be encouraged to use more digital technology in the history classroom.

On May 3, 1915 Captain James Ross, a medical officer with the 3rd Brigade, Canadian Field Artillery wrote, "First of all we could see the air get green above the trenches, then firing started and then we opened up. They shelled us pretty heavily at the battery, but did very little damage," (Ross, 1915). The Germans had gassed the Canadian positions at St. Julien in the Ypres sector of Belgium. Although the 3rd Brigade might have been spared the worst of it, the 1st Brigade Canadian Field Artillery was mauled that day. The unit's War Diary, the official record of its actions and movements, stated that it endured an intense enemy barrage and was reduced to forming composite batteries from its twelve remaining guns. During the shelling, Lieutenant Alexis Helmer from Hull, Quebec was killed (1st Brigade Canadian Field Artillery, War Diary, 1915).

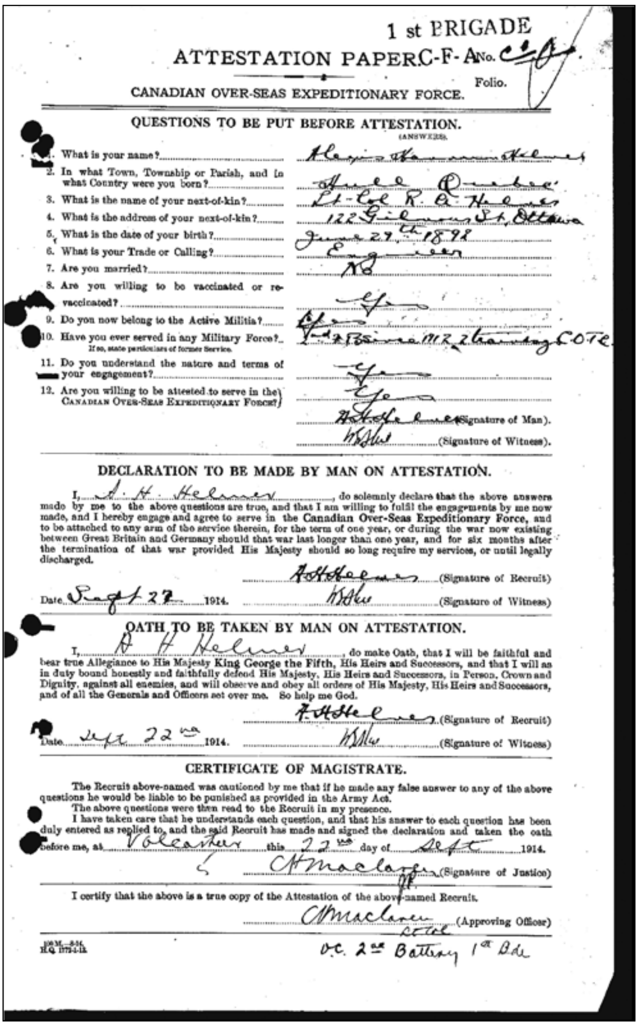
Who was Alexis Helmer? Who were the other men, and some women, from western Quebec who enlisted in the Canadian Expeditionary Force (CEF) during the First World War? What was their war experience like? How can we honour their service and sacrifice? The Western Quebec Soldier's Stories project is an attempt to answer these questions. The project was about students melding the traditional practices of the historian with digital research and using new digital technologies like online databases, blogs, and Google Earth to develop and expand upon historical thinking skills. Historical thinking skills are seen as the disciplinary methods that are employed by historians practicing their craft. Abilities such as using evidence, chronology, cause and consequence, continuity and change, and historical empathy fall under the rubric of historical thinking skills (Seixas, 2006; Wineburg, 2001).

This project has its origin in the work of another teacher. Blake Seward, a history teacher in Smiths Falls, Ontario was intrigued by the names on the local cenotaph. He set out with his students to explore and to document the war experiences of these soldiers. His "Lest We Forget Project" has spread nationally with the help of Library and Archives Canada (LAC), and now the Canadian War Museum (CWM).

This paper will discuss how in our classroom, we moved from traditional paper research and writing, to sharing the war stories of the men and women of our community using new technology. In doing so, our students engaged in the work of historians in researching and writing, but used the web to communicate in both written and visual form using WordPress and Google Earth. Through this process the students developed their sense of historical consciousness by researching their own community.

The students in Smiths Falls had names on their cenotaph as a starting point; however, in Aylmer we did not. Despite the lack of individual recognition on the war memorial, the names of those who served in the First World War are still able to be found. A visit to the local Anglican Church gave a number of names on the honour roll. A search of the nominal rolls (lists of soldiers on embarkation to Europe) of local units like the 38th Battalion also yielded a number of results. As well as these traditional research methods, a search of online databases like the Canadian Virtual War Memorial (http://www.veterans.gc.ca/eng/collections/virtualmem) and the Canadian Great War Project (http://www.canadiangreatwarproject.com) also proved fruitful. Combined there are possibly hundreds of stories of soldiers and nursing sisters from Western Quebec to be told.

The next step was to discover more about a particular soldier. In Canada, the records of soldiers from the First World War are held by LAC. They are in the process of being digitized, but a portion of the files are freely accessible on the LAC website. The scanned documents are the attestation papers that were filled out for (or by) the man when he enlisted in the CEF. The database is searchable by the soldier's name or regimental number and leads the viewer to a GIF copy of their attestation paper. Students were each assigned a regimental number and asked to go to the database and bring in a copy of the attestation paper of their soldier or nurse. I used my own great grandfather as a model and demonstrated the steps involved in finding the attestation papers.



1 st BRIGADE

ATTESTATION PAPER C-F-A No.

Folio.

CANADIAN OVER-SEAS EXPEDITIONARY FORCE.

QUESTIONS TO BE PUT BEFORE ATTESTATION.

(ANSWERS.)

1. What is your name? ...
2. In what Town, Township or Parish, and in what Country were you born? ... Hull Quebec
3. What is the name of your next-of-kin? ... Lt-Col R. A. Helmer
4. What is the address of your next-of-kin? ... 122 Gilmour St, Ottawa
5. What is the date of your birth? ... June 27th 1898
6. What is your Trade or Calling? ... Engineer
7. Are you married? ... No
8. Are you willing to be vaccinated or re-vaccinated? ... Yes
9. Do you now belong to the Active Militia? ... Yes
10. Have you ever served in any Military Force? If so, state particulars of former Service. ...
11. Do you understand the nature and terms of your engagement? ... Yes
12. Are you willing to be attested to serve in the Canadian Over-Seas Expeditionary Force? ... Yes

A H Helmer (Signature of Man).

(Signature of Witness).

DECLARATION TO BE MADE BY MAN ON ATTESTATION.

I, A. H. Helmer, do solemnly declare that the above answers made by me to the above questions are true, and that I am willing to fulfil the engagements by me now made, and I hereby engage and agree to serve in the Canadian Over-Seas Expeditionary Force, and to be attached to any arm of the service therein, for the term of one year, or during the war now existing between Great Britain and Germany should that war last longer than one year, and for six months after the termination of that war provided His Majesty should so long require my services, or until legally discharged.

A H Helmer (Signature of Recruit)

Date Sept 22 1914. (Signature of Witness)

OATH TO BE TAKEN BY MAN ON ATTESTATION.

I, A H Helmer, do make Oath, that I will be faithful and bear true Allegiance to His Majesty King George the Fifth, His Heirs and Successors, and that I will as in duty bound honestly and faithfully defend His Majesty, His Heirs and Successors, in Person, Crown and Dignity, against all enemies, and will observe and obey all orders of His Majesty, His Heirs and Successors, and of all the Generals and Officers set over me. So help me God.

A H Helmer (Signature of Recruit)

Date Sept 22nd 1914. (Signature of Witness)

CERTIFICATE OF MAGISTRATE.

The Recruit above-named was cautioned by me that if he made any false answer to any of the above questions he would be liable to be punished as provided in the Army Act.

The above questions were then read to the Recruit in my presence.

I have taken care that he understands each question, and that his answer to each question has been duly entered as replied to, and the said Recruit has made and signed the declaration and taken the oath before me, at Valcartier this 22nd day of Sept 1914.

C H Maclaren (Signature of Justice)

I certify that the above is a true copy of the Attestation of the above-named Recruit.

C H Maclaren (Approving Officer)

O.C. 2nd Battery 1st Bde

Fig. 1: Attestation form

The information researched from the Attestation Forms allowed the class to determine the socioeconomic make-up of the soldiers that they are studying. For example, Alexis Helmer's form states that he was single, an engineer, had prior military experience in the militia and was the son of a Lieutenant-Colonel. Alexis Helmer appears to be middle class—but were all soldiers middle class? John Sheahan was a chemical tester. Ferdinand Leon, conscripted into the CEF, was a labourer (Helmer, Sheahan, Leon, Attestation Forms). Was there a class difference between English and French soldiers from this area? Taken together, the attestation forms allow the class to make inferences about what the community was like almost a hundred years ago. As well, the individual student can begin to form a mental picture about the soldier as the forms also contain a rudimentary description of the man. We know that Alexis was blue eyed, fair haired, and had a scar on his left leg (Helmer, Attestation Form).

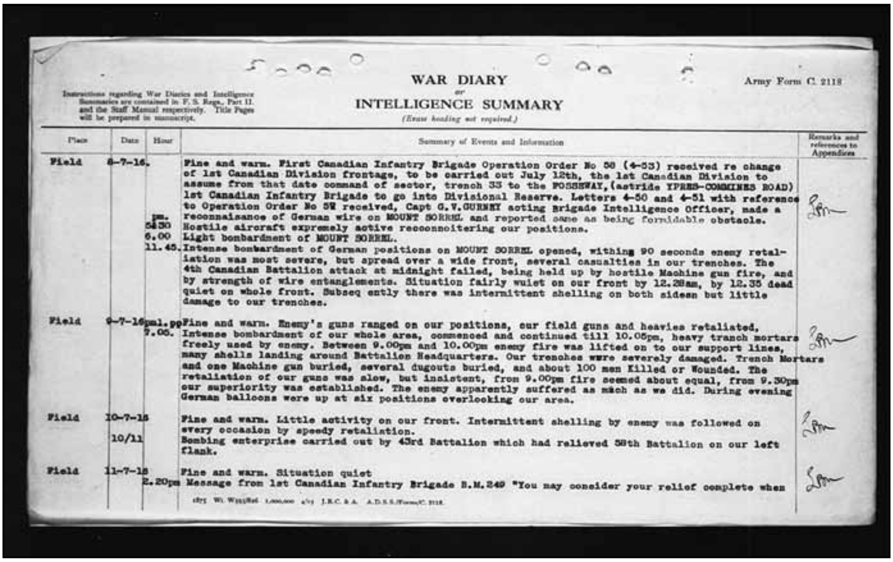
After analyzing the attestation papers, the class members were ready to go to the Canadian War Museum to see the rest of their soldier's file. The students were given an introduction to the different types of documents found in a soldier's file by museum staff. What followed was total immersion for the next two hours. Time flowed as the students were transported back in time and learned about the journey of their soldier.

Fig. 2: Analyzing primary source documents

Among the documents that were analyzed were casualty forms and the record of service. These two forms serve as the foundation for the students' research. The record of service was created at headquarters and is generally more legible, while the casualty form was created by the soldier's unit often while he was at the front. The title "casualty form" is a misnomer as it not only documents a soldier's injuries, but also some movements that the soldier went through. These forms begin with the embarkation to Britain from either Quebec or Halifax and list the ship that the unit sailed on. What usually follows is where the ship arrived in port and then where the unit went for training in England. Any changes in the unit that the soldier was affiliated with are also listed on the form. When the unit was transferred to the front was also noted and all further notations are vaguely listed as being from either "the field" or France. The casualty forms will note if the soldier went on leave, fell sick, or violated discipline which usually resulted in Field Punishment no. 1—being tied to a fence post or other fixed object for two hours a day and then subjected to hard labour. Gunshot wounds, lacerations, and other injuries were listed along with the process of the wounded soldier as he was transferred from field ambulance to casualty clearing station to general hospital. The forms may also record the soldier's ultimate fate if he died during the war. By examining the files, the students participated in the actual work of historians—looking at the fragmentary record of the past and trying to re-assemble the pieces.

Although the casualty form and the record of service offer a lot of insight into the movement and experience of a soldier, they do not give any indication of what the soldier went through while in the trenches of France and Flanders. For this information we needed to cross-reference with the unit War Diary. The War Diaries are available electronically from the LAC website. One can search for a particular unit, but the entries in the War Diaries are not searchable, nor are they necessarily organized in a chronological way. Furthermore, some units had similar names, particularly artillery units. Because of the overwhelming amount of information, some students find this step particularly onerous (Lee, 2002). Despite this barrier, the War Diaries provide an excellent source of information. While some Diaries were rudimentary in the description of event, others had officers that wrote with a narrative flair. According to historian Tim Cook (2006), the quality of the War Diaries greatly improved following the intervention of the Canadian War Record's Office, which wanted to have material for the official history of the war. The Diaries are also a great source for official orders and maps that were deposited in the appendices. By cross-referencing a soldier's file with a war Diary we are able to find out that Lt. Alfred Rimmer of Aylmer, Quebec was attached to the 1st Battalion and was at Mount Sorrel when he died in "intense bombardment of our whole area" (War Diary, June 1916, 1st Battalion CEF, p. 5).

He was not the only one, as one hundred other men were either killed or wounded in the German shelling that June.



WAR DIARY
or
INTELLIGENCE SUMMARY
(Erase heading not required.)

Army Form C. 2118

Instructions regarding War Diaries and Intelligence Summaries are contained in F. S. Regs., Part II. and the Staff Manual respectively. Title Pages will be prepared in manuscript.

Place	Date	Hour	Summary of Events and Information	Remarks and references to Appendices
Field	8-7-16.		Fine and warm. First Canadian Infantry Brigade Operation Order No 58 (4-53) received re change of 1st Canadian Division frontage, to be carried out July 12th, the 1st Canadian Division to assume from that date command of sector, trench 33 to the FOSSEWAY,(astride YPRES-COMMINES ROAD) 1st Canadian Infantry Brigade to go into Divisional Reserve. Letters 4-50 and 4-51 with reference to Operation Order No 58 received, Capt G.V.GURNEY acting Brigade Intelligence Officer, made a reconnaisance of German wire on MOUNT SORREL and reported same as being formidable obstacle.	
		pm. 5.30	Hostile aircraft expremely active reconnoitering our positions.	
		6.00	Light bombardment of MOUNT SORREL.	
		11.45.	Intense bombardment of German positions on MOUNT SORREL opened, withing 90 seconds enemy retaliation was most severe, but spread over a wide front, several casualties in our trenches. The 4th Canadian Battalion attack at midnight failed, being held up by hostile Machine gun fire, and by strength of wire entanglements. Situation fairly wuiet on our front by 12.28am, by 12.35 dead quiet on whole front. Subseq ently there was intermittent shelling on both sidesn but little damage to our trenches.	
Field	9-7-16	pm1.pp	Fine and warm. Enemy's guns ranged on our positions, our field guns and heavies retaliated,	
		7.05.	Intense bombardment of our whole area, commenced and continued till 10.05pm, heavy tranch mortars freely used by enemy. Between 9.00pm and 10.00pm enemy fire was lifted on to our support lines, many shells landing around Battalion Headquarters. Our trenches were severely damaged. Trench Mortars and one Machine gun buried, several dugouts buried, and about 100 men Killed or Wounded. The retaliation of our guns was slow, but insistent, from 9.00pm fire seemed about equal, from 9.30pm our superiority was established. The enemy apparently suffered as mach as we did. During evening German balloons were up at six positions overlooking our area.	
Field	10-7-16		Fine and warm. Little activity on our front. Intermittent shelling by enemy was followed on every occasion by speedy retaliation.	
	10/11		Bombing enterprise carried out by 43rd Battalion which had relieved 58th Battalion on our left flank.	
Field	11-7-16		Fine and warm. Situation quiet	
		2.20pm	Message from 1st Canadian Infantry Brigade B.M.249 "You may consider your relief complete when	

Fig. 3: War diary

What to do with all of this information? I had previously asked students to write a narrative essay describing a soldier's war service. Last school year, I wanted to try something new by incorporating new technologies into the history classroom, which according to Lévesque (2008) has not been done often in the past. I thought that it would be interesting if we could somehow map out a soldier's experience using Google Earth. Working with Paul Rombough of LEARN (www.learnquebec.ca) who set up a WordPress blog and wrote a script that allowed students to easily transfer the information from the blog entry to Google Earth, students plotted the movements of their soldiers across the globe. This gave the project two new dimensions. One was sharing their research in a real-world medium, and the other was the special context of seeing exactly where their soldier went.

The blog (western-quebec-soldiers.com) was loosely inspired by the posting of letters from the Trenches of Pte Harry Hamlin, 90 years after he had originally written them (WW1 Experiences of an English soldier). The students were asked to write a post for each major movement of their soldier. Most took to the assignment quite easily, but some had difficulty with the technical side of making blog posts or linking to Google Earth. But with some coaching by Paul, they were able to overcome these small obstacles. Overall the students were once again completely engaged in the task. Paul supplied laptops for the students and we spent an afternoon in the school library working on the blog entries. Many of the entries include pictures or maps to provide extra context. The students also cross-referenced the entry to a "pin" that they had placed in Google Earth. This allowed the students to make a virtual tour of their soldier's progress from western Quebec, to training in Canada, to Halifax for embarkation, to training in England, and finally to France or Flanders. It was revealing to see just how far some of these men went.

Fig. 4: Screenshot Google earth

Throughout the project it was interesting to see that the students would take ownership of the person that they were researching. They would refer to them as "my soldier" or "my guy." Some would go and try to visit the address on the attestation form, or use Google street view to see where they had lived. Many openly wondered what became of their families? Did they have children? Or if their soldier had survived the war, what happened to them? These questions were left unanswered, but they underlined the developing historical consciousness of the students. They realized that these men and women were individuals who had lives and families much like their own. The people in the past lived in this community, walked the same streets, and lived in the houses around the corner. Their soldier had become the face of the First World War.

Overall, the project was a success. Students were engaged throughout the entire process. The experience allowed students to practice disciplinary skills like analyzing primary sources, and developing historical empathy towards the soldiers and nurses that lived in the past. They also combined older research methods like handling historical artifacts and documents, and using newer technologies like databases and scanned documents. The students expressed their research in an authentic way by creating their blog posts and mapping out the soldier's journey using Google Earth. Lest We Forget has ensured that these students will never forget the people of their community who answered the call to duty almost one hundred years ago.

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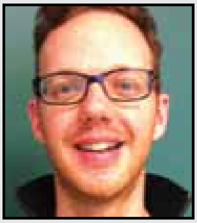

Matthew Russell is head of the social studies department at D'Arcy McGee High School in Gatineau, Quebec. He is interested in the development of historical thinking skills and the historical consciousness of young people. The Lest We Forget project and the memory of the men of the First World War are especially important to him. Matthew's great grandfather, Sapper Thomas Cameron, was wounded at Vimy Ridge and Passchendaele.

  

Re-forming Networks Through "Looping": An Ecological Approach to a Teacher's Incorporation of New Technologies in Early Childhood

Teresa Strong-Wilson and Sheryl Smith-Gilman, McGill University
Penny Albrant Bonneville

ABSTRACT

In this article, we discuss a teacher's agency and digital pedagogy who, following a four-year Learning with Laptops professional development initiative, relocated from a Grade Six to a Grade One class. An ecological perspective on teacher agency combined with Actor Network Theory underscores the "repertoires for manoeuvre" available to teachers (Priestley et al., 2012, p. 211). The early childhood classroom presented unique openings for "looping" elements of the teacher's previous network into a new context. Through re-forming networks, new spaces for digital pedagogy materialized.

Adults often scramble to keep up to date with the multitude of technological devices while at a very young age, children often actively seek out the plethora of toys and tablets embedded with computer chips that sing, talk, and dance at the press of a button or the swipe of a finger. Ipad and cellphone apps (applications) intended for young children now number in the thousands (Szabo, 2011). As the contemporary generation of children settles into the first years of school, teachers are discovering that young learners growing up with technology process material differently from previous generations (Oblinger & Oblinger, 2005; Zevenbergen & Logan, 2008). Teachers have often been resistant to incorporating new technologies in the classroom, especially with young children (K-3) who have been considered as too young or not yet developmentally ready, too impressionable, or better served by outdoor play (Linebarger & Piotrowski, 2009; Plowman, McPake, & Stephen, 2010). Professional development in the area of new technologies has largely focused on older students (aged 8 and up). Our article focuses on the "looping" that one early childhood teacher used to spark technology integration within the primary wing of her school by connecting older with younger students. Our article could have also been called "upstairs/downstairs." Early childhood teachers often live "downstairs" in schools while upper elementary classes occupy the upper floors. While this arrangement is often for very practical reasons and does not imply a hierarchy, it can also remind us of how young children—and ECE teachers—are often underestimated or misjudged (Kane & Mallon, 2006). Penny presently lives "downstairs." She began her career teaching early childhood then experienced a turn in her practice when, as a Grade 5/6 teacher, she moved "upstairs" and became part of a professional development initiative called "Learning with Laptops" (LWL). Inspired by her new-found vision of teaching grounded in new technologies, Penny returned "downstairs" to the primary wing. One of Penny's larger goals, which also became part of the school mandate, was to promote technology integration in the primary wing. In this article, we see how Penny struggled to manoeuvre her new-found sense of agency in the primary wing. We suggest that to understand how she "looped" (moved forward) elements of her previous network into her new context, we need to take an "ecological" perspective on teacher agency.

New Technologies and Early Literacy

While early literacy intervention has been the by-word of early childhood research and practice for at least the past three decades, only recently has research and practice attended to *early* digital literacy (Flewitt, 2011). Most studies have focused on technology use of children ages 8 and up (Ito et al., 2009). Lankshear and Knobel (2003) surveyed the contents of nine major journals between 1999 and 2002, searching for literacy and new technology studies of children up to 8 years old; most articles focused on technology as a support to print literacy. Building on the Lankshear and Knobel review, Burnett (2010) reviewed studies involving young children that were published between 2003 and 2009. Across the 36 articles selected from the 698 reviewed, Burnett identified three trends: technology was used to deliver literacy, or technology was a site for interacting with others around texts, or technology supported meaning-making. The majority of articles (23) continued to fall into the first category, in which the focus was on print literacy (i.e., phonological awareness, reading comprehension, vocabulary). Four studies fell into the second category, where the focus was on children's talk. Nine studies explored technology as a medium for meaning-making, in which literacy was understood more broadly.

Debates around the place of technology in early childhood learning have also given rise to discussion about the teacher's role (McManis & Gunnewig, 2012). The latest Position Statement of the NAEYC and Fred Rogers Center (2012) is that "the adult's role is critical in making certain that thoughtful planning, careful implementation, reflection and evaluation all guide decision making about how to introduce and integrate any form of technology or media into the classroom experience" (McManis & Gunnewig, 2012, p. 6). However, the research upon which the present article is based suggests that more is involved than a teacher's thoughtful planning. Technological innovation can be an aspect of change at the classroom level, but it also implies a broader shift, which involves not just a teacher but a network: teachers, administrators, students, and potentially the broader community, local and global. It also involves the "non-human" network of infrastructure, which needs to be in place in order for teachers to be able to access and use technology in their pedagogy. Penny faced two main challenges: a) the adaptation of her pedagogical knowledge around new technologies to working with young children, and b) the creation of a "culture" of digital pedagogy in the primary wing of her school. The first challenge she readily achieved. The second one proved more challenging. We propose a theoretical framework of the ecology of teacher agency combined with actor-network theory to understand Penny's classroom achievements in the primary wing. She used her "network" of her past Grade 6 students to "loop" change forward. Penny's story helps us to better understand how incorporating new technologies within schools is not just about teachers but about the networks teachers navigate to help accomplish change.

Teacher Agency and Educational Change

New technologies present one of the greatest challenges to schools, on multiple levels. They require decisions about the allocation of resources. Probing questions may be raised by parents or school board members about the difference that new technologies actually make to student learning. Teachers are aware of how "plugged in" students are outside of school and struggle to make the curriculum interesting and relevant. The so-called "teacher factor" with respect to incorporation of new technologies in schools is often framed as a problem of how to generate teacher agency (UNESCO, 2008). Agency has been considered as an essential component of teacher change and curriculum reform (Hibbert, Heydon, & Rich, 2008). Traditionally, agency has been understood as the capacity to respond constructively to change by acting autonomously, despite external constraints (Priestley, Edwards, Priestley & Miller, 2012). Agency tends to be associated with such words as: "selfhood, motivation, will, purposiveness, intentionality, choice, initiative, freedom, and creativity" (Emirbayer & Mische, 1998, p. 962). In recent years, other ways of understanding agency have been explored (Priestley et al., 2012), including collective agency, contextual approaches to agency, agency of networks (Fenwick & Edwards, 2010), and ecological notions of agency (Biesta & Tedder, 2007).

Sociologists Emirbayer and Mische (1998) think of human action as social engagement. This involvement with others is informed by the past (e.g., habits), by the future (the capacity to imagine alternatives), and by the present (the ability to mobilize past and/or future to address present situations). Emirbayer and Mische refer to each of these as, respectively, iterative, projective, and practical evaluative forms of engagement. These are useful ways to think about agency as not ONE thing but as multiple, depending on the context in which we find ourselves. The possibilities for human agency change over the life course, depending on where we are, at what time in our lives, in relation to which other people. By seeing agency as contextual, we can understand how teachers *manoeuvre* agency within any given situation (Priestley et al., 2012).

One direction in which this contextual concept of agency has been developed in adult learning is ecological: "by means of an environment rather than simply in an environment" (Biesta & Tedder, 2007, p. 137). In other words, individuals interact with one another and with their environments but those environments also influence (enable and constrain) teachers' agency. When speaking about technology integration within larger institutions like schools, the environment also includes technological infrastructure (viz., machines, places to store them and means to access them) and resources (those who are knowledgeable about technology). Actor-network theory (ANT) is interested in the formation and sustaining of networks, including the relationships between human and non-human elements: their interconnections as well as the struggles and negotiations for power, which can involve: creating roles, setting policies or routines, and applying for funding (Fenwick, 2012). While ANT has largely been applied to large, powerful networks, it has also been used as a lens to understand how knowledge and practices move within schools especially during times of educational reform, and teacher professional development (Riveros & Viczko, 2012).

A contextual theory helps us understand the teacher as social actor in relation to other social actors. Actor-network theory helps us understand how the formidable presence of technology influences educational reform, which affects the ecology of teacher agency. What Fenwick (2012) calls an "ANTish" approach to ANT can help locate the points at which teacher agency is interrupted and derailed, as well as identify what helps mobilize teacher creativity and innovation, thus contributing to a more nuanced understanding of the project of introducing technology in schools across grades (e.g., in a primary wing).

The Post-LWL Context

"What happens to student and teacher engagement when the tools are withdrawn or diminished?" (Strong-Wilson, Harju, Mongrain, & Thomas, 2008, p. 10). This was one of the main questions motivating the Balancing Literacies project, which emerged in the post-LWL landscape following a research collaboration between McGill University and New Frontiers School Board that had transitioned through four successive two-year teacher cohorts, involving 28 teachers in all. Learning with Laptops (LWL), a New Frontiers initiative, had used a teacher action-research approach to gather and share data in collaboration with a research partner, McGill University (in a research project called Changing Literacies, Changing Formations). Key tenets of the co-created professional development model were face-to-face meetings, a teacher blog, documentation of practice, and public sharing of research (Strong-Wilson et al., 2012). The school board provided infrastructure: class sets of laptops, with some "topping up" and refurbishing of computers by administrators of the participating schools. Central was the provision of ongoing technical and pedagogical support from the LWL leader, Bob Thomas. The PD initiative marked a turning point in teachers' lives (Strong-Wilson et al., 2012). One of the LWL reports prepared for the school board concluded with the question of what would happen when the tools were withdrawn: the hardware, support, and collegial collaboration. What would happen when those elements became detached from their LWL ecology, in which teachers felt energetic and supported, and became translated into the school context, in which LWL teachers would likely be positioned as agents of school change? This was the main question motivating the post-LWL Balancing Literacies research.

While LWL attempted to ease the transition, for instance by having principals participate in LWL and develop re-investment plans as the focus of their research, the shift back to the school context was nevertheless abrupt. Penny Bonneville, who is a co-author on this article, was one of those LWL teachers.

The Balancing Literacies project[1] on which this article is based used a qualitative research approach to study the phenomenon of teachers' negotiating literacies and the meanings that social actors ascribe to events and experiences (Denzin & Lincoln, 2003; Stake, 1995); the research invited teachers to develop their own questions, as part of an action research design, similar to the one used in the LWL research. For the LWL "teacher graduate," the post-LWL landscape involved a negotiation of literacies, with LWL teachers being positioned as leaders in school reform. Over 2010 and 2011, classroom observation and interviews took place with five elementary classroom teachers. One LWL teacher, who is the focus of this essay as well as one of its co-authors, had recently moved back to teaching early primary education, and was charged with leading the integration of technology within the primary wing of her school. Sheryl and Teresa met with Penny to see what she was interested in investigating. Sheryl became the primary contact, visiting seven times (totaling 22 hours) with 68 minutes of videotaped classroom interactions.

In the first year of Penny's return to the primary wing, early childhood teachers at her school were not yet ready to engage with the technology, for reasons of inexperience, caution, and feeling overwhelmed at the thought of having to integrate yet another teaching tool into their daily routines. Although Penny was there to offer support, the thought of yet another "job" to do was unappealing to many. "I was very fortunate to have been given formal training and an incredible support system for two years before exploring technology on my own. These teachers were asked to do the same without the training" (Penny, Personal Communication, April 20, 2013). Penny therefore looked for other means to "manoeuvre" teacher agency with respect to new technologies within her classroom and eventually, the primary wing. Penny initiated a research wiki, in which she collected and posted information as well as reflective thoughts on what became her mentorship project. In this article, Penny tells the story of her project, drawing on the wiki as primary material.

Penny's Context

School board priorities were on reading and writing, supported by technology, but with the emphasis moving towards print and the engaging of children with books. The Daily 5 program was exemplary of this focus, and was mandated in all elementary classrooms across the board.[2] One example of how technology could support literacy was evident through school subscriptions to Tumblebooks, a website where children could click on the pages and hear a story being read to them;

Penny was instrumental in this change, as her principal proudly pointed out (Interview with principal, Dec. 13, 2010). At Penny's school, equipment was also a priority: providing each of the two floors with a mobile lab. A lab had already been put into place "upstairs," while the "downstairs" primary grades section was outfitted with 10 iBooks, 5 iPads, and 5 iPod touches. Penny was made responsible for downloading the apps (applications), which largely focused on reading and math. When asked how technology supported the Daily 5, the principal identified the Smartboard as key. Just about every class had one, she maintained, a tool which allowed for greater interactivity and was more suited to children's contemporary learning styles: "being able to touch the screen and have it move or attached to a link on the internet, to me, it's all part of [it]: it's the reading, the writing, the media, it's the understanding; it's all there" (Interview, Dec. 13, 2010). The principal acknowledged some of the post LWL "network" challenges: some teachers struggled with integration, the availability and upgrading of equipment remained an issue within diminishing technology-targeted funds, including the elimination of funds to mentor others. Supportive of Penny, the principal acknowledged the importance of the tools: "If the teacher doesn't have the tools, then they don't have a way to learn it." The principal also reinforced the importance of the Daily Five, to which she believed technology would lend its support to build students' literacy "stamina" (Interview, Dec. 13, 2010).

While moving "downstairs" to the primary grades was an enormous change for Penny, she was committed to her practice of integrating technology. Penny was aware that technology implementation was minimal in the early grades of her school and focused on taking on a mentoring group of "expert" Grade Six students (former LWL students) to help her Grade One class use laptops by the end of the school year. Her research questions were: How can technology stimulate collaboration between older and younger students? How can this partnership support sustainability of managing technology effectively in our school?

The Mentorship Project: Penny's Story

Living LWL Upstairs

My journey began in 2006 when I joined an action research project involving my school board and McGill University. It was a two-year project during which I taught in a totally immersive technological environment. My primary role was being a teacher-researcher. I co-taught the same group of Grade 5/6 students with a French colleague, who was also in LWL. I was part of a network of other LWL teachers, with support from the *board in the person of Bob Thomas and support for the research by the McGill team. It was a golden opportunity.*

I searched for methods that would inspire and excite my learners. For example, poetry took on a new dimension, as when students searched the Internet for poets and different styles and examples of poetry. My colleagues reported that the schoolyard was buzzing, my students reciting limericks and tongue twisters! Another outstanding project was digital storytelling. Students created a visual concept of "Romeo and Juliet." Students created multi-media presentations that incorporated movie, voice, sound, and musical effects. Our music specialist eagerly became involved. Students witnessed the collaboration of two teachers with very different areas of expertise. The project flourished, becoming more complex by the second. It was Reform practice at its best. Students were inspired with an unexpected passion and appreciation for a historical piece of literature.

Moving Downstairs: Technology Integration with Grade Ones

In 2010, I was asked to move from Cycle Three to a bilingual Cycle One class, my mandate being to build technology-based learning situations with primary students. A mobile cart was purchased for the ground floor early grades, with ten MacBooks, five iPads and five iPod Touches. Teacher training sessions were organized. The network was ready and functional by January.

January

For 3 weeks now, Ipads have been integrated into my Daily Five Program. During the first week, every child easily explored the iPad / iPod Touch devices. A variety of apps (Math, Sight Word/Vocabulary building, and basic French vocabulary) were preloaded. Within three weeks, students were autonomous in their learning.

When entering uncharted waters, simple safe rules need to be established. Details were critical: labeling and color-coding earplugs to avoid confusion and for proper hygiene, and forming groups for fair Daily Five rotation. Ultimately, my goal was to have students using MacBooks and exploring bookmarked sights within our School Board Portal by June.

However, Internet access meant obtaining parental permission, which I didn't have yet. Permission slips needed to be returned before we could continue. I needed to show the children how to use their codes (username and passwords) and log into the portal. Overwhelmed, I sought help from my former students in Cycle Three experts: former LWL students.

Tapping Into My Network

March 29

I posted a mentors "sign up" sheet for grade six students. By the end of the first day, one student responded, leaving me surprised and disappointed. Nevertheless with some encouragement, by Thursday afternoon, I accumulated 12 names. The very first student to volunteer was a boy new to our school who was having a hard time adapting. He asked me daily, "When are we going to start?" A week went by. Sixteen students signed up.

April 8

My excited student volunteers would meet Friday noon in my classroom. The secretary repeated our message in our Morning Announcements over the intercom. The students arrived promptly. However my list of sixteen had dwindled to six.

I explained the two stages of the project. Stage one: training my mentors to support grade one students to access an Internet browser, find the portal, log in using their username and password and then log into their electronic portfolio. Once in ePearl, mentors would show the younger students how to upload photos and videos. They would help them write a reflection on the uploaded artifacts. Lastly, mentors would show students how to make a voice recording of themselves reading. Stage two was to access and explore Abracadabra.

The mentors were excited to start. Unfortunately, two sessions would have to be held since the group was divided into two homerooms. Challenges with finding a convenient day (i.e., amid Ped days, holidays) led us to meeting on April 13 at 12:30. "Bad luck 13" came into play. All of my mentors but one had double booked themselves or were absent. When you get kicked off the horse, you need to climb back on! My new strategy was to speak with colleagues and arrange a mentor training day. I wanted them to be confident and knowledgeable when it came time to interact with the younger students.

April 27

I initiated another lunchtime meeting with my mentors. The secretary, through daily announcements, reminded students. The lunch bell rang and I waited with bated breath. My group of four mentors was now reduced to two. Never losing faith, I was thankful to have two dedicated students. We were ready to proceed.

Mentoring Begins

The older students would demonstrate beginning procedures, which my students would repeat independently. I created a checklist that began with, "How do you turn on the computer?" Subsequent headings followed: "Entering a book title in ePearl" and "Taking a voice recording sample." Final steps included "saving your work," logging out of the portal, and shutting down.

My two mentors came after lunch, greeted by highly receptive grade one students. The mentors confidently talked the younger ones through the whole process. During recording time, the mentors discovered that the classroom was too noisy. They took the initiative and asked if they could move into the hallway. I was glad they took ownership of the situation. They were kind and patient with the younger students. When they were in the hallway, I followed and videotaped. A problem had occurred during the recording portion. Students could not be heard when they played back the recording. Both mentors problem-solved and agreed that next session, they would need headphones with a microphone to record properly. Towards the end of the session, the mentors transferred the computer to the youngsters and gave them hands-on time. Thirty minutes passed quickly. The mentors put away all the material and left with big smiles on their faces. When I asked if they wanted to come back, their answer was a big YES!!

Friday May 6

My mentors are keen, dependable citizens. My proudest moments were watching them set up the equipment and address important details. They were instant problem-solvers and pillars of patience with their mentees. I take pride in knowing that I taught these students last year in grade five. I am proud and thankful to have them in my classroom.

When asked why he was mentoring, one mentor simply replied: "Because I get to use the laptops!" When someone asked me why I became involved with the LWL project, I answered the same, "Because I get to use laptops!"

May 17

My loyal mentors, my partners, have come officially for about one month. I've become observer rather than instructor. I began integrating laptops into daily instruction. I preloaded the laptops with a "Note Book File" called The Life Cycle of Living Things. In the morning I showed the lesson on the Smart Board so students could see the links. After recess, I set up eight students and let them go! The children learned to navigate, moving from one web page to another by opening and closing different screens. They were able *to reload "Note Book" if they accidentally closed the window. They independently listened to songs, watched video clips, played games, and visited websites. It was great. A large "thank you" goes to my mentors!*

Looping

June

I have been familiarizing my students with laptops. They're getting quite good and are diligent at asking questions if unsure. Good practices and a solid foundation have been established. The mentors have been unable to come for the last week due to exams and fieldtrips. However next week, they will be modeling their mentorship to two grade five students, so that the process can continue next year. I have chosen two students. All parties involved are keen and prepared.

September

My year began with the golden opportunity of remaining with my Grade 1 students, who are now in Grade 2. Looping (moving up with my class to the next grade) entered my vocabulary; it is a word I have grown to cherish, in more ways than one. It was also a practice I was applying to the mentors.

My new grade six mentor reminded students how to log in and enter the school board portal. Although appearing simple, it entails several tedious steps. Under the mentors' guidance, students navigated to our classroom community, allowing me to integrate technology into the "Daily Five" practice.

My students were ready to move onto bigger, more impressive projects, and so was I. An extended project began: an Anti-bullying campaign wherein the Grade Two students paired with Grade Six students to learn the steps involved in creating an iMovie. Several technological tools were incorporated such as a digital storyboard graphic organizer and cameras for photography. The young children acquired skills in transferring formats to QuickTime, transcribing their stories, formatting frames, loading, inserting and cropping their pictures, adjusting time durations and inserting transitions. Students labored for 7 hours on their individual movies, each of which had a duration of one and half minutes!

What fascinated me was that all students enjoyed complete autonomy with the technological tools. They took control of their learning. They collaborated and made creative choices. Students' work was showcased when we invited the school to view the movie productions. An Open House welcomed families and community members to celebrate our students' success. I am so proud of them all: the mentors and my students!

Discussion

Penny's story tells how a teacher began the integration of new technologies with a notion of agency carried over from her participation in a highly supportive professional development context. Penny called LWL a "golden opportunity," like Charlie's ticket in Roald Dahl's famous *Charlie and the Chocolate Factory*. Post-LWL, Penny and her LWL Grade 6 colleague were successful in establishing a new network with non-LWL teachers "upstairs" when they secured a professional development grant, which allowed for release time. Penny's collaboration with the Music teacher also continued. In the post-LWL world, teachers had to increasingly negotiate their own agency in their own school context. Once Penny moved "downstairs," she had to think about how she could use her existing networks and build new ones. The primary teachers had to be brought on board slowly. Some social actors were positioned to be more supportive than others. The principal, for instance, played a key role in encouraging Penny's integration of new technologies in the primary wing by positioning her as a mentor of other teachers and more importantly, by providing the non-human tools, the mobile lab. She also allowed her to "loop" upward with her Grade 1 students into teaching Grade 2. The tools represented new learning opportunities for Penny, which stimulated her own desire to find creative ways to incorporate iPads and iPods in the primary grades.

Penny's creation of a mentorship project with her former Grade 6 LWL students represented a shift in teacher agency from being localized in the teacher as leader and capacity builder, to agency as more distributed: "manoeuvred" among a wider network of social actors: the student mentors, Penny's own Grade 1 students (who "looped" with her), the principal (who had the foresight to allow for the looping), Penny's "upstairs" colleagues, and the Grade 5/6 teachers with whom she later paired on a bullying project. Through this manoeuvring, Penny was able (with her student mentors) to bring her primary students from learning how to log in to creating an iMovie: a project that more closely resembled the exciting digital pedagogy that Penny had been part of in her culminating year in the LWL project.

From the perspective of early digital literacy, Penny also negotiated the several pressures on the use of technology in the primary classroom. While the "apps" primarily served the school and Board mandate of reading, in which technology is positioned as "deliverer of literacy," the extended network with the Grade 6 students and teachers, through the bullying project, allowed for technology to become more of a "medium for meaning-making" (Burnett, 2010, p. 254).

Conclusion

Penny's mandate in moving "downstairs" to Grade 1 was "to introduce technology … from the bottom up" (Interview, Jan. 25, 2011). This particular mandate initially proved challenging. An ecological understanding of teacher agency draws attention to the "repertoires for manoeuvre" available to a teacher at a particular point in time in particular circumstances (Priestley et al., 2012, p. 211). Penny had to seek out or create other networks, radiating outwards from the environment that was most within her control: her own classroom. An Actor Network Theory approach to educational change emphasizes the interaction of human and non-human tools. Penny's desire to keep her LWL professional development knowledge moving and active in her pedagogy would not have been possible without "the little network that is happening at all the [learning] stations" in her classroom "especially [with] the technology" (Interview, Jan. 25, 2011). Children were exploring apps on iPads and iPod Touches. This network was made possible by the tools, which were made available through the principal manoeuvring school funds. What Fenwick (2012) has usefully postulated as an ANT-ish approach to educational change, allows us to appreciate how different forms of network-like spaces can be created; spaces that may be in flux and provisional yet constitute the primary, ecological sites for agency. An ANT-ish approach, for instance, points to the importance for Penny of maintaining her "upstairs" network, even though she was no longer a Grade 6 teacher. It was from this network that future student mentors for the primary wing would be drawn: "The trend would be, if I am looping to get that base and send them [the students] off, by the time the teacher gets them in grade three, and if the teacher is willing to incorporate technology into their pedagogy …" (Penny Interview, May 26, 2011). Through re-forming networks, new spaces for digital pedagogy with younger students may materialize. This flexible space continued to move over the following year, with the primary wing now slowly coming on board.

Upstairs/Downstairs

As time moved on and projects became more visible to the school and possibilities of integration were being discussed, teachers' interest piqued. The turning point happened after our "Open House" and my students' work had been showcased for the entire school to see, which ignited a spark among my fellow teachers. By the end of my second year downstairs, there were two primary teachers who had come on board and were using the technology cart. The school purchased another ten iPads, which brought our total to fifteen. I was still the "go to girl" but my role intensified downstairs. I created an *agenda system where teachers would reserve times within our daily schedule to secure the cart. We are now in year three of integrating technology in Cycle One. Our third year began when four of my colleagues and myself applied for our P.I.C (Professional Improvement Committee) funds and took a trip to Boston to attend the "iPad Summit." The trip was amazing and set the tone for the rest of our school year. The cart is now in use all day long, five days a week, by teachers in the primary wing. The Daily Five program has initiated the greatest participation of teachers in integrating technology into their pedagogy. Teachers will ask me to find certain apps that complement their unit of study and I load them on the iPads. I have written another PDIG proposal to strengthen this area of integration for next year. We are still at the beginning stages when it comes to sharing best practices but are definitely headed in the right direction. The fire is burning bright at our school.*

Notes

1. This research would not have been possible without the support of McGill's Internal Grants (SSHRC) program, for whose financial support we are grateful.

2. The Daily 5 (created by Jane Boushey & Dale Moser) is a series of literacy tasks arranged at different learning centers in the classroom. In groups, students rotate around the centers throughout the week. Typical centers may include: 1. Read to self; 2. Read to someone; 3. Listen to reading; 4. Work on writing; 5. Work on words. The objective is to support students in developing literacy skills according to their abilities with their peers.

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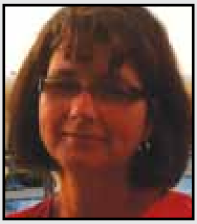

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Knowledge Building and Knowledge Forum: Getting Started With Pedagogy and Technology

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ABSTRACT

Knowledge Building provides a model of education for a knowledge age—a model of collective responsibility for idea improvement. This article provides two examples of getting started with the pedagogy and the technology, one from Senior Kindergarten, with students working together to understand why leaves change color in the fall, and the other from Grade 1, featuring explorations of the water cycle. In addition to the classroom work that is reported, commentary on school practices from a Librarian-Technology coordinator and Vice Principal are included to provide a broader school perspective on the work presented in this article.

Introduction

The emergence of the "knowledge age" has created the need for citizens able to work with ideas (Bereiter, 2002; Florida, 1995; Warner, 2006). Knowledge Building addresses this need by engaging students directly and productively in sustained work with ideas, with students assuming collective responsibility for idea improvement (Scardamalia & Bereiter, 2003). Two concise, published overviews on Knowledge Building theory, pedagogy, and technology are a chapter in the *Cambridge Handbook of the Learning Sciences* (Scardamalia & Bereiter, 2006) and a special issue of the *Canadian Journal of Learning Technology* (Jacobsen, 2010).

The founders of Knowledge Building pedagogy have identified 12 principles to serve as pedagogical and technological design parameters (Scardamalia, 2002; Scardamalia & Bereiter, 2006; Scardamalia & Bereiter, 2010):

Real Ideas, Authentic Problems. Students' ideas and problems of understanding drive knowledge advancement and need to be at the heart of classroom interactions.

Improvable Ideas. From the earliest ages, students understand that ideas are improvable and that working to improve idea quality, coherence, and utility brings their work into line with others trying to create a better world.

Idea Diversity. To create new ideas it is essential to compare and combine diverse ideas, take risks with ideas, and work through complexity rather than focus primarily on asking questions and finding right answers.

Rise Above. Students deal with competing ideas by formulating higher-level ideas that capitalize on the strengths and overcome the weakness of the competing ideas.

Epistemic Agency. Students learn to take over high-level knowledge work (generating ideas and plans, evaluating results, etc.) usually reserved for teachers.

Community Knowledge; Collective Responsibility. Each student accepts responsibility for what the group as a whole is able to achieve, with focus on generating ideas the whole community will find useful.

Democratizing Knowledge. All members of the community find productive roles and take pride in what the group as a whole is able to achieve.

Symmetric Knowledge Advancement. Students recognize that advancing the frontiers of knowledge is a civilization-wide effort in which they can participate, and that contributing to the knowledge advancement of others and of their community returns gains to their own knowledge advancement.

Pervasive Knowledge Building. Students come to see all problems, in and out of school, as occasions for building knowledge.

Constructive Uses of Authoritative Sources. Authoritative sources are valued means for understanding the state of the art in a field; they are also objects for critical analysis and improvement.

Knowledge Building Discourse. The discursive practices of the community engage all participants in transforming ideas, with critical analysis and efforts to go deeper highly valued.

Concurrent, Embedded, and Transformative Assessment. Assessment is an integral part of the students' efforts to advance knowledge, with self- and group-assessment part of the knowledge-building process.

Knowledge Building pedagogy is fostered through use of knowledge-building technology—technology that creates an environment favorable to the processes of expertise and innovation, as reflected in the above principles. Knowledge Forum is an online community space (www.ikit.org; see also Scardamalia, 2004) specially designed to support these processes. "Views" are created by students who may produce diagrams, models, or other backgrounds on the view using a graphics tool. "Notes" are contributed to these "views," and notes can live in multiple "views," to reflect the different perspectives created by different view backgrounds. Students reference, and build-on other students' notes, and create "rise-above" notes—notes that synthesize content in several notes. High-level knowledge work is further supported through use of "scaffolds"—discourse markers that help participants use and review their work in light of discourse moves deemed important to advancing their discourse. For example, scaffold supports from the theory-building scaffold include, "My theory…", "I need to understand …", "A better theory is …".

In this article we show knowledge-building principles in action in two "getting-started" contexts: (a) Senior Kindergarten exploration of why leaves turn color in the fall and (b) Grade 1 exploration of the water cycle. The site of this work is a laboratory school at the University of Toronto. Excerpts from interviews with a Librarian-Technology coordinator and Vice Principal are included to provide a broader school perspective on the work presented in this article. The Librarian-Technology coordinator chairs weekly Faculty Knowledge Building/Professional Development Meetings; the Vice Principal previously taught in the same school, specializing in use of Knowledge Building/Knowledge Forum. To help the reader track interview comments and knowledge-building principles, we use italics each time an interview or principle is presented.

Questions addressed in this paper include: How can teachers build a classroom community that supports idea generation, diversity, careful listening, and interaction to foster idea improvement with self-direction? What are the benefits of Knowledge Building pedagogy and technology? These and other issues will be discussed and recommendations provided for enhancing effective Knowledge Building principles in elementary-school classrooms.

At the Dr. Eric Jackman Institute of Child Study (JICS), University of Toronto, Canada, children are introduced to Knowledge Building principles when they enter the school at age three. Playing with ideas is natural and in evidence as soon as children learn to speak, but the more demanding process of discussing ideas in a community, with members committed to continuously improving those ideas, is not common. A Knowledge Building community treats ideas as "improvable" and the basis for reflection and conceptual change (see Zhang, Scardamalia, Lamon, Messina, & Reeve, 2007).

There were 22 children each in the Senior Kindergarten and Grade 1 classes described in this paper: some students spoke a second language, none were considered ESL learners or learning disabled. The two classes were taught by two different teachers.

Knowledge Building in Senior Kindergarten

At the beginning of the school year, Fall season, children viewed leaves changing color and falling down. Leaves changing color takes place over many weeks—a period of time that allows the children to note and observe leaves that are still on the tree beginning to change color, then starting to fall from the tree, then the rate of falling increasing until there are no more leaves on the tree. The children may also observe the temperature changing, rainfall, or the wind blowing stronger. Their exploration reported here took place September through December, with the work growing organically as ideas and questions arose. Typically students were actively involved in experiments, reflections, and discussions multiple times throughout the week, but a week could pass without further exploration. The fact that phenomena of interest occurred outside each child's home and school engaged students in exploration of natural phenomena, and things they wondered about and wished to understand—a productive context for exploring *real ideas, authentic problems* (Zhang et al., 2007).

Interview—real ideas, authentic problems; improvable ideas: "Often visiting teachers to the school will ask, 'How do I start? What's the beginning?' We explain that we have the children begin with an experience that generates questions of understanding, areas of learning that they want to learn more about. …'theories' of the children at the beginning of the study. … It is the starting point of the Knowledge Building process. As new information is acquired (through consulting authoritative sources, experimentation, and developing a collective knowledge through the Knowledge Building discourses) new theories develop, allowing the students to refer back to their initial theories and understand how they have evolved—helping them to understand the Knowledge Building principle that 'all ideas are improvable.'"

To start, the teacher engaged the students in a whole class discussion—what the children refer to as "KB Talk" (Knowledge Building talk). The children typically sit in a circle and share their ideas while the teacher writes down each idea and engages each child. In the case reported here the question "Why do leaves fall?" became the focus for the children's study of trees. Soon after generating ideas, the students walked to a neighborhood park and were asked to decide which tree in the park was their favorite. Each child then photographed that tree, and collected one leaf from the tree to bring back to the classroom. The children then carefully traced their leaves and drew in the lines, or veins, as some children already knew to call them. The photographs and traced leaves were then prominently displayed where the children could make comparisons and connections based on shape, size, and color (see Figure 1).

Fig. 1: Real ideas, authentic problems: Students are engaged in understanding the world

A few days later, the teacher proposed to the children to collect 10 different leaves. Back in the classroom, the children were asked to create a poster grouping their leaves in some way—for example, by kind or shape (see Figure 2). The teacher emphasized the importance of each child's contribution because everyone in the classroom needed to benefit from his/her work. This is a possible way to address the principle of *community knowledge; collective responsibility*; (see Scardamalia, 2002; Zhang, Scardamalia, Reeve & Messina, 2009).

Fig. 2: Community knowledge, collective responsibility: shared artifacts

> *Interview—community knowledge; collective responsibility*: Traditionally, students are responsible for their own learning only. In Knowledge Building students learn for their own sake but also to contribute to the knowledge of the community… New information cannot be only shared at the end of the unit such as is often done in Project-Based Learning but instead continuously so that everyone shares a breadth of understanding along with a specialized deep knowledge based on their research interest…making the individual's learning visible to everyone else in the classroom for the benefit of all.

By engaging students in grouping leaves by size and shape the teacher made it easy for students to share their ideas during group discussions. Indeed, the group discussions were animated and rich in content. The children discussed why leaves were falling, why they changed color, why they got wrinkled. Each child expressed ideas; the teacher helped each child give voice to an idea and be understood by everyone. In this way, the teacher addressed the issue of *democratizing knowledge* (also see So, Seah, & Toh-Heng, 2010) while students learned that every idea can be shared and developed, regardless of the speaker's personality and preferred mode of communication.

> *Interview—democratizing knowledge*: "Perhaps students feel insecure about sharing their ideas in a written form or orally. Knowledge Building allows many ways for students to contribute: Knowledge Forum notes, through drawings, KB talks, oral presentations, recorded presentations, sharing internet information, etc. Because Knowledge Building is about ideas—all children are on equal ground. And because we value 'idea diversity' all students feel safe to offer their theories as a starting point. The teacher is not presenting her/himself as the 'authoritative' source with all the answers—instead presenting her/himself as a learner as well. This prevents children from 'playing the game of school' in which students try to guess what the teacher is thinking. In Knowledge Building, the entire community shares the mission to have deep understanding—thanks to the contributions of each and every member."

The students were also made aware of the existence of different ideas. First they would hear the idea from a peer, then re-voiced by the teacher, and accordingly be in better position to understand that others in their community have ideas that are different from theirs. This is one of the possible ways to get started with the principle of idea diversity (see Law & Wong, 2003).

> *Interview—idea diversity*: "A misconception I had as an early career teacher was that my role was to get children to the 'right answer' as quickly and easily as possible. This is unfortunate because it prevented my students from experiencing and appreciating the complexity of learning. In Knowledge Building, we value idea diversity and recognize the value of having many ideas so that we can compare and contrast them, and deepen our understanding. Of course this approach takes time but the result is true learning rather than superficial and shallow knowledge acquisition."

By making sure that each child was heard and fully understood, the teacher had her students actively working toward reciprocity in knowledge advancement. The students get a start on the Knowledge Building principle of *symmetric knowledge advancement*, learning that to give knowledge is to get knowledge (Scardamalia, 2002). Although important, this principle can be difficult to implement in a classroom.

> *Interview—symmetric knowledge advancement*: "One aspect of this principle is to have the students specialize in different areas of the inquiry topic, become experts in those subtopics, and then share their knowledge with the whole group. Let's say all of the students are working on astronomy. Some students might be working on black holes, some on gravity, some on orbits, etc. They are engaging in the process of Knowledge Building as a real community of experts would, taking part in a collective responsibility for the knowledge advancement of the whole group."

The children in the class, encouraged by the teacher's enthusiasm for the ideas and observations they brought to the class, added to the conversation from conversations they had at home. For example, based on conversations at home with their parents some children introduced information about oxygen and root systems and some worked with their parents to further classify the leaf they brought to class. By emphasizing and encouraging connections and differences between ideas expressed in class and at home, and at different times and places, the teacher conveyed *pervasive knowledge building* (see also Nirula, Woodruff, Scardamalia, & Macdonald, 2003).

> *Interview—pervasive knowledge building*: "Life is naturally integrated; learning is naturally integrated. In schools, we traditionally have compartmentalized curriculum. Knowledge Building shows us that concepts are related to each other and best approached in an integrated way. Children on Knowledge Forum write for a purpose, they advance their theory building while practicing their writing skills. Measuring angles in a light experiment is an authentic application of geometry in math. These are both cross-curricular forms of integration but the pervasive nature of Knowledge Building is that big ideas emerge that connect different strands of science, e.g., the study of light is connected to the study of sound and astronomy, etc. [...] In the Library or the classroom, if a child shares an idea or a theory that is actually incorrect, we don't stop and say, 'No, that's wrong.' The students' misconceptions have an important role to play in the inquiry process… Knowledge Building teachers first establish their classroom as a safe environment where children are encouraged to share their ideas and half-baked theories free from judgment. … and use these to prepare for future inquiry work, without simply correcting the students in that moment. We know from research that simply telling the right answer does not lead to long-term learning."

In the Senior Kindergarten class, the teacher helped the students keep track of a knowledge building discourse by archiving it and making it visible in the classroom (e.g., transcripts of discussions on chart paper) or by simply reminding the children orally during a discussion of what they had previously thought/shared. This led to the formation of new questions. The teacher re-read the ideas expressed by the children in the previous discussion, to help them keep track of the starting point of their ideas and to be aware of the improvement of their theories (see Figure 3).

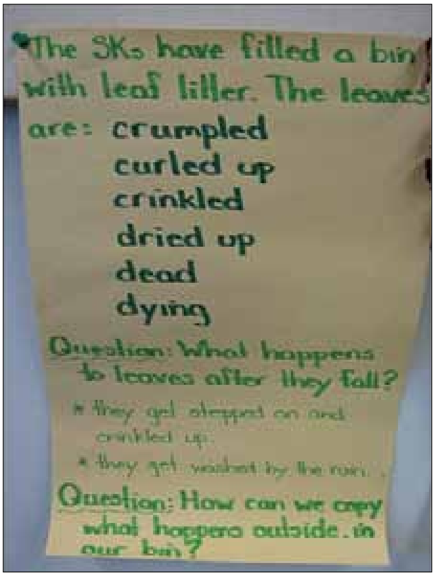

Fig. 3: Improvable ideas: Poster of children's discussion of the improvement of their theories

Knowledge-building discourse is more than sharing knowledge; the ideas of the group actually get refined and transformed through the discourse over time. Additionally, important facets of Knowledge Building work include engaging students in designing experiments and reading books to try to find some answers to their questions.

> Teacher: "How does chlorophyll travel? We have come up with three 'maybes': maybe the chlorophyll wipes off; maybe the chlorophyll goes down the veins back to the tree; maybe the chlorophyll turns into humus and then goes back to another tree."

Through observations, experiments, reading, reflections—and discussion throughout—children come to see ideas as improvable; in some cases they were able to find answers to their questions and throughout they generated new questions. It is important to note that the ideas offered by individuals become deliberately "detached" from a particular student and "owned" by the group as a whole. The continuous reference to the ideas of the group created a psychologically safe environment for the students, where they could feel free to express their ideas without immediately being labeled "right" or "wrong," and then work on those ideas to improve their quality, coherence, and utility (Scardamalia, 2002).

> Teacher: "Yes, [the leaf] is almost black. Last time we talked about two possible explanations why it had stretched. Someone suggested it grew longer because it flattened out [...] the other suggestion was that maybe it is growing."

At various points in their *knowledge-building discourse*, students addressed high-level ideas and difficult concepts such as oxygen or chlorophyll. At this point the teacher believed that their *idea improvement* depended on *constructive use of authoritative sources*. For this reason the teacher explicitly told the children that she would read a book where they might be able to find some answers to the questions raised during the last discussion.

> Teacher: "No matter how long we watch the leaf, we don't see the chlorophyll. I found a book that could help us and give us some answers. It's not a story, it has information in it, so it will sound a bit different."

In introducing authoritative sources it is important to emphasize that use of the resource is not simply to answer questions but to engage students in constructive use of resources (see Zhang et al., 2007)—to understand better the present state as well as the growing edge of knowledge in the field (Scardamalia, 2002)—also feeling free to question information there and work toward refining understanding of it.

> *Interview—constructive use of authoritative sources*: "Even experienced Knowledge Building teachers grapple with the appropriate time to introduce authoritative sources: too soon, and you risk hindering the flow of the children's theories and ideas. Too late, and the children's ideas might stagnate, or lose momentum. It is really a hard thing for teachers new to Knowledge Building to delay introducing authoritative sources. Teachers on our staff who are new to Knowledge Building might come to meetings early on in their inquiry topic and say, 'I was thinking of introducing authoritative sources now'. I can remember one teacher asking about this, and many of the other experienced Knowledge Building teachers around table

answered, 'Just wait, just give it a few weeks, let's see where the kids go with it'. The new teacher did, and it worked beautifully."

Thus students were encouraged to discuss new ideas, especially ones they had raised, that were not addressed in the resource at hand.

Teacher: "Now, how should we find out what happens when the leaves die?"

Asking children to help design experiments represents an early effort to transfer high-level agency for knowledge work to students so that they are in position to assume *epistemic agency* (see Nirula et al., 2003). In a group discussion, the teacher reminded the children of their own questions, and the students were asked to design a way through which they could test their ideas. The teacher encouraged the children to reflect on different variables and options to be considered when designing an experiment. Leaves were placed in bowls of water, in sand, and dry leaves were put in a bin with toys to stomp over them, like feet. Predictions were made for each experiment, such as the prediction that leaves in water would grow. By designing experiments, the students were "empowered" to address their personal questions rather than having the teacher design all experiments and learning experiences (see Figure 4).

Teacher: "Someone suggested we put it back in water. Do you think it will be shorter or longer now, or maybe the same length?"

Fig. 4: Example of experiments run by children in senior kindergarten: measuring changes of length in leaves

> *Interview—epistemic agency*: "If we start with epistemic agency, we might scare teachers new to Knowledge Building. This principle is actually about what the role of the teacher is in the inquiry process. This is truly saying, 'give children the power to design.'"

In the Senior Kindergarten, after the teacher had commented on the breadth of understanding demonstrated during a discussion, including how leaves make sugar for the tree, and how water and oxygen travel through leaves, one student asked if the previous class had learned as much. When the teacher noted that the other class had focused on roots, not leaves, the student responded: "Well, that's what we should study next. How do roots grow?" In Knowledge Building, the class may move on to a new area of inquiry but as this example suggests, an effort is made to provide an account of the current state of understanding as well as noting more to be learned. Students are also encouraged to return to ideas from different vantage points and at different times, and link those ideas to support ever-deepening and connected knowledge advancement.

Knowledge Building in Grade 1

As seen in the previous section, the ability to play with ideas seems natural and easily initiated with very young children. One of the obstacles in the "improvement" process relates to the need to record, revise, and synthesize ideas. How can these processes be turned over to students? As we saw in the kindergarten example, the teacher is continually modeling these processes for the students. Knowledge Forum (Scardamalia, 2004) represents an online community workspace that supports these processes and engages students directly in them (see also Wegmann & McCauley, 2009). Knowledge Forum is a web-based application; however teachers at JICS do not generally promote use of Knowledge Forum at home, respecting privacy of all team members. JICS teachers recommend that Knowledge Forum be used when students start to read and write, notably during Grade 1.

Preparing Students for Engagement in a Knowledge Forum Discussion

The Grade 1 students had experienced Knowledge Building in their previous two years of school, thus they were accustomed to generating ideas, listening to each other, and building onto each others' ideas. So the students arrived to Grade 1 prepared for the next important step in knowledge creation—moving ideas to a home—Knowledge Forum—where they could be recorded, revised, and improved. Since the cognitive cost of writing and reading is high (McCutchen, 1996; Just & Carpenter, 1992) and many students experience difficulties when it comes to reading characters, formulating, spelling, or transcribing ideas, it is important to develop these processes in a context that is engaging (Bereiter & Scardamalia, 2010). Writing and reading should enter into the process of Knowledge Building naturally, as a logical continuation of work with ideas. The Grade 1 teacher addressed reading and writing expectations through using Knowledge Forum to help students build knowledge.

The Grade 1 students were involved in a yearlong inquiry focused on "cycles," beginning with the topic of water. Their *improvable ideas* time took place twice a week for 30-45 minutes. This time might be spent reading and discussing texts together, having whole class KB Talks, doing experiments, drawing or writing in their Lab Books, and so forth. About halfway through the school year, each child started to have two 15-minute turns per week on Knowledge Forum.

Grade 1 students explored *real ideas, authentic problems*, by starting with an experiment. A plastic cup half full with water was placed in a resealable storage bag and the bag was taped onto a window in the classroom. The level of water was marked on the cup (see Figure 5). After a few days the children noticed water pooling in the bottom of the bag. Where did it come from? This inquiry lasted three months.

Fig. 5: Experiment on water in Grade 1

Introducing Knowledge Forum

Once students generated a few ideas, the teacher demonstrated how Knowledge Forum can help them in recording ideas, so those ideas can be improved in a community space. Below is a description of the first Knowledge Forum session in Grade 1, which lasted 45 minutes.

During the first 10 minutes of the class, the teacher invited students to sit on a carpet, while she was projecting a blank Knowledge Forum view onto a big screen. The teacher explained that every child has access to this electronic space to record ideas so that their ideas can be preserved and improved. Together, the teacher and children collectively decided to name this new view "Grade One Water Experiment." Then she explained how to record a note, give it a title, and save it. From the beginning, as suggested by group efforts to title their view, the teacher is releasing *epistemic agency* to students (see Nirula et al., 2003).

The next day the teacher worked with each child, encouraging each to state his/her best theory—a theory that would explain why there was water in the bottom of the bag. The teacher typed everything the child said in a Knowledge Forum note, under the student's name (their writing skills were too limited for them to record the ideas on their own), and contributed it to their "Grade One Water Experiment" view. To help students elaborate their theories, the teacher asked clarifying questions (e.g., "Tell me more about where you think the water came from?", "How do you think the water got there?") but she did not push them towards any particular answer. Students were free to go in any direction with their ideas. Once the student had finished telling his/her theory and it had been recorded, the teacher asked each child to think of a title. She stressed the importance of the title to every child she worked with, and defined it as a main idea, or "what's important in your theory." Students need to navigate the vast information they have access to and summarize; creating a title is a developmentally appropriate way to begin to develop such capabilities. They can quickly see that a generic title such as "Water" will not be helpful for others who may be searching for specific information, as they are all working on water. Thus students need to think deeply about what is unique about their note. Sometimes the teacher helped students to find this main idea by asking clarifying questions. For instance:

> Teacher in the Grade 1 classroom: "So where do you think the water came from?"
> Student: "It has been raining a lot lately, so I think it came through the window and into the bag."
> Teacher: "*So should the title be 'rain'?*"
> Student: "*Yes*"

Once a note had been posted, the teacher showed the child how to open and read the notes produced by other students, explaining that others may have different ideas. The teacher emphasized that Knowledge Forum is a place to record ideas so that they can be reviewed later. During the next two days, every child had an opportunity to write a note with the help of the teacher and over the next several weeks the children closely observed as water continued to accumulate in the bottom of the bag. They also noticed streaks of water droplets on the sides of the bags, and that there was less water in the cup itself. The class also had regular KB Talks where they could share their theories. The teacher then typed the children's improved theories into a "build on" note. There were some children whose theories were similar to their initial theories, while other children's theories reflected their improved understanding of where the water in the bag came from:

> "The water evaporates to the top of the bag and then it falls to the corner of the bag."
> "My theory is that the water vapour goes up and changes its state, and turns into liquid and goes down and falls into the bottom of the bag."
> "My theory is that the water from the top of the bag dripped down into the cup. P.S. How did the water get to the top of the bag?"

In March, halfway through the school year, when the children's reading and writing skills were stronger, they were able to work more independently. They quickly learned to open and read classmates' notes and to create their own notes. The students were excited about this new adventure—their theories had a place to "live"—a community space that meant their ideas were not simply expressed and forgotten, but recorded and available to be built on by others (see also Chuy et al., 2010 for discussion on theory building). The students seemed to especially appreciate "build on" notes to their notes. Their engagement in reading and writing on Knowledge Forum motivated them to continually exercise literacy skills, dramatically reducing the need for additional, unrelated reading and writing activities in the classroom.

After the initial excitement about recording, reading, and building on ideas in Knowledge Forum, the challenge is to incorporate community dynamics that allow students to take on the more difficult processes of idea improvement, and make this process commonplace and enjoyable (Scardamalia & Bereiter, 2010). Below are some of the strategies employed by the Grade 1 teacher.

The children used Knowledge Forum two times a week for 15 minutes a session. Priority was given to their own real *ideas* and *authentic problems* of understanding. *Authoritative sources*, including books, were not introduced right away; rather, the children had a chance to present their ideas, read each others' notes, and try to improve their theories before having their ideas potentially overshadowed by more formal, "correct," or accepted ideas.

The interplay between work on and off the database and between student ideas and authoritative sources is critical in helping the children engage in idea improvement, as well as for conveying that Knowledge Building is *pervasive* and coextensive with all aspects of their engagement with the world. Toward this end, student time on Knowledge Forum was intermixed with "KB Talks." Children heard each others' theories and questions and built onto each others' ideas through both online and face-to-face *knowledge-building discourse*. Often ideas generated in "KB Talks" would be recorded in Knowledge Forum at the next opportunity. And as students became more accustomed to the interactive aspects of online and face-to-face Knowledge Building discourse they—or the teacher—would request that an idea be recorded on Knowledge Forum so that the class could return to it at a later time.

> *Interview—knowledge-building discourse: "Knowledge-building discourse* is the core of a Knowledge Building class. It is the way to hear about the diversity of ideas in the classroom and the diversity of research experiences that is needed to develop the shared community knowledge. It is how we learn from each other and contribute to the learning of each other. While there may be different activities and experiments occurring in the classroom, KB Talks help focus the identified learning goals of the community. KB Talks help ensure accountability of the members of the learning community—we meet to learn from and with each other. KB Talks may be about concepts the students are trying to understand but they can also be about the process of learning and how we are operating as a Knowledge Building community. They give us the opportunity to reflect on our learning methods and see what needs to be improved."

As indicated above, Knowledge Forum includes scaffolds for high-level discourse such as theory building (see Chuy et al., 2010 for details). Students are encouraged to use scaffold supports such as "My Theory" and "New Information." To initiate such activity students simply click on these phrases situated in the surround space for their note and the selected discourse marker appears in the child's note. To encourage children to use these scaffold supports, the first grade teacher sat with each child, reflected on a note he or she had written, and decided together which scaffold should be included. Scaffolds can be added at any point, before any text is generated or after the fact. Increases in notes written by students can be seen in Figures 6, 7, and 8.

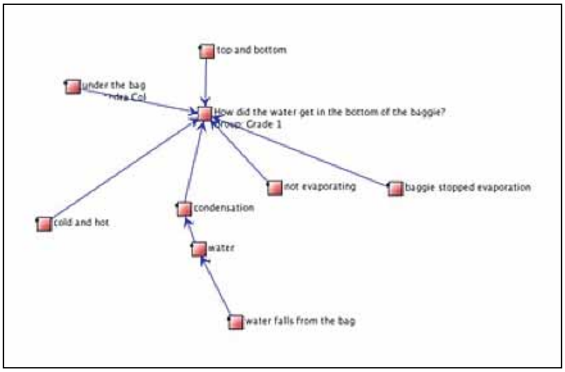

Fig. 6: Notes written by students in a single view: April 20, 2013

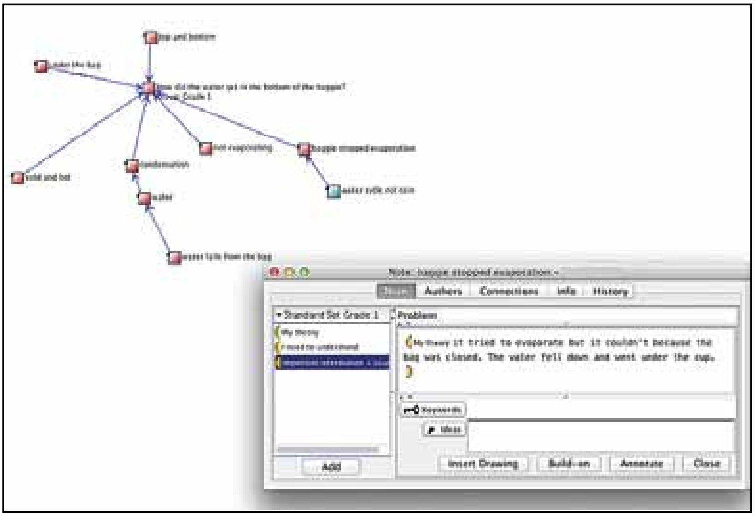

Fig. 7: Notes written by students in a single view, with example of a new note contribution: April 24, 2013

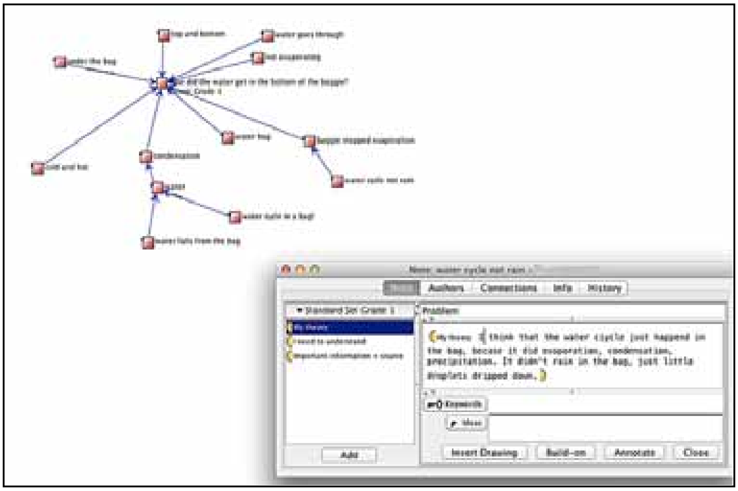

Fig. 8: Notes written by students in a single view with example of a new note contribution: April 26, 2013

To develop understanding of the important role authoritative sources might play in Knowledge Building, the teacher reads to the children from a variety of sources. The teacher may even present contrasting data and information from different books to highlight for students the need to deal with supportive as well as conflicting information. As the teacher reads aloud to students, she stops often allowing them to ask questions, make comments, theorize, and relate what they are hearing to their own lives and experiences. This injection of new ideas and information sparks idea improvement. Another way to use authoritative sources is to give children time to read books with a partner. A stronger reader may need to be paired with a child who is just beginning to read. As the children read they are encouraged to help each other out with hard words and to talk about what they are reading. As an additional benefit of paired reading, the children are able to discuss the reading and thus refine their understanding before they share ideas more publicly.

Conclusions

The goal of this paper is to provide a useful resource for teachers who would like to get started with the pedagogy of Knowledge Building and the technology of Knowledge Forum. Toward this end two examples of teacher-student engagement in Senior Kindergarten and Grade 1 were presented, interspersed with interviews from the Librarian/Technology coordinator of the school and Vice Principal. According to this team, *idea diversity, improvable ideas*, and *real and authentic problems* are central and a good way to introduce newcomers to Knowledge Building pedagogy. Ideas should be at the centre of a Knowledge Building classroom and it is the work of the group to develop and refine them. Teachers agreed that *rise-above* and *concurrent, embedded, and transformative assessment* are very difficult principles to implement, and should probably be addressed in a later stage. Rise-aboves are often used as a sort of a published note toward the end of a line of inquiry to convey how students' knowledge had grown. *Concurrent, Embedded, and Transformative Assessment* is challenging for new teachers to take on at the start, as it also goes beyond self- and peer-evaluation. It is really about "what do we need to do next?" and students should be intentional about that. Even though difficult to implement, these principles are fundamental for creating feedback, assessing outcomes, and identifying what the community needs to do next in order to keep improving ideas.

In conclusion, Knowledge Building supports sustained creative work with ideas, and through meaningful engagement supports development of a broad range of literacy and 21st century competencies. Children gain experience holding the "steering wheel," using technology to support advancement of community knowledge.

Acknowledgments

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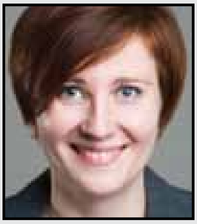

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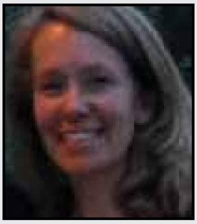

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Participatory Video as a Catalyst for Informal Learning and Expression: A Review of a PV Training in Uganda, 2012

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ABSTRACT

Previously, video production was a skill set practiced by trained individuals, but new technologies have opened the doors so that anyone can be a filmmaker. This paper explores the history and conceptual foundations of participatory video (PV), and offers a reflective perspective on its applicability as a teaching and learning tool. A review of a PV training in Uganda is featured to highlight the methodology used in practice and the challenges faced. The authors propose that an approach to PV which combines the best existing practices with a closer alignment to its foundational principles is worthy of further research.

In his study *Confronting the Challenges of Participatory Culture: Media Education for the 21st Century*, Jenkins (2009) writes, "We are moving away from a world in which some produce and many consume media toward one in which everyone has a more active stake in the culture that is produced" (p. 12). Participatory video (PV), a technique used with increasing frequency in education and development, can act as a unique catalyst for learning and expression. The underlying principles of PV are also congruent with the vision of many theorists who sought to develop alternatives to the dominant educational paradigm; in particular, Freire (1970), who differentiated between the "banking" model of teaching and problem-posing education.

The prevalence and low cost of media production devices today poses an interesting opportunity to educators, both formal and non-formal. Previously, video production was a skill set practiced by a few highly trained individuals, but new technologies have opened the doors so that anyone can be a filmmaker. This makes video production ideal for integration into what is known as participatory culture. Jenkins (2009) explains, "A participatory culture is a culture with relatively low barriers to artistic expression and civic engagement, strong support for creating and sharing creations, and some type of informal mentorship whereby experienced participants pass along knowledge to novices" (p. xi). Applying the principles of participation to the process of video production is the defining characteristic of participatory video. Walker (2013) makes the point that video production "requires critical thinking, teamwork, and engagement. This process is what makes video production such a profound and transformative experience for participants. At once, they become storytellers, activists, and creators of knowledge and information" (p. 99).

PV is a technique in which trained educators teach storyboarding, framing, camera operation, and other basic video-making skills to an enthusiastic group of participants. The principles and methods of PV have been most widely applied in activism, education, and development (Walker, 2013). Although no rigid methodology for PV exists, and often projects are context specific, there is a growing body of literature on the successes and common challenges faced around the world by PV facilitators and the communities they work with. High, Singh, Petheram, and Nemes (2012) state, "The freedom to innovate and develop one's own ideas about participatory video is an important part of the tradition" (p. 45). The importance of context-specific flexibility is consistent with the approach of Freire (1982), who asserts that an educational program "cannot be something static." He further argues that "one cannot regard a program abstractly and metaphysically—it was created as a result of reality and has to be changed, dependent on the reality" (p. 36). Indeed, this raises questions about the scalability and capacity for replication that are of significant importance to educational curricula and development practices alike.

A Brief History and Review of PV

Often the origins of PV are traced back to the Fogo Island Communication Experiment. Between 1967 and 1968, filmmakers from the National Film Board of Canada's Challenge for Change program made over 26 short films on Fogo Island, off the coast of Newfoundland. A government relocation program threatened the isolated population of the 300 year-old settlements, and the films were used for horizontal communication between residents with the goal of facilitating organization towards collective action (Corneil, 2012). According to Corneil,

> the Fogo Method, as it came to be known, began as an experiment in ethical documentary, and many of the principles developed within this early experimental stage remain core principles in methodologies of participatory video as it is still practiced today. (p. 25)

At present, participating in a PV project is part of the process of acquiring new media literacies. Jenkins (2009) characterizes the new media literacies as "social skills, as ways of interacting within a larger community, and not simply as individualized skills to be used for personal experience" (p. 32). These interactions are what make participatory video more than just a transfer of technical skills, whether in the context of education, development, or social action. As reflected in the video accompanying this paper, the requisite basic technical skills for planning and shooting a video can be acquired quite easily. Although the video highlights a case from the development context involving adults, the same can be expected from youth in a classroom or a non-formal setting.

PV and Development

Beyond the technical aspects of participatory video lie the transformative elements of the process. In the context of development, this change can be expressed as greater empowerment through the creation and ownership of knowledge and information, an increase in critical thought, and an increase in civic engagement. In their handbook entitled *Insights Into Participatory Video*, Nick and Chris Lunch (2006) frame PV as "a tool for positive social change … a means of empowerment for the marginalized and … a process that encourages individuals and communities to take control of their destinies" (p. 4). Perceiving such qualitative changes often poses a challenge to organizations accustomed to dealing with quantitative assessments, as is frequently the case in the development world so often constrained by project timelines and donor-established outcomes. Therefore, development organizations often emphasize the immediately tangible benefits of community-generated media, specifically the final products themselves, and their utility in vertical communication. Regarding this point, Lunch and Lunch (2006) note that, "the films can be used to communicate the situation and ideas of local people to development workers and formal researchers, and to decision-makers and policymakers" (p. 13). Furthermore, community-created media content has a certain resonance with donor agencies that are given an opportunity to see the reality of their project sites from the point of view of their program "beneficiaries." This makes PV particularly useful as a fundraising tool. A collective community voice is especially vital to development agencies applying appreciative inquiry principles to their project planning, and PV can be remarkably effective in this regard.

In addition to vertical communication, the media created by participatory video can be readily shared horizontally from peer to peer or community to community. Lunch and Lunch (2006) note that PV films can be used in a

> community-to-community exchange to spread ideas, and to encourage and inspire. [The films] may even be relevant to communities in other countries with similar conditions and problems. PV can thus enhance the capacity of people to share their local knowledge and innovations across distances and to stimulate locally-led development in other countries. (p. 13)

These various uses highlight the multifaceted nature of archival media. A village drama, on the other hand, which can employ many of the same participatory principles in its production, is expressed only at the site where it is performed. The output of PV as a digital, easily shareable medium means the legacy of a single project has communication potential far beyond its place of origin.

As expected, participatory video can fit neatly within the dominant framework of communication for development, in which a people-centered approach is applied to a development initiative with the intention of encouraging the people to implement a certain plan. However, in reference to that approach, Quarry and Ramirez (2009) question whose plan is actually being promoted. They advocate an alternative framework, one in which communication media

> can be used to help people facilitate their own discussion of their own predicament leading to their own plan of action. This implies a much more people-centred and bottom-up approach that will not necessarily fit into an overall plan prepared by others. This, in fact, suggests *another* approach to development. (p. 21)

PV and Education

In the context of teaching and learning, many of the same external benefits of PV can be applied, such as the usefulness of created media in vertical (students to teachers or administrators, or members of the community at large) and horizontal (peer to peer, class to class, or school to school) communication. The internal, and perhaps more abstract concepts put forth by Freire, such as conscientization, have more relevance among educators than they do for development practitioners. Freire (1970) emphasizes the role of communication in education when he states,

> Only through communication can human life hold meaning. The teacher's thinking is authenticated only by the authenticity of the students' thinking. The teacher cannot think for her students, nor can she impose her thought on them. Authentic thinking, thinking that is concerned about *reality*, does not take place in ivory tower isolation, but only in communication. (p. 77)

Indeed, the self-reflection and critical inquiry that can accompany a participatory video production are in accord with Freire's aforementioned problem-posing educational paradigm, a process which allows men and women to

> develop their power to perceive critically *the way they exist* in the world *with which* and *in which* they find themselves; they come to see the world not as a static reality, but as a reality in process, in transformation. (p. 83)

Some educators may possess a measure of skepticism regarding the utility of participatory video in a formal classroom setting. Again, if the focus is on the media outputs of a project, then its benefits only go as far as the participants' (and educators') vision for the exhibition and dissemination of the video, much like the model dominant in development. If, on the other hand, educators were to apply the process-based principles of Freire, they would then see the media outputs as secondary to the participatory video exercise. Media production is, in itself, problem-posing education. Jenkins (2009) speaks directly to this point in the greater context of formal education and the new media technologies:

> Historically, we have valued creative writing or art classes not only because they help to identify and train future writers and artists, but also because the creative process is valuable on its own; every child deserves the chance to express him- or herself through words, sounds, and images, even if most will never write, perform, or draw professionally. Having these experiences, we believe, changes the way youths think about themselves and alters the way they look at work created by others. (p. 6)

Some Challenges

In the preceding sections, participatory video has been described as a set of principles rather than a methodological praxis. This presents a number of challenges to both development practitioners and educators alike. What happens when these principles are not adhered to? Without robust methodological processes, many teachers and development actors, who often have diverse responsibilities and expertise, will be unable to make the ad hoc decisions and adjustments required to ensure that true participation is taking place. Tamara Plush (2012) argues, "Development projects often adhere to tested theories and methodologies, but participatory video is often brought into these initiatives without the necessary rigor in design or implementation" (p. 67).

A comprehensive review of the literature conducted by Low, Rose, Salvio, and Palacios (2012) reveals many similar challenges. They assert, however, that the overall scholarship on the subject has not kept up with the increased utilization of participatory video fieldwork, either with regard to development work or research. They conclude that

> the majority of … publications describe the benefits of the method and therefore tend to be celebratory and uncritical, failing to address the difficulties that arise in theorizing the need for participatory video projects and research, accepting funding for them, and conducting and disseminating them. (p. 50)

This brief review has discussed some of the major theoretical challenges surrounding PV, particularly at the intersection of theory and practice. Because of the context-specific nature of participatory video, each project will face its own practical challenges based on the local conditions and realities under which it is initiated. A summary of these will be outlined in the following section, which discusses a PV training of trainers (ToT) and their initial attempt at facilitating PV with a community.

Click here for video

Training of Trainers: Katakwi, Uganda

Communities throughout Africa have a rich oral tradition of storytelling and public theatre to pass important messages around villages and across generations. With this strong tradition, oral and visual forms of communication are the most effective way for community members to engage and teach each other. Traditionally, however, this form of communication in the most rural areas has been predominantly restricted to "live" versions due to limited access to modern forms of mass media such as television, film, radio, and so forth. (Mushengyezi, 2003). In more recent years, though, typical barriers to their uptake such as cost and availability of these technologies, have been drastically reduced.

In 2010 the Red Cross Red Crescent Climate Centre partnered with the Ethiopian Red Cross Society to support members of a women's group in Wage Wargaje through the PV process. Members of this group chose to develop a film documenting the many benefits of using a fuel-efficient cook stove in the household, with the aim of increasing the adoption of the stoves being promoted by the women's group (Benn, 2011). Despite initial fears of operating the cameras and the unfamiliar nature of developing a film, members of the women's group quickly learned how to use the new technology and embraced its advantages in sharing information. After the film's completion, it was initially shown to 80 community members from five *Kebeles*[1] near Wage Wargaje. After these screenings, the members of the Wage Wargaje women's group were interviewed and together they suggested three key advantages of film documentation over their more traditional forms of oral communication. First, video is more memorable than traditional forms of oral communication. Second, video can document and show evidence of the key messages they wanted to pass along, such as decreased smoke exposure. They concluded that this visual documentation provides more credibility than oral communication alone. Finally, they agreed that video could be a medium to help spread their message to a much larger audience as well as to audiences in distant places (Castro, 2011).

Catalyzed by the high level of satisfaction expressed by the women's group in Wage Wargaje, the Red Cross Red Crescent Climate Centre organized a subsequent PV training in Katakwi, Uganda in 2012. This training of trainers (ToT) event was targeted toward highly experienced, community level officers from eight partner organizations. Partners were selected based on their involvement in the Partners for Resilience (PfR) alliance,[2] a five-year collaboration in nine countries among five lead organizations: the Netherlands Red Cross, Cordaid, CARE, Wetlands International, and the Red Cross Red Crescent Climate Centre. Representatives from these organizations and their local partners came from four countries in Africa: Ethiopia, Kenya, Uganda, and Mali.

During this five-day training, representatives were taught the basics of storyboarding, video camera operation, framing, and editing. Trainees were also taught basic elements of the visual language of filmmaking such as how filming with low and high angle shots can show power and weakness, respectively, of the subject, as well as the meaning of various field sizes and interviewing angles. More complicated techniques such as depth of field, manual focus, and lighting were not covered. While these basic skills are important for all PV facilitators to possess, more critically, representatives also learned how to teach these skills to others. The PV process centers on the pivotal recognition that communities can document and create their own narratives with minimal outside support.

Once trainees were sufficiently comfortable with the hard and soft skills of PV, they traveled to Ongongoja, a remote village in Katakwi District, to meet with a community risk reduction team (CRRT) supported by the Uganda Red Cross Society. Trainees now took on the role of training facilitators and handed the cameras over to the community members, who began to experiment with them. Members of the Ogongoja risk reduction team also experienced initial trepidation in using the filming equipment, similar to the women's group in Wage Wargaje. This was quickly overcome, however, and members experimented with varied lighting and sound situations, as well as inventive local special effects developed to improve the narratives of their stories. They also received guidance from the PV ToT trainees in regard to the basics of framing and storyboarding, though the more detailed aspects of camera angles and field sizes were not covered due to time constraints.

Experienced field officers are quite comfortable interacting with community members and leaders in diverse settings; nevertheless, being asked to step out of their typical leadership role and hand over complete control to the community can be challenging for some. In the case of this PV ToT, however, handing over control to the community did not present significant challenges, especially for those with limited prior film experience. It is the belief of the authors that the shared learning experience of the ToT trainees and the community members helped to facilitate this process. Many of the PV ToT trainees viewed the PV process as an innovative and refreshing approach to interacting with community members.

PV in the Community

The technical aspects of the filming process are only half of the PV story, and not the most critical piece. It is the softer side of the PV process that is most important; it allows community members to interact collectively in new ways with one another and with their civil society partners. When carried out correctly, PV can be the moment when actions speak instead of words, and community members learn that they are truly in control of the message that will be projected to others about themselves, whether within the community or externally.

In terms of working together, collaboration is an important aspect of community life in a rural setting; this PV training also provided the opportunity for community members to experience collaboration with one another in new ways. For example, one element of the PV exercise is that all members must gain experience both as director and as camera operator. In their World Bank report entitled *Gender and Economic Growth in Uganda*, Ellis, Manuel, and Blackden (2006), emphasize the fact that the local culture has strong, customary male-dominated gender roles. The type of collaboration intrinsic to PV provides a unique opportunity for traditional women to take a directorial role. In a few cases it was clearly seen that women who were otherwise quiet and reserved became noticeably engaged and confident when in the role of director or camera operator, though some initially needed extra encouragement from facilitators to feel comfortable.

After only a day and a half of learning how to storyboard, use camera equipment, and experiment with filming techniques, community members, who had never held a video camera before, became filmmakers. With the help of the PV trainees the films were given a final round of edits and were screened at a local school for the community at large. An excerpt of one of the screened films is shown in *PV Training In Uganda* produced by Walker (2012). Although a thorough PV process would involve a longer community engagement period, for example Lunch and Lunch (2006) suggest 12 days, the ToT nature of the training limited the available community interaction time to a day and a half. Despite the limited time, the rapid adoption of these skills speaks to the accessibility of basic filmmaking techniques and technology. It is the authors' belief that the rich culture of storytelling and public theatre found in Uganda, as a means of communication between communities and generations, greatly contributed to the ease with which filmmaking skills were adopted.

Facilitators Return Home

Following that screening, the PV trainees officially became PV facilitators and returned to their home countries to facilitate the PV process in additional communities in West and East Africa. Malik Adan of Kenya Red Cross notes in the film, *PV Training in Uganda*:

> It came out very clear that the community now will be empowered … in our place with the skills of video taking. They can take whatever they want. That can be used for policy, horizontal and vertical communication, from peer to peer and also for policy makers to help the community. (Walker, 2012)

Upon returning to Kenya, Malik trained community risk reduction groups in PV. They chose to develop films to document trainings and key aspects of their chosen risk reduction activities. As these activities are documented, films can be developed and used to teach local government officials and other community-based organizations about those activities. In the long run, videos of trainings can also be used to refresh key skills of community risk reduction team members, or to give a basic introductory training to new members (S. Temesgen, personal communication, February 11, 2013).

In Uganda, CARE trained an additional 13 staff of local partners as well as 25 community members. During this training, participants created a film called *Environmental Conservation: Our Responsibility*, which highlights the dangers of tree cutting, charcoal burning, and bush burning. This film was screened for community members at large, raising awareness about local risks, and increasing interest in the development of further PV films (M. Anguparu, personal communication, February 14, 2013).

In Mali, Wetlands International trained community members from Noga Village in the PV process. Trainees chose to develop their first film on their reforestation work in the Niger River Delta to help decrease desertification and strong wind gusts in their community. The film features a risk reduction team meeting to organize their tree-planting plan and proceeds into shots of the actual tree-planting process (IUCN, 2012). This film was shown to 130 community members to raise awareness in the community about the reforestation project and its benefits (F. Sadio, personal communication, February 18, 2013). It can also be used to promote the work of the community when the risk reduction team meets with local authorities and civil society organizations.

Even with increasing access to technology, however, a number of challenges still remain and have been documented in the year following the participatory video training. Despite the relative affordability of a basic video camera, another partner in Uganda had equipment stolen early on in the process and was unable to replace it (N. Abdul, personal communication, January 31, 2013). A partner in Mali noted that while the cheaper equipment was more accessible, it meant sacrificing a lot in terms of video quality, which was not desirable within his organization and the communities he supports (F. Sadio, personal communication, February 18, 2013).

While traditional cost and access barriers are decreasing in relation to video cameras, other challenges at the community level were cited by facilitators such as a lack of power, the need for a computer to edit the films, and a television or large laptop to screen them (M. Anguparu, personal communication, February 14, 2013). These challenges are also consistent with some of those documented by Baumhardt, Lasage, Suarez, and Chadza (2009) during their PV work in Malawi with the Malawi Red Cross Society.

One prevailing challenge also observed by the authors is the limited ability to provide follow-up support to PV ToT participants and communities at large. Because of resource constraints, organizations typically hire outside consultants to facilitate PV trainings rather than having in-house PV experts. This lack of in-house expertise and the competing day-to-day pressures and priorities of the larger project management cycle, into which PV activities are integrated, limits the capacity of organizations to provide additional follow-up support after the core interaction of the PV process has concluded. These internal pressures can also inhibit critical supervisory staff from adopting this methodology, which suggests the need for stronger champions within institutions, as well as longer-term relationships with PV experts.

A Different Approach

There is a need to evaluate what is meant by the PV process, and by extension, when this process comes to a conclusion. The process described by Lunch and Lunch (2006) is designed to facilitate insider-to-outsider communication, and a screening with the community is held more on principle rather than in a genuine effort to deeply reflect upon the issues documented in the film. Their approach places a clear emphasis on the value of the video production process itself in order to achieve the wider goals of horizontal and vertical communication, and merits praise for this dimension.

Others such as Digital Green, an India-based NGO, put significantly more emphasis on the post-production screening of the participatory videos and corresponding mediated discussions within farming communities, led by local community members. In their study of Digital Green's methods, Gandhi, Veeraraghavan, Toyama, and Ramprasad (2007) assert that films should be screened to exhaustion in an effort to reach wider audiences and increase farmer participation. They argue that this approach provides an important opportunity for community members not involved in the film production process to give feedback and verification of the videos, while also creating space for farmers to share their experiences testing and adopting new agricultural techniques introduced by government extension officers. Digital Green's mediated screening sessions offer a dynamic not present in the Lunch and Lunch approach; however, these screenings present unidirectional agricultural extension innovations, thereby facilitating outsider-to-insider communication.

An approach combining the salient features of the two above PV paradigms, production focused and screening focused, into a lengthier and more reflective process of insider-to-insider communication, is worthy of development and research. Indeed, such an integrated paradigm would be more congruent with the theoretical framework of Paulo Freire's education as the practice of freedom, as well as Quarry and Ramirez's "*another* development."

Conclusions

Participatory video creates the space for alternative and more collaborative forms of teaching and learning than those found in typically traditional educational or development interventions. In the development setting, in particular, PV allows communities to drive the narratives of their own stories in order to target messages to the key stakeholders they wish to reach.

Although, in the context of the PV training of trainers featured in this paper, there is insufficient data to support the argument that conceptual themes such as conscientization occur among PV participants—indeed, it was not one of the goals of the exercise—it, nevertheless, is a significant dimension of the process. The emphasis that development agencies place on quantitative and tangible results in the short term may make it difficult for them to recognize this important outcome of PV. Educators, however, both formal and non-formal, are not bound by these constraints, and have greater freedom to incorporate PV into their curricula. To educators, the Katakwi

PV training can, at the very least, serve as an example of the simplicity and ease with which people can adopt and use new technologies. As stated, today anyone can be a filmmaker. It is the hope of the authors that the merits of the principles behind participation speak for themselves.

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Notes

1. The smallest administrative unit found in Ethiopia.

2. More information on the Partners for Resilience alliance can be found at: http://www.partnersforresilience.nl

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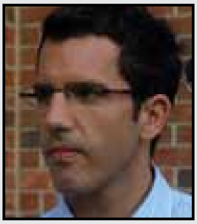

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