

TOWARDS A PEDAGOGY OF ONLINE CONSTRUCTIONIST LEARNING

Stager, Gary

The University of Melbourne Dept. of Science and Mathematics Education 21825 Barbara St. Torrance, CA 90503

USA Email: gary@stager.org

Pepperdine University Graduate School of Education and Psychology 21825 Barbara St. Torrance, CA 90503 USA

Email: gary@stager.org

ABSTRACT

For nearly a decade, my colleagues and I at Pepperdine University's Graduate School of Education and Psychology have played a leading role in designing online learning environments for post-graduate courses intended for mid-career professionals. These successful programs, notably the Educational Technology EdD and Online Master of Arts in Educational Technology, incorporate progressive teaching practices and rely on Socratic dialogue, peer mentoring, collaboration and access to primary resources.

The primary difference between the Pepperdine approach and others is our embrace of constructionism, the notion that knowledge is constructed through the active engagement of a learner and shared within an active community of practice. All theory presented in courses is expected to be useful in the life or workplace of each student since *knowledge in use* is an important tenet of constructionism. Our courses enforce an expectation of collaboration, peer-review and making thinking public. Student diversity is supported by the sharing of resources and requests for clarification by fellow students. The educational experience is framed by an ongoing conversation and exhibitions of student work rather than based on the delivery of content.

This paper will also explore specific pedagogical and curricular strategies employed in a recent *Technology and Learning* Masters-level course.

1. INTRODUCTION

Pepperdine University's Graduate School of Education and Psychology was a pioneer in offering online degree programs for mid-career education professionals. The Online Master of Arts in Educational Technology (OMAET) degree program I helped develop began in 1987 and the partially online Ed.D. program is a few years older. Seven classes of students, representing approximately 500 students from across the globe, will have graduated from the OMAET program by the time of WCCE 2005. This is quite an accomplishment given that many similar universities continue to grapple with what the Internet might mean for their future.

1.1 The Structure of OMAET

From its inception, OMAET built upon Pepperdine's progressive education tradition of applying theory to personal practice. Online education was neither viewed as a marketing opportunity or an instructional compromise requiring a diminution in the quality of educational experiences afforded to students. Offering the program online has paid numerous positive dividends for faculty and students alike. The OMAET program incorporates progressive teaching practices and relies on Socratic dialogue, peer mentoring, collaboration, access to primary resources and continuous communication between teachers and students.

OMAET compensates for the lack of face-to-face contact between students and faculty in ways that actually lead to greater intimacy and access. Students are required to meet at the Pepperdine campus for four-five days at the beginning of the degree program at an immersive experience known as VirtCamp. At VirtCamp, students are introduced to the philosophical basis for the course of study, taught to use the communications tools required by the program and engage in immersive computer-based problem solving activities that lay the foundation for discussions of community of practice, Vygotsky, constructivism, constructionism and related learning theories. Most of all, the students get to know each other before they commence their formal OMAET studies. Students then meet midway through that year (and their studies) at a professional conference. This offers professional learning opportunities in addition to office hours with faculty, class sessions for the second semester and additional opportunities to bond as friends, colleagues and members

of their learning community. The importance of the informal student-led social events organized during VirtCamp and the mid-point meeting is inestimable in sustaining the community of practice.

At the end of the program all students return to Pepperdine to present exhibitions of their work from their course of study along with a personal action research project. The ARP is developed across all three semesters of OMAET and presented to an audience comprised of classmates, other cadres, the university community and alumni prior to graduation.

Perhaps the most important way in which OMAET overcomes the distance between students is by employing a cohort model of course organization. Each student is in a "cadre" of fewer than 25 students for his or her entire course of study and every student takes exactly the same courses. Since the theory explored in each course is to be applied in each student's personal context, it is possible for preschool teachers, corporate trainers, school technology coordinators, educational software developers and managers at Boeing to learn together in the same class. In fact, the diversity of student perspectives, needs and experience tend to enrich the learning experience for everyone. Such diversity is often addressed by a selection of texts each student can read in addition to the more general books read by all. This requires professors to be well-read, resourceful and sensitive to the specific needs of individual students while striving to achieve common educational objectives. An actual example of student-selected books will be presented later in this paper.

The diverse perspectives and expertise found in a cadre lead to stimulating discussions and various forms of assistance with personal problem solving. Students get to know one another very intimately over the course of a year and often share resources that they think would be helpful or interesting to a classmate. The world and the World Wide Web are so vast that it having a dozen or two critical friends scouting resources for you makes the cadre model invaluable.

An emphasis is placed on making personal knowledge public. This is supported by a strong emphasis on reflective practice and the public posting of personal work on student web pages. In most courses, students are encouraged to share their work at various stages of completion and to engage in peer editing. Students are routinely invited by faculty to share their technical expertise or recount unique experiences from their personal experiences. In the community of practice everyone is a teacher and a learner.

Each cadre has one faculty Cadre Madre or Cadre Padre responsible for advising each student, supervising individual student's action research progress and serving as an ombudsman to the university. Other professors communicate with the Cadre Madre/Padre to help ensure student success.

The cadre structure allows students to really get to know one another during their face-to-face events and through constant and continuous interaction online. In a traditional university class, students might spend a few hours together each week with little or no contact in between class sessions. The nature of online learning, particularly in OMAET, is such that students have constant access to each other and their teachers for support, inspiration, discussion and simple camaraderie. The fast-paced nature of the world, particularly the field of technology, creates opportunities for serendipitous learning experiences based on current events, student questions or discoveries. The teachable moments seem to occur 24/7. As a result, students do not feel isolated. They report that they are closer to their cadre-mates than they often feel to their colleagues at work, or on occasion members of their own family.

The OMAET program is divided into three semesters progressing from the personal to the public, or the micro to the macro. The two or three courses each semester are organized to focus on learning, teaching and leadership. The action research project and the underlying educational philosophy of OMAET are constant across the entire program.

Synchronous and asynchronous technologies are used to facilitate communication and collaboration in OMAET. Tapped-In (www.tappedin.org) is a multi-user environment used by Pepperdine's Graduate School of Education for the purposes of synchronous communication. Pepperdine has a virtual building on the Tapped-In campus and each student has his or her own virtual office. Some students invest considerable effort into outfitting their office with all sorts of virtual decorations and objects. This helps them make the virtual experience more personal. Students often meet in Tapped-In to host study sessions or collaboration on particular projects. They even meet just to chat.

Simple Netscape newsgroups were used for asynchronous communication for the first six years of OMAET. The university recently compelled us to use Blackboard for that purpose. Students often establish their own cadre listservs or use instant messaging technology to facilitate peer-to-peer communication during the program. In fact, students regularly instant message each other during synchronous class sessions. This is neither disruptive nor counterproductive behaviour since the personal discussions are invisible to other users and tend to support the class discussion through

clarification and the sharing of helpful just-in-time resources. Personal autonomy and initiative are highly valued traits in OMAET students.

A combination of asynchronous and synchronous communication supports a variety of different learning and teaching styles. Synchronous communication lends itself to simultaneous conversation, student advisement, collaboration on short tasks and role-playing scenarios. Asynchronous communication is ideal for sharing resources, seeking assistance, posting articles to inspire conversation and for ongoing discussion.

OMAET continues to rely on text-based communication although students and faculty occasionally experiment with audio/video streaming, video conferencing and voice-over-IP. Text is a fine medium for communication in a graduate school setting. It requires little bandwidth and no special hardware. Most importantly, text, particularly when used in an asynchronous context, is deliberate. You have the chance to reconsider, revise and edit your thoughts before hitting the send button.

OMAET's relatively low-tech high-touch approach to online learning requires little start-up or ongoing technology costs and makes it easy to transition more traditional face-to-face courses totally or partially online.

VirtCamp, the cadre model the mixture of communication technologies combine to overcome the distance separating students and faculty.

The affordances of learning online the OMAET way tend to outweigh any constraints. Faculty can teach from wherever they happen to be, largely at their convenience and the same applies to student learning. This increases "contact time," the quality and frequency of interactions between everyone in the learning community. Teaching and learning from the comfort of your home or office, at your convenience, leads to a greater investment in the educational process. Students and faculty freed from driving to a campus at inconvenient times are likely to use that time for research, skill development and publication.

2. EDUCATIONAL PHILOSOPHY UNDERLYING OMAET

Most attempts at online learning is based on delivering repurposed content to students via the Internet. Communication, collaboration, community and construction are afterthoughts grafted onto modern correspondence courses. Despite the low-level interactivity that accompanies clicking the mouse and checking email, there is little interaction between the hearts and minds of learners. We at Pepperdine believe that the regular exchange of ideas between colleagues and is more critical than the highly touted information at your fingertips or the potential to manage large numbers of students electronically.

OMAET is built upon the social learning theories of Vygotsky, Lave, Wenger, Piaget and Papert. The cadre acts as a community of practice in which expertise is distributed, knowledge is shared and where work is collaborative. Learning is less about being told something - instruction, than making connections between ideas, resources and experiences - construction.

Seymour Papert's constructionism/instructionism dichotomy offers a lens through which to view the future of education - real and virtual. Papert coined the term, instructionism, to describe the educational philosophy and related practices based on the notion that you improve education by teaching better. Portals, web quests, instructional management systems, computer-assisted instruction and most online courses are artefacts of instructionism. Instructionists over value content and make the learner the target of instruction. Distance learning is instructionist in nature. Distributed learning is constructionist. (Cannings and Stager, 2001)

Constructivism is the idea that knowledge is something you build in your head. Constructionism reminds us that the best way to do that is to build something tangible - outside of your head - that is personally meaningful. (Papert, 1990) In subsequent writing, Papert says that knowledge is best constructed in a social context where the participants make something shareable. OMAET is also about sharing. Ideas, strategies, resources, tips, tricks, time, attention and personal work are shared in order to enrich the entire community. The knowledge acquired in the community of practice that is the cadre is often shared with the wider community in which the student works and lives. Notions of overlapping communities of practice are central to the learning theories laying the foundation for OMAET and are reinforced through the practice of OMAET.

Knowledge that is more or less explicit can be embedded in procedures or represented in documents and databases and transferred with reasonable accuracy. Tacit knowledge transfer generally requires extensive personal contact. The

"transfer relationship" may be a partnership, mentoring, or an apprenticeship, but some kind of working relationship is usually essential. (Davenport, pg. 95)

3. OMAET COURSES

OMAET courses include: Educating Today's Learner; Technology and Learning; Curriculum and Technology; Mentoring and Team Leadership; Managing Technology in an Educational Setting; and The Practicing Professional. While these courses all use technology, none of them is built upon a particular technology. Such an approach would be both technocentric and shortsighted. In the world of academia, a course on designing web pages created in 1996 might be in the course catalog for decades despite subsequent technology making the process trivial or the lack of intellectual substance inherent in the topic. It has been our informal experience that entering students possess nearly the technological fluency of our recent graduates. This fluency is viewed as a gift that allows us to focus on more powerful ideas and make technological concerns more transparent.

Over the years, the most significant change to the OMAET program has been dedicating more course units to the Collaborative Action Research courses that each student takes each semester. It was determined that students required more contact with faculty in the process of creating their major research project. The ARP (action research project) assumes the importance of a typical Masters thesis in OMAET.

Course content, activities and assigned texts change constantly in OMAET as a result in shifts in practice, emerging technology and particular faculty expertise. In the age of the Internet, articles from the Web and new texts emerge rapidly and need to be considered by informed scholars. Despite occasional changes in course content, title and syllabi, the structure of OMAET continues to serve students extremely well eight years after its creation. That may be attributable to the flexibility of the program structure, the autonomy granted faculty and the ongoing role students play in the evolution of OMAET.

4. THE REINVENTION OF A COURSE

During the autumn of 2004 I decided to reinvent the *Technology and Learning* course after several years of successful operation without the need for dramatic changes. The major assignment required by the "old" course asked each student to learn something, anything new. They were then asked to reflect on the experience of learning, join an online community concerned with the subject or skill they were learning, document the learning process online, teach someone else something they learned and whenever possible, use technology to help construct knowledge about their chosen topic.

The richest learning projects tended to define expectations. Students learned to surf, cook like their Italian Grandmother and develop expertise in the mortuary business. Many students looked back fondly on this learning project and it provided a nice foundation for discussing various learning and teaching theories. Some students had a very difficult time differentiating between learning and teaching and their less successful projects would focus largely on teaching someone else something, rather than learning themselves.

Despite the largely successful track record of this project and the course built around it, several concerns led me to reinvent the course. It should be noted that while I taught two out of three sections of this course, no colleague now or in the future will be required to make similar changes to the way in which they teach the course. I certainly hope that I will inspire the practice of colleagues as much as they inspire the way I teach.

4.1 The Structural Imperative for Change

The increasing number of units granted to the action research course caused another course, *Shaping the Learning Environment*, to be eliminated. That course explored the various features of real and virtual learning environments in terms of productive contexts for learning. The course also introduced strategies and tactics for activism in order to help students realize their objectives for transforming their personal work contexts.

Exploration of critical elements in learning environments and productive contexts for learning could be incorporated into a new Technology and Learning course. Activism would have to be addressed later in the course sequence.

4.2 Learning with Technology

Although the course was titled, Learning and Technology, I agree with Seymour Papert that computers and computing offer profound opportunities to learn new things, old things in new ways and construct knowledge in ways that would

be inaccessible without access to technology. Constructionism particularly applies to learning with digital technology. *If you can use technology to make things you can make a lot more interesting things. And you can learn a lot more by making them.* (Papert, 1999)

I was fearful that the previous focus on learning anything left the specific construction of knowledge with computers to much to chance. It might have been possible for a student to graduate from the OMAET program without having used computers for more than communication or informational retrieval. Such informational aspects of computing are certainly valuable. In fact they make OMAET possible. However, the focus on information technology (IT) is inadequate for professionals professing expertise in educational technology despite the fact that current educational practice is consumed with IT as manifest in the obsession with data, student research, content delivery and student management. The single-minded focus on IT reduces the power of the computer as an intellectual laboratory and vehicle for self-expression resulting in a significantly reduced impact on the nature of schooling. Students who will eventually be leaders in all aspects of the educational enterprise require a broader base of experience from which to operate, advise and lead.

Constructionism is not a spectator sport. You cannot subcontract the construction to others and speak convincingly about the value of computers in education or constructionism itself. Therefore, it was necessary to reinvent the Technology and Learning course in order to offer provocative minds-on experiences that would lead students to reflect on their own experiences and consider alternative ways of thinking, learning and teaching. I decided that this course should provide concrete computer-based experiences that would give life to the theories taught in the accompanying learning theory course.

Another impetus for this course transformation was a desire to assist students in understanding the work of Seymour Papert. Students in the OMAET program typically read Papert's books, The Connected Family and/or The Children's Machine, yet one reading of Papert is hardly adequate if one wishes to gain a working understanding of his ideas. Failing to spend sufficient time and energy studying the work of the "Father of Educational Computing" in a graduate level course on educational technology would be intellectually dishonest. The work of Seymour Papert is too vast, fundamental and to some, inspirational, to be ignored by educational technology practitioners.

Many students are alienated initially by Papert's harsh critique of schooling and educational computing since their professional identity may be associated with teaching or managing technology in a school setting. I suspect that such critiques would be processed more objectively later in the program, yet the early focus on learning in OMAET requires that Papert be tackled early in the course of study. My hope was that students engaged in the types of learner computer relationships described by Papert would make them more open to his powerful ideas.

While Papert's Samba School metaphor might be explored in an unchanged OMAET program, it would be difficult for students to truly understand "Mathland" or the transformational potential of computing as a "microworld" for learning without common experiences learning with computers in a Papertian fashion.

4.3 The "New" Course

It was implied earlier that OMAET does not front-load content and deliver it to students. In fact, books play an important role in our online world. Each course instructor continues to assign books. Students are informed in advance of the new semester so they may order the books with sufficient time for them to arrive. Cadres often organize bookstores registered with Amazon.com as an affiliate organization. Books purchased via that site generate commissions students often use for celebrations at the end of their studies.

In the course being discussed, students were asked to read three required texts. These are real books, written by recognized experts offering supporting or conflicting perspectives on important issues. Very few, if any, traditional anthology-based textbooks are used by OMAET. The first book, Frank Smith's Book of Learning and Forgetting, has been used by OMAET for many years. Smith, a linguist, offers a beautiful and provocative treatise on learning written in terms that captures the imagination of our new students. Seymour Papert's book, The Children's Machine, offers Papert's learning theories and discusses the role computers may play in the future of learning and the reinvention of schooling. Other papers, speeches and articles by Papert are also read.

For the third required book, students are asked to select one book from a selection of four. Two of the books address preschool through secondary education while the other two books address learning in a community of practice outside of the school context. The latter two books are ideal for the non-teachers in our program, but students are free to choose a book related to the level they teach or just one that interests them the most. It is not uncommon for a student from industry to read a book related to primary education if they have a child that age.

The Hundred Languages of Children introduces students to the innovative learner-centered educational approach practiced in the preschools of Reggio Emilia, Italy. I wish every student could read this book because the beautiful optimistic style of education, just recently appreciated from Reggio Emilia, offers many ideas for learners of all ages.

Rethinking High School offers accounts of successful secondary school reformers. While this is an extremely fine book, I may replace it in future years with Dennis Littky's new book, The Big Picture. Littky is doing the impossible – creating schools based on the needs and interests of every child and he has successfully done so in urban settings at the high school level. Not only that, his organization, The Big Picture Company, has found a way to scale up these innovations so that “Big Picture” schools now number in the dozens across the United States. The book is a great read that balances theory, practice and contemporary political realities to invent successful new public schools for diverse populations of children.

The Long Haul by Myles Horton and Herb Kohl tells the story of the Highlander Folk School, an overlooked, but important institution in the education of many of America's civil rights and labor leaders. “We Shall Overcome” was written at Highlander. Students often rate The Long Haul as the most inspirational book they read during their studies. Thinking in Jazz was written by an ethnomusicologist and includes numerous interviews by the world's finest jazz musicians. The book explores the collaborative learning on the bandstand, the transfer of knowledge between musicians and the improvisational nature of learning.

The three books read by students during the course introduce and support the learning theories stressed by OMAET, but they do so in the context of innovative practice, and in the case of Papert with the assistance of technology.

5. TOWARDS A PEDAGOGY OF ASYNCHRONOUS COMMUNICATION

The class began when I posted three articles for the students to read and respond to via the class forum (asynchronous discussion board). These provocative, perhaps even odd, articles were intended as ice-breakers. They told the story of people deeply engaged in a relationship with technology. All three stories detailed the ways in which the lives or thinking of the people were amplified or transformed by the use of computers. The ice-breakers were intended to stimulate active discussion in the forum and to signal that this class would be unlike any other the students had ever experienced.

The articles used as ice-breakers may be found on the web at the following locations:

- <http://www.stager.org/omaet2003/maze.pdf>
- http://www.wired.com/wired/archive/10.06/wolfram_pr.html
- http://www.wired.com/wired/archive/8.03/kingdoms_pr.html

The discussion at times strayed from issues regarding learning and technology to arguments what some students viewed as antisocial or obsessive behaviour. Other students of course offered conflicting points of view. This often-heated exchange of ideas was intentional on my part. I wanted students to get emotionally and intellectually involved in the life of the community. For most students, participation in a text-based discussion over many days with a large number of people viewing the same evidence from different perspectives was a new experience. Coping with the rapid, frequent and voluminous exchange of ideas posed another challenge for new OMAET students. Frank Smith suggests in the assigned text that professional conferences offer an excellent metaphor for a productive learning environment.

A colleague once told students that asynchronous discussions were not like a cocktail party. I replied, “Apparently you have never been to a cocktail party with a room full of smart people.” I believe that the metaphor for asynchronous communication, especially in a learning context, should be quite similar to a good cocktail party. The people and conversation are interesting. A diverse group of people participate in the discussion and you may find yourself swept-up in a conversation you could have never predicted.

Furthermore, a boring partygoer could be avoided by joining a different conversation, going outside or by searching for another shrimp puff. My class discussions had to maintain both the intensity and flexibility of a great party. In fact, I am responsible for hosting a party that lasts thirteen weeks and is intellectually nourishing for every student.

As a result, it is critical that students learn to cope quickly with an active asynchronous learning space. Knowing which message is worthy of thought and which should be skimmed may be an important 21st Century skill. My classes are quite notorious for an enormous number of postings per semester. It is not uncommon for twenty students and I to exchange 4,000 forum postings in one semester. Learning how to remain engaged without having to respond to every utterance is a skill my students need to develop in order to get the most out of the course.

I propose a hypothesis that states, “Successful asynchronous learning environments require a great deal of volume in order to sustain interest and to support a plurality of learning styles.” I hope others will test this hypothesis and report their results in the literature.

6. LEARNING ADVENTURES

OMAET faculty work hard to model progressive educational practices that stress experience, personal meaning, intrinsic value and application. I attempt to remove any aspects of behaviourism or coercion from my teaching. Therefore, my primary goal for the course was for students to be active participants in the learning community. They do so by sharing ideas, asking questions, participating in discussions – regardless of whether it was initiated by a professor or another student, by taking risks and by being reflective in their practice.

I encourage my students to strive for precision in their use of language and I attempt to do the same. Therefore, I did not use the term, *assignment*, in this course. I referred to what students were to *do as learning adventures*. I preferred the spirit of a learning adventure to the notion of an assignment upon which students would be judged. The learning adventure encouraged students to jump in over their heads, take risks, have fun and see what they might learn along the way. These adventures would take a week or two to reach a point at which sufficient reflection was possible. Many of the adventures could last a lifetime, but a week or two seemed adequate for students to overcome technical hurdles, enjoy an experience and reflect upon it. In the spirit of constructionism, each adventure afforded students with opportunities to construct knowledge through the conscious act of making something shareable. Students were encouraged to use the class forum (asynchronous discussion boards) to post questions, strategies, resources, triumphs and disasters. All represented opportunities to contribute to the knowledge in the community of practice.

6.1 Learning Adventure 1

Due to space constraints, not every learning adventure will be detailed. It should be possible capture the spirit of this approach with the examples provided. The first formal learning adventure continued the pattern of cognitive dissonance introduced with the ice-breakers. Each student was asked to download Finale Notepad (www.finalenotepad.com), free music composition software and compose a piece of music in five days. The only additional detail provided students was arbitrary. A student asked, “How long does the composition have to be?” I replied, “12 bars.” I was purposely vague, as I wanted the students to discuss and define all aspects of the project through forum communication. I of course would respond to any question asked of as long as I had the ability to answer it. Some students had never read a note of music, others had studied music theory for years. None of us could have known about specific expertise prior to the experience.

Finale Notepad had the benefit of being free, cross-platform and based on traditional music composition – dragging notes and rests onto a staff.

Within five days *every* student composed a piece of music, some better than others. Some students used modern techniques from chance and serial music, while others struggled to assemble something simple that sounded good. Other compositions featured multiple instruments, harmony and counterpoint. Students listened to each others music during the composition process if the files were shared and all of the finished masterpieces were published online.

During the reflective discussions about their individual learning processes, students reported how useful it was to use the Internet to lookup information, ask each other questions, define terms, seek help, read manuals and share their work. All of these observations are accurate and important. However, not a single student realized that they were *composing music*. A few years ago, only freaks like Mozart or people with an elite education could be composers. Despite music being so important in society, the creation of it was off-limits to most people. The microcomputer and software like Garageband is changing that by lowering the barrier to participation and allowing a form of bricolage that can lead to formal understanding and art making. Each of my students did the work of a composer with no formal instruction. They merely relied on the intelligence and generosity of their community, plus the role the computer played in the mediation of their own thinking. Your personal music compositions could then be used in other presentations, videos, radio broadcasts and multimedia projects. That is the nature of computer-facilitated media convergence.

6.2 Learning Adventures 2a, 2b and 2c

Since there is no better way to understand Seymour Papert’s learning theories than to use Logo, my students spent about a month learning in MicroWorlds EX, the latest generation of programmable parallel-processing multimedia environments for learning built upon the Logo programming languages. (www.microworlds.com) The first Logo

learning adventure was a twist on a classic Logo activity, quilt making. Each student was given one procedure by me that would command the turtle to draw a square. The challenge was to use the turtle to draw within that square and make a patch for a quilt. This activity offers students experiences with turtle graphics, procedure writing and simple programming. MicroWorlds EX lets the user put all of the programs, objects and variables in the “backpack” of a turtle. That turtle is then exportable and may be emailed to another user or used in other projects. That shareability reinforced the theme of sharing that was so important to constructionism and social learning theory. Turtles could be posted in the forum and then assembled by students to create an infinite series of quilts. Many students exceeded expectations.

Student desires to learn more sophisticated “tricks” for enhancing their quilt patches would be catered to upon request. Students routinely inspired their peers’ thinking upon posting their quilt or patch. Students were able to experience the learning of powerful ideas from mathematics and computer science in a collaborative context that supported the learning philosophy of OMAET while offering authentic experience with Papert’s theories. I also modelled a style of teaching that did not rely on lecture, predictable outcomes or the centralized expertise of the teacher.

A subsequent learning adventure required students to program their own Pacman game. A tutorial was provided to serve as scaffolding for projects that met a minimum standard of successful completion or exceeded expectations, such as the students who figured out how to publish their interactive video games on the web. Once again students demonstrated a mastery of animation, probability, logic, variables, velocity, feedback, parallelism, collision detection and a host of other powerful ideas by using MicroWorlds EX.

The third MicroWorlds EX project used the software as a laboratory for exploring a number theory problem known as the Hailstone or Collatz Problem (it goes by my many names). This is a problem that third graders can explore and professional mathematicians continue to find fascinating. The MicroWorlds EX tools I provided serve as a lab assistant that allows each student to test a hypothesis, collect data and represent it in several ways. The tools and names the problem is known by was all I told students. They were expected to share their hypotheses online and then try to disprove the hypotheses of their peers. Some students endeavour to alter the underlying code in order to modify or enhance the available tools. Others looked the problem up online and discovered that although simple on the surface, they were engaged in the frontiers of mathematics. One of my classes extended the activity by contributing PowerPoint slides detailing their mathematical observations and hypotheses to be combined in a virtual mathematical conference. I told students that they could draw pictures or use recorded speech to explain their mathematical thinking if doing so with words was too difficult. This project reinforced the notion that there are many ways to learn and express your knowledge. It also reminded the students of the concentric communities of practice that you are engaged in every time you learn something new.

Other learning adventures included an exercise in using the Web to answer a politically-charged open-ended question with questionable data on all sides of the issue, exploring the solar system with the open-source simulator, Celestia, (www.shatters.net/celestia/ and podcasting. Podcasting (www.stager.org/podcasting) is an Internet phenomena approximately as old as the course in which the students were enrolled. It allows anyone to broadcast audio programs on the Internet in a subscribable format that automatically installs on an iPod or other portable audio device. The recent headlines about podcasting represented an opportunity for our students, all non-programmers, to get in on the ground floor of a new creative movement made possible by emerging technology. Within hours of presenting my classes with the challenge of producing a podcast, several students had succeeded at doing so. They then shared their newfound expertise with their peers.

7. CONCLUSION

Not every student responded to each learning adventure with the same enthusiasm or finished product, yet every student benefited from the learning associated with using technology to engage in serious intellectual endeavours. By the end of this class, every student had a working understanding of constructionism and used computers in ways they may never have imagined. As Papert suggests in Mindstorms, they learned to think mathematically, because they did the work of mathematicians while immersed in a mathland. They were composers engaged in the timeless tradition of music composition and they explored the solar system while wearing fuzzy slippers. All of this was made possible by applying constructionist learning theory in an online community of practice that produced enough stimuli, support and expectations of reflective practice to assist students to learn about learning while learning to do wondrous things. This work offers inspiration for other virtual learning environments as well as more traditional classrooms. The world is full of powerful ideas, exciting challenges and amazing things to learn. Distributed learning communities and computers offer a magic carpet for realizing our intellectual and creative potential.

Note: More specific information about this course, complete with additional learning adventures are available at <http://www.stager.org/learningadventures>.

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