ETEC 533: Assignment 8:

Thoughts, Findings, and Future

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Introduction

Math, science, and technology go hand and hand. When one thinks of the development of technology, they imagine scientists and mathematicians in labs and on computers. I am reminded of Eratosthenes who, it is said, used a pole and a measuring stick to study our Earth. With these rude tools and a sophisticated understanding of geometry he was able to calculate the circumference of the planet. In reality, Eratosthenes perhaps used cutting edge technology for the era, such as a gnomon and a compass. Likewise, apocryphal or not, an educator's imagination is sparked by Archimedes' 'eureka' moment, when the Greek polymath realized that the displacement of water caused by the bodies submerged in it revealed the clues of that object's density and, therefore, of its composition. His discovery, and the application of the science and mathematics with which it is inextricably intertwined, led to applications like submarines and hot air balloons. Much later, during the so-called Sputnik Crisis, public and political anxiety were galvanized enough to make great investments in education in the United States and elsewhere in the western world. And what was the focus of this investment? Science, Technology, Engineering and Math (STEM subjects). Nowadays, scientific advancement is even more intimately connected to technology. At CERN, for example, operation requires the participation of many nations that fund whole teams of physicists, computer scientists, engineers, and mathematicians. These groups all work within their specializations to

collect, produce, and interpret the data, all with the goal of revealing some of the deepest mysteries of our universe[1]. However, despite the apparent success of science and collaboration, we have voices that say science education needs to be rethought and refocused. Science is for more than just scientists. All walks of life need scientific and mathematical literacy (Mazur, 1998, Wieman, 2007). Elsewhere, advocates are saying that STEM and STEAM[2] fields of education need more emphasis at all levels in order to prepare students for the world into which they will graduate (Ge, Ifenthaler, & Spector (eds.), 2015). At the same time there are societal and institutional hindrances that keep individual teachers from introducing more technology into their classes (Mishra & Koehler, 2007).

But what do all these musings have to do with my practice of education? The development of technology and its acceptance and use by society are not always straightforward processes. Nevertheless, for educators who strive to improve their practice and continue to be relevant, it seems necessary to acknowledge and embrace the development of technology. This course, ETEC 533: Technology in the Math and Science Classroom, has taught me much about how these changing forces continually affect and complement each other.

[1] The documentary "Particle Fever" illustrates the interesting dynamic that exists between the various fields involved in the operation of the Large Hadron Collider at CERN.
[2] The added 'A' is represents the Arts.

In this paper I will be reflecting on this intimate relationship between science, technology, math, and education. Specifically, I will address the following three questions:

1. What has this course taught me that I will utilize in my own educational practice?
2. How does technology and research inform the study of education?
3. What are some areas of research that I would like to continue to find out more about?

1. What has this course taught me that I will utilize in my own educational practice?

This course has reinforced and enriched a number ideas I have studied about motivation, the importance of activating prior knowledge, the possibilities and promise of constructivist teaching and learning, and the importance of a continuing loop of assessment, feedback, and assessment (National Research Council, 2000). I have written elsewhere about these important elements of teaching and so will not elaborate on them here. ETEC 533 has also given me valuable experience with tools that can facilitate these beneficial pedagogical insights through the various activities and assignments. Was it Einstein that said we don't really understand something until we can explain it to our grandmothers? The process of creating a tutorial for our peers

was an especially beneficial project. It was an in-depth and engaging assignment that gave me intimate and relevant knowledge of the content. It also increased my understanding of the process that must take place for new technologies to be introduced in the classroom. This fits nicely with my belief that teachers must continually update their practice. This continual improvement has always been a necessity of teachers but it is perhaps especially relevant in times of such rapid change like the one in which we find ourselves. Furthermore, the community that we worked within and the collaborative nature of the assignments embodied the collective attitude that I believe is necessary in education research, development, and implementation.

I never considered teaching technology as an end in itself. Great poetry need not begin with a lesson on pencils and erasers. However, the arguments presented in the literature throughout this course have solidified my understanding of when and, especially, why to use technology. When discussing the perspective from which STEM fields see technology, Milner-Bolotin (2015) notes that "technology is viewed as a vehicle for exploration of science and mathematics ideas permeating the world we live in, a tool for engineering design, artistic expression, as well as a field of inquiry within itself (p142)." I am more dedicated than ever to utilize technology in a meaningful and purposeful way. We will not just use devices in class because they are available but because they achieve a clear pedagogical goal. The

technology should help students to “transform scientific facts into scientific ideas (Ibid, p143).”

Finally, this course has given me some insight into assessment. Assessment is important to education because a number of other factors rely on it. In order to activate a student’s prior knowledge or to teach in their zone of proximal development it is necessary to first assess a student’s current level of understanding. It is crucial to find out what and how a student is thinking to get feedback and to correct misconceptions. Furthermore, assessment and the data that results from it are needed, from a political point of view, to justify expenditure or institute change. Assessment is a clearly a vital tool of teachers. As Handelsman, Miller, and Pfund (2007) put it, “In science, data collection is central to discovery; in scientific teaching, instructors collect data to evaluate teaching and learning.” Assessment is more than just getting a letter to put in a report card. Regular and authentic assessment can aid metacognition and improve learning strategies (National Research Council, 2005). I have always struggled with assessment but this course has given me some practical ideas and tools for success. Classroom response systems offer myriad possibilities for getting and displaying information quickly. Learning management systems allow peers and instructors to take part in the assessment process by providing feedback. The assignments gave me this experience (active learning) and my peers assisted me greatly (collaboration).

2. How does technology and research inform the study of education?

Technology has always marched forward and informed further advancement. It is an old trope that we are standing on the shoulders of giants. However, in the realm of education, technology has made certain advancements that have fundamentally changed the way we approach teaching and learning. Of course, theories of effective pedagogy have a long history of dictating teaching practice. The collection and analysis of data has frequently been used to steer policy. But what is being revealed by increasingly sophisticated study of the brain indicates some interesting and important implications for the field of education (National Research Council, 2000). For example, PET and fMRI scans now allow researchers to observe the brain as it learns and changes. Add to this the continued developments in cognitive psychology and we observe a new frontier that we are just starting out upon. I look forward to the discoveries with personal and professional interest.

As a substitute teacher I have been handed many science and math lessons to deliver with little time to prepare. I typically gather a few videos together to augment the book. Research presented in this course has shown me that even after viewing and discussing an experiment, students misinterpret and misremember what they have seen, often simply recalling what they expected to see (Crouch & Mazur, 2001, Milner-Bolotin, Kotlicki, & Rieger, 2007, Wieman, 2007). This research leads directly to the low-tech solution of getting students to predict what they think will happen and

discussing their predictions with peers prior to conducting the experiment. If there is a misconception, the cognitive dissonance will aid in the assimilation of the correct concept. We see that simply designing questions and tasks with an eye to their cognitive affect can help to increase the engagement and success of students (Beatty et al., 2006). Further refinement of this process and the addition of data collecting and sharing technology is realized through Interactive Learning Experiments as illustrated my Milner-Bolotin, Kotlicki, and Rieger (2007).

To put it simply, “pedagogical approaches involving more interactive engagement of students show consistently higher gains” in tests of fundamental understanding of concepts (Wieman, 2007). However, despite rigorous research and development of pedagogical techniques based upon the data, practice and policy often follow public and political interests rather than empirical findings. What can be considered ‘conventional wisdom’ and ‘experiential wisdom’ often ends up directing standard operating procedure (Galway & Sheppard, 2015). Practices can persist in the classroom even when lacking conclusive evidence of their efficacy or even in the face of contradictory evidence (Pashler et al., 2009). These findings highlight the need for researchers and academics to be even more vigilant and to provide multiple sources of evidence on individual issues (Wieman, 2007). The development of research and recording technology will certainly aid in this task.

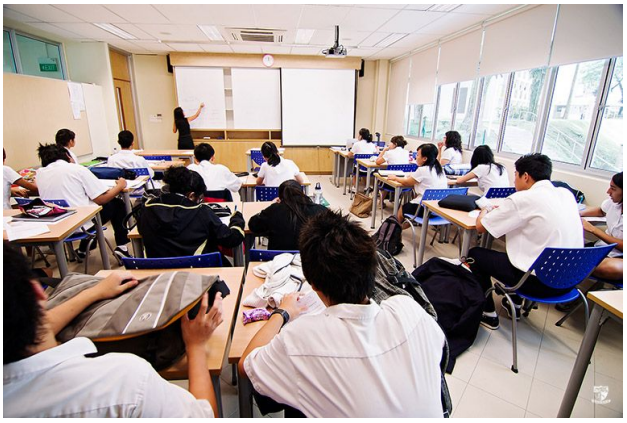
3. What are some areas of research that I would like to continue to find out more about?

Research continues and I want to remain on the cutting edge of it. That is a large part of the reason I enrolled in the MET program to begin with. A question that confronts me and drives me forward in my studies was put succinctly by Sugata Mitra when he asks, “A five year old today, by the time he is 25, it is going to be 2031. Can any teacher say that they are preparing that child for 2031, for an unknown world?” (GOOD Magazine, 2012). He also penetratingly asks, “what for?” when discussing the objective of practicing times tables in our current world. I believe a ‘why’ and a ‘what for’ should be the keystone in all educational decisions. If the educational practice is not preparing a student for life in the future, why are we wasting their time? I want to continue to explore ways to remain relevant in our rapidly changing technological landscape.

I was involved in the tutorial group that studied Bring Your Own Device programs. This policy seems eminently feasible in the schools at which I work. Through the collaborative development of the website I have learned a great deal about the difficulties that surround such a policy and the benefits that can be realized from it. However, there are clear and present challenges. I recently sought out the learning resource teacher at a school where I was starting a three week placement. I wanted to get access to the wifi for my personal devices but it proved to be a laborious ordeal. I was never able to get

permission to connect with my non-school-approved devices. This shows that there are roadblocks that need to be overcome before allowing students to bring, and successfully use, their own devices in school. I want to continue to explore this interesting form of pedagogy to help ease schools into the transition.

I think a BYOD policy would dovetail nicely into my next area of interest: Flipped Classrooms. I see classroom management as the primary time waster in my practice and I believe it is because the character of the students have changed. We have the technology that could enable us to be freed of the constraints of conducting classes in such a rigid chronological order. Students are able to access information at all times and from everywhere and yet we continue to ask them to all pay attention to the same lesson at the same time. The images below show how little classrooms have changed in the last 100 years.



Even with unprecedented technological growth in the intervening years, we continue to have classes that focus on the teacher and deliver a prescribed

curriculum to be consumed by every student of a certain age. I think flipped classrooms and the paradigms that they institute will shake up this stale model.

Finally, the DIY movement (Kafai & Peppler, 2011) and the work of John Paul Gee (Gee, 2008) have sparked my interest although the research in those fields has not yet trickled down significantly into the classroom. When we look at the communities of 'makers' and the legions of 'gamers' that can be found on the internet, one similarity stands out; motivation. People don't need to be admonished to play a video game or create something they are passionate about. They do it because they are intrinsically motivated. It is this kind of motivation that the school system needs to be more aware of when planning learning experiences and the environments in which those experiences take place. I hope my continuing studies will show me how technology and pedagogy can help bridge the gap in motivation that I see between formal education and these other highly self-motivated practices.

Conclusion

This course has given me much to think about and has equipped me with a number of tools to put those thoughts into action. The research on brain development has convinced me of the importance of the types of learning experiences and activities that children take part in. The pedagogical practices and theories have given me the ideas and tools to make those activities and

experiences more beneficial. I have a better understanding and respect for the relationship between education and the research that drives it. I also see more clearly the role that technology can play in that relationship. Finally, I have found answers to some of my questions while adopting new questions to take their place. This, I believe, is the natural and desirable progression in the life of a reflective and effective teacher.

References

Beatty, I. D., Gerace, W. J., Leonard, W. J., and Dufresne, R. J. (2006). Designing effective questions for classroom response system teaching. *American Journal of Physics*. 74(1), DOI: 31–39. 10.1119/1.2121753

Big Think. (2013, May 1). *Neil deGrasse Tyson: Don't Sit Around Waiting for a Sputnik Moment.* [Video file]. Retrieved from https://www.youtube.com/watch?v=h2M3uURGW0M

Crouch, C. H., and Mazur, E. (2001). Peer instruction: Ten years of experience and results. *American Journal of Physics* 69: 970–977

Galway, G., & Sheppard, B. (2015). Research and evidence in education decision-making: A comparison of results from two pan-Canadian studies. *Education Policy Analysis Archives*. 23(109). DOI: http://dx.doi.org/10.14507/epaa.v23.1905

Gee, James Paul. (2008). Learning and Games. *The Ecology of Games: Connecting Youth, Games, and Learning*. Edited by Katie Salen. The John D. and Catherine T. MacArthur Foundation Series on Digital Media and Learning. Cambridge, MA: The MIT Press, 2008. 21–40. DOI: 10.1162/dmal.9780262693646.021

Ge, X., Ifenthaler, D. & M.J. Spector (Eds.), *Emerging Technologies for STEAM Education,* Educational Communications and Technology: Issues and Innovations, DOI: 10.1007/978-3-319-02573-5_8

GOOD Magazine. (2012, May 30). *Future Learning | Mini Documentary | GOOD* [Video file]. Retrieved from https://www.youtube.com/watch?v=qC_T9ePzAN

Handelsman, J., S. Miller, & C. Pfund (2007). *Scientific Teaching*. W.H. Freeman and Company.

Kafai, Y.B., and Peppler, K.A. (2011). Youth, technology, and DIY: developing participatory competencies in creative media production. *Review of Research in Education.* (2011) 35:89. DOI: 10.3102/0091732X10383211

Math Centre. (2014, December 8). *How did Eratosthenes calculate the circumference of the Earth?* [Video file]. Retrieved from https://www.youtube.com/watch?v=Cce1XJ3BCxg

Mazur, E. 1998. Moving the mountain: Impediments to change. *Proceedings of the third annual NISE*. Ed. S.B. Millar, 91- 93. Washington, DC: NISE

Milner-Bolotin, M., Kotlicki, A., and Rieger, G. (2007). Can Students Learn from Lecture Demonstrations: The Role and Place of Interactive Lecture Experiments in Large Introductory Science Courses. *Journal of College Science Teaching* January/February: 45-49

Milner-Bolotin, M. (2015). Technology-Enhanced Teacher Education for 21st Century: Challenges and Possibilities. In X. Ge, D. Ifenthaler, & M.J. Spector (Eds.), *Emerging Technologies for STEAM Education,* Educational Communications and Technology: Issues and Innovations, DOI: 10.1007/978-3-319-02573-5_8

Mishra, P., & Koehler, M. (2007). Technological pedagogical content knowledge (TPCK): Confronting the wicked problems of teaching with technology. In C. Crawford et al. (Eds.), *Proceedings of Society for Information Technology and Teacher Education International Conference 2007* (pp. 2214-2226). Chesapeake, VA: Association for the Advancement of Computing in Education

National Research Council. (2000). *How People Learn: Brain, Mind, Experience, and School: Expanded Edition*. Washington, DC: The National Academies Press. DOI: https://doi.org/10.17226/9853

National Research Council. (2005). *How Students Learn: History in the Classroom*. Washington, DC: The National Academies Press. DOI: https://doi.org/10.17226/11100.

Pashler, H., McDaniel, M., Rohrer, D., & Bjork, R. (2009). Learning styles: concepts and evidence. *Psychological Science in the Public Interest*, 9(3), 105–119.

Ted-ed. (2012, September 6). *How taking a bath led to Archimedes' principle - Mark Salata.* [Video file]. Retrieved from https://www.youtube.com/watch?v=ijj58xD5fDI

Wieman, C. (2007). Why Not Try A Scientific Approach to Science Education? *Change*, 39 (5), 9-15