Editorial

Elizabeth King

Elizabeth King is Assistant Professor at the Department of Educational Foundations, University of Wisconsin-Whitewater, Whitewater, Wisconsin, USA.

Introduction

The need to better prepare pre-service teachers (PST) to effectively leverage educational technology in their classroom practice has been an ongoing topic for decades. The manner and extent to which new teachers integrate, adopt and adapt new technology and digital media in their classroom has been linked to both the quantity and quality of specifically related coursework, experiences (modeling) and skills developed during their degree program (Agyei and Voogt, 2011; Albion and Ertmer, 2002; Drent and Meelissen, 2008). But, despite the importance of training during the pre-service phase, the problem remains that teacher education programs often do not sufficiently involve technology and digital media preparation. (Dawson, 2008; Kirschner and Selinger, 2003). As a result, many students graduate underprepared for the expectations of today's technologically equipped classroom.

This is likely somewhat surprising due to the common (mis)perception that millennials are technology-savvy "digital natives" (Prensky, 2001), immersed in digital media and highly skilled at leveraging technology for their personal and academic goals. More recent interrogation of this notion has given rise to more nuanced models of technology attitudes and practices among young adults (Rikhye *et al.*, 2009) suggesting that enthusiastic and ubiquitous technology adoption may not be the norm. Research specifically considering teacher education students' technology skills and attitudes supports this and offers additional implications for teacher education programming and curricula development.

Examining the technology attitudes of undergraduates, Squire and Giovanetto (2006) describe education majors, in comparison to their counterparts in other undergraduate disciplines, as having greater negative attitudes towards technology and a lower level of technology usage overall. Not surprisingly, they also reported having lower levels of technology competence and lower efficacy.

In addition Hayes and Ohrnberger (2013) examined the technology attitudes, usage and adoption practices of PST. Findings depicted PST as minimally engaged with technology in their personal lives and viewing technology as only having a marginal impact on their future teaching. Longitudinal research conducted (King *et al.*, 2014) over the past three years (King, 2017) suggests similar patterns. Considering the technology skills, attitudes and future use of technology in the classroom, of the 223 PST at a mid-western College of Education, reveal low-level technology use for personal and academic use and negative opinions about the use of technology in the classroom. This work also highlights a strong correlation between students with low level technology skills and those intending to use highly didactic, teacher-centered pedagogical practices in their future practice (King, 2017).

Considering these studies together there is reason for concern over the technology skills, attitudes and perspectives of PST concerning technology usage. However, this is further compounded by the integration of computational thinking across the spectrum of K-12. Indeed, STEM and STEAM education has received tremendous attention as a high demand

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content area. Specifically, computational thinking instruction in elementary education is seen as crucial foundational learning for middle and secondary STEM education (National Research Council, 2012).

As a result, K-12 educators, including elementary education teachers, are increasingly being tasked with teaching computational thinking in conjunction with programming and computing technologies (Grover and Pea, 2013; Kafai and Burke, 2013). Commonplace areas for classroom integration include such widely accepted curricular content as problem solving, development of procedures and processes and logic (Barr and Stephenson, 2011). For PST to implement computational thinking with computer technology, teacher preparation programs must provide instruction (and access to experiences) in both computational thinking and technology skills.

This paper provides a discussion of how students enrolled in a teacher education program located in a small, Midwestern town are working to develop these vital skills. The College of Education (CoE) is considered to be the largest teacher preparation program in its state. Graduating nearly 450 teaching candidates per year, the quality and preparation of the College's students can have a dramatic impact on the shape and substance of classroom practice. Currently, there are only two majors, which require any sort of technology coursework, special education and elementary education. This leaves the entire area of secondary education devoid of related coursework. However, all degree programs are so structured with requirements that no electives can be integrated. Adding another required course to the degree would push the credit-to-degree requirements over the mandated four-year maximum, and therefore, no additional coursework may be added as a degree requirement.

The institutional obstacles to incorporating an instruction on educational technology and digital media into the existing teacher preparation programs are significant. Therefore, initiatives have been designed based upon creating new, non-credit learning experiences. The following vignette and accompanying short essays provide illustrative descriptions of the initiatives in action. Starting first with a vignette of the Radical Adaption of Technology for Teaching (RATT) Lab's activities, discussion is deepened by short essays written by three students involved in a variety of the College's non-credit activities.

A day in the Radical Adaption of Technology for Teaching lab

It's 8.30 a.m. and the flexible learning space known as the *RATT Lab* is already buzzing with activity. The space, a former laboratory used for psychological experiments on rats, has been converted to a student-centered teaching and learning space known as the RATT Lab. Coffee is brewing, the morning jam's already queued and playing on the cobbled together sound system. Several students are scattered throughout the lab's many seating areas accessing their daily news feeds on their laptops. The décor is eclectic, resembling more of the basement on *That 70s Show* than a cutting-edge teaching research and design Lab. The furniture and décor were salvaged from the campus surplus center and reflects several different decades. It is comfortable and definitely worn. Conversation is peppered by talk of the day ahead, what is going on in the world and an upcoming event where they will demonstrate their technology and teaching skills to a class of special education students.

While eating breakfast, those involved in the demonstration begin tackling their instructional plan, while the others retreat to different parts of the lab to tinker with things they are interested in. One student is playing a video game on the big-screen TV. She is exploring how the storyline of a popular video game, *Life is Strange*, might be used in a high school English Language Arts (ELA) course as a tool to connect high-engagement content/ popular culture with ELA standards. A junior in the special education program who has

been leading the robotics program for a local middle school, is showing two CoE classmates in the science education program how to use LEGO Mindstorms.

Yet another group is collected in a small room off the back of the lab hunkered down around an odd-looking contraption – a 3-D printer one of the students built by himself over Winter break. A math major who is endlessly interested in all things STEAM, learned in November that he could build his own 3-D printer, and by the time classes resumed in January, he reappeared with his own 3-D printer to add to the lab's growing collection of tech-tools. Today, a small group of future teachers are gathered around the machine to figure out a modification to the current interface between the 3-D modeling program and the printer.

All of these conversations (and the morning jam) can be heard over the unique buzzes and beeps of the Makerbot 3-D printer that has been churning out a print that was set to run over night, and the steady hum of the Cricut electronic die cutting machine that's being used to print bulletin board materials. In this lab, what was once a very low-tech process, creating bulletin boards, has been improved and automated by the use of the Cricut. The collection currently being printed will be used by one of the students to support a unit she is teaching during her field placement.

These students have membership in one or more of the CoE's non-credit digital media initiatives. To support the development of tech skills and habits of mind, the College has developed a Digital Media and Learning Certificate program. This initiative is a tactic to round end bureaucratic obstacles and provide students access to developing their tech prowess. Supporting the certificate program is a student organization, Education. Technology. Innovation. (EdIT) that was designed *by* students *for* students. Students participating in these programs comprise the RATT Lab crew and collectively identify themselves as the Future Teacher Brigade (FTB).

Around noon the group begins to thin out just a bit as some head off to class or work and students for the 1 p.m. course start filtering in. The class meeting in the lab space is Introduction to Education and Teaching and is taken by students prior to their admission to the College of Education. Students are arriving early for class so they can access the technologies and resources in the Lab. Students in this course have selected projects to work on that involve integrating high-interest technologies to support teaching standards-based content and twenty-first century skills (such as teaching history using comics and game design). The students have already participated in a unit considering the future of life and work in the twenty-first century. Now they are researching the kinds of skills and knowledge *their* students will need and developing related teaching strategies.

Foundational to this is growing comfortable using digital tools, technologies and contemplating the current, and future nature of knowledge and information. As mentioned previously, education students tend to lag behind their peers in other majors in the development of technology skills, as well as their attitudes toward the use of technology. Students in the CoE fit squarely in the center of that tendency. Holding class in a space where the use of tech-tools is *organic and playful* lowers the risk and encourages tinkering (Thomas and Brown, 2011). Students in the DML Certificate program and the EdIT organization serve as mentors for these students – it is a student community where peer to peer sharing of knowledge and skills is central. Students from the Introduction to Education course begin to inhabit this space where technology, making, youth popular culture, games *and especially play* are ubiquitous. This is a safe student-centered space. As their faculty advisor, I provide mentorship and resourcing to provide access to digital media and tech tools, experiences (conferences, field placements with innovative master teachers and involvement with special projects), as well as access to professional networks of teachers, administrators and field experts who regularly interact with these students both on-campus and virtually. The lab itself has been largely bootstrapped – funded through approximately US$20,000 (over three years), which has been spent on equipment and resources.

The following essays were written by three undergraduate PSTs deeply engaged across the spectrum of these activities. They identify themselves as the FTB and fully intend to deeply impact the lives and learning of their students. These are the voices of tomorrow's teachers intently focused on honing their craft and unleashing the power of innovative pedagogies, youth culture, technology and digital media to reach and teach the next generation of K-12 students. Key to their success is not the typical route of courses and field placements. Certainly, these components have set the foundation for their classroom effectiveness. However, it is their non-credit, self-directed learning embedded within a student-populated learning community that has contributed to exemplary preparedness for teaching in contemporary education settings.

Kayleigh bitters: connecting English Language Arts with STEAM through participation in a student-centered learning community

ELA classrooms face a surprising level of criticism. Typically, this stems from a loss of subject value emanating from a traditional curriculum that has become less relevant and lost in a progressive shift, displacing its need. The stigma revolves around several core principles:

- reading is boring;
- reading texts penned old, dead, white men is meaningless to an ever-growing population of diverse students; and
- writing is a waste of time because the five-paragraph essay is not relevant to life outside academics.

These criticisms have increased with the current push for STEM and other related high-tech workplace preparedness initiatives.

Compounding this is a prevailing attitude that computers and word-processing programs have made knowing grammar and spelling obsolete, that reading a 300-page novel is pointless because the average attention span is less than that of a goldfish. It also does not help when that most *old guard* ELA educators are heavily wedded to the classics and traditional teaching methods heavily steeped in grammar and essay writing. Nonetheless, I am passionate about ELA as the result of some pretty amazing teachers who have inspired me and transformed my understanding of what an English class *could be*. These teachers broadened my perspectives. Today, I cannot see myself leading instruction focusing exclusively on the classics or requiring students to pour over endless grammar worksheets. That said, I certainly see the value in the content underlying these practices, and I realize my inspiration is to bridge this change and help my field pivoting away from traditional teaching methods and content. Indeed, this has been the focus of my undergraduate degree, and a primary factor in being selected for the highly competitive teaching internship I have recently acquired.

When I came to college, I was so overwhelmed by being away from home that I did not have any intention of becoming involved on campus. I laid low in my dorm room and went home nearly every weekend. It was not until my Sophomore year, during a required education course, that I connected with a faculty member who introduced me to the importance (and possibility) of using technology and innovative teaching practices in the classroom. After enrolling in the DML Certificate program and participating in several independent study projects, I was invited to design and teach two professional development sessions for my peers at the College's annual technology conference. Working in conjunction with a classmate, we taught *Scrapbooking in the Clas*sroom and *Pop Culture in the Classroom*, which were the highest attended sessions at the conference. I was surprised that they did so well, but more importantly, I was shocked by how much fun they were to plan and lead! I learned more than I could have imagined. I was on such a high that I asked my faculty mentor what else I could be involved in. She mentioned that I should

join her student organization, EdIT (Education, Innovation, & Technology). Participating in EdIT, alongside a group of equally enthusiastic PST provided me with an endless stream of professional development that has continued into the present.

Perhaps the most pivotal of these experiences was attending a professional conference, the Games Learning Society Conference. From that point on, my perspective on education completely changed. My original idea of what an English classroom *coul*d came to life as I realized the possibilities I had been studying were real, and more importantly, that they were being implemented by incredibly creative and innovative teachers from all over the world.

Since then I have moved into a leadership position with EdIT and currently serve as the President. I have also completed the DML Certificate program. Through these activities, I have focused on working with STEAM and twenty-first century skills. As I mentioned previously, the push for high-demand STEM training has taken precedent over other subjects, like English. While many people in my field are threatened by STEM, I find it fascinating and filled with tremendous possibilities. Their fear is driven by concern over a potential decrease in need for the kinds of literacy skills taught in ELA classes. But, my work focuses on putting the "A" in STEM – or rather, STEAM, where the arts and the full spectrum of literacy skills are interconnected with the sciences and math.

To be honest, when I first became involved with educational technology, I was excited about all of the cool things we got to play with. At that point, I was not really thinking about these "toys" for their implications for learning ELA, but instead about having fun. However, once I played and experimented, I began noticing the implications STEM technologies have for English (like using coding to follow story lines, or video games to discuss theme and other literary devices). Today, I see ELA as focusing on critical thinking and analysis, pattern recognition, digital literacy, research and discovery about society (as a whole and oneself). These are vital, foundational skills that are valuable in the modern workplace, as well as across the lifespan.

I also believe we need to get away from the idea of *integrating technology into the classroom*; that misses the point and the potential. Our focus should be on starting with digital culture and youth culture and making connections to educational expectations. By doing so, we can facilitate developing the skills our students already have. We can inspire them to follow their interests in ways that speak to them and build on their unique ways of knowing. Reflecting on my own learning experiences, I realize this was central to the effectiveness of my informal learning experiences in the RATT Lab and the DML Certificate program. They have fostered inquiry habits of mind and taught me how to leverage interest-driven learning and collaboration with peers (and experts). I was able to *play*. I got to use technology, dig deep into pop culture and follow my curiosity. Perhaps most importantly, I learned to do these things while working with my fellow classmates who have learned right alongside me. This level of engagement, and this sort of deep, transformational learning just cannot be taught in a *How to Teach with Technology Class*.

Maria parks: the power of real-world experience, coursework and informal on-campus learning in preparing future teachers

My ultimate vision for education is a system that gives children the tools necessary to lead a happy and productive life, a system where no child goes hungry or is scared to go home, and a place where children learn lessons that will mean something to them 20 years down the line. Sadly, that is not what educational institutions look like today. The system has failed too many children. That's my *Why I Teach*. I want to make a difference in the lives of my students and catch the ones who seemingly always fall through the cracks of the system.

That's my goal and my motivation – and I know I'm not alone in this. My fellow classmates, the members of the FTB, share my perspectives and feed my motivation. The FTB grew out

of the RATT Lab only a few short years ago. It was here that I found my academic home; a place where my values on education have been shared – and also challenged. My journey with the FTB began my freshman year. I saw a poster advertising a club called EdIT, a group for aspiring teachers to come together to talk about technology and innovative pedagogies. Something about that intrigued me, so I decided to attend one of the information sessions. I have always been a person who follows opportunity. In fact, my journey really began the summer before freshman year of college, following the curvy path of opportunity.

I had just graduated from high school and I was planning to volunteer at the summer school program in my hometown as I had done the previous two years. I was on my way to meet with my cooperating teacher when I ran into a former teacher. After brief small talk, she asked me if I would like a job as a special education aide for the summer and whisked me away to talk to the principal in charge of the program. I had an on-the-spot interview, and was hired.

Since then, I have been continued to work for my hometown district. I'm currently co-teaching a middle school course, The Lego Engineering class and co-coaching a First Lego League Team, which is a national competition using the Lego Ev3 intelligent bricks. In the course, we teach students to think about the engineering process, tinkering, gears and types of motion and using the Lego Ev3 Intelligence Bricks. The bricks are programmable and are simple enough to be used with elementary students but can be also used by college students. We start off summer school by getting into the nuts and bolts of engineering, as well as the process and the base knowledge the students need before we start teaching them to program. Programing has recently become more accessible through a Chrome app or iPad app that combines the simplicity of drag-and-drop programing with the ability to increase the complexity through specialized blocks for a variety of operations and sensors.

During fall semesters I co-coach a First Lego League team, which is a national competition using the Lego Ev3 intelligent bricks. For this competition, students program a robot to complete a series of missions. As a component of our program, they also complete a related research project. During spring semesters, we participate in a SumoBot competition where students build a robot to compete in a speed and agility timed task, battle bot and give a presentation.

This past year I also helped to start a Girls Who Code program, which is a program specifically for girls to get them involved in the computer science fields. In addition, I have also dabbled with teaching Minecraft and recently began teaching a summer school course: Exploring Makerspace. This is perhaps the most engaging and dynamic class I have had the opportunity to create and implement. We are using the laser printer, completing design challenges and also playing with Spheros and Ozobots.

During practices, nearly everything we do is in groups of two or more, and we actually teach team building. We also do a great deal of work with goal setting. Because of the nature of these programs, we are continually working toward an end goal and use SMART (specific, measurable, attainable, realistic, time bound) goals. To practice, I design challenges with a set of restrictions that they have to work with to create a final product. After all of the practices, when these teams really come together, it truly becomes something spectacular. The best thing about watching these kids learn is when they encounter a problem. They question the problem, talking to each other and researching how to figure it out. They are practicing the skills they need to be successful in a twenty-first century world.

People often assume that the purpose of these courses and co-curricular activities are to get kids into engineering or STEM careers. While that can be a goal, these programs are helping the students learn problem solving and critical thinking skills, encounter

engineering principles, engage in teamwork and develop perseverance and grit – all while working within constraints and an explicit time line. This is the heart of twenty-first century skills, skills and dispositions that are in high demand in the modern workplace.

People also tend to assume that I'm a science major; I'm not. I'm actually a special education major. What I'm teaching is outside my content area and not something I can earn a license in. In actuality, courses on making and doing entry-level coding through Spheros and Ozobotts typically do not connect to a specific licensure area. As a result, for-credit coursework (which normally aligns to specific licensure areas) in this area is quite uncommon. This is why it is essential for PSTs to be provided enrichment opportunities to build knowledge and skills in this area. While I'm good at learning technology on my own, having a learning community of other students has been essential in deepening my knowledge and exposure.

In the words of Rita Pierson, "Every child deserves a champion – an adult who will never give up on them, who understands the power of connection, and insists that they become the best that they can possibly be". For me, part of being a champion for my students is opening doors to all kinds of new possibility. Technology can be tool I like placing a new piece of technology in front of my students with little instruction and just let them run with it; let it spark curiosity. Every child is curious, but not every child is *naturally* curious. Sometimes we need to find what makes that child curious, what makes them question what is in front of them. The light-bulb moment is something I live for and something that can be achieved by figuring out what makes a child tick – *what makes that light spark*. It is not always easy to find, but it is worth every second of effort.

Nolan Pawelski: shifting perspectives on math education

Math [. . .] the mere mention of the word causes students to bemoan, "When will we ever use this?" Often, students are told the concept they are learning will be used in a more advanced math class next year, or that it is simply a thought experiment. While students alienate their math teachers by asking this question (which is why teachers give such cursory responses), they raise a vitally important point. *Why should they learn math?* In the search to enhance the rigor and expand the scope of the math taught in school, math has lost its relevance. Yet, relevance is what math, and students, need the most. To prepare students to become active and productive members of local and global communities, students need to engage in mathematical tasks within a relevant context that not only develops understanding of math concepts, but skills related to problem-solving, collaboration and technology. Additionally, when done effectively, the study of math can authentically incorporate cutting edge technologies and digital media tools.

For this to happen, a shift in pedagogy must occur. Math teachers typically use an outdated mode of instruction, the gradual release of responsibility model (I Do, We Do, You Do). This model prevents the use of contexts truly relevant to students and provides few opportunities for students to develop problem-solving, collaboration and technology skills. Instead of the gradual release model, a more appropriate strategy is LESRA: launch, explore, summarize, reflect and apply model. This instructional approach encourages students to construct knowledge of math through the exploration of a mathematical task either individually or in small groups; this occurs during the "launch", "explore", "summarize" and "reflect" steps. In addition, students extend their learning in the LESRA model by applying the math concepts learned through exploration to other contexts or real-world scenarios during the "apply" step.

While brief – I encourage those interested to seek further information regarding the research and application of this instructional framework explanation of the LESRA model – within this description, we begin to see how this model allows students to develop problem-solving and collaboration skills. During the "explore" step, students work on their

problem-solving skills by developing different methods for tackling a problem, such as trial and error, creating a representation, etc. Similarly, during the "explore" step, students practice collaborating with peers by working together to achieve a common goal, i.e. solve a mathematical task. However, the LESRA model can incorporate technology skills by using various technologies, such as dynamic mathematics software (GeoGebra), 3D printers, cameras, development boards (Arduino and Raspberry Pi), robotics (Sphero), etc., to assist students during the "explore" step. Lastly, and most importantly, the LESRA model allows for the use of relevant tasks. As stated early, students extend their learning during the "apply" step by applying the math concepts learned through exploration to other contexts or real-world scenarios. This step provides a convenient opportunity for students to connect their learning to problems important to them, thus keeping the math relevant.

While powerful, the LESRA model cannot standalone. For a math educator to utilize the LESRA model effectively, an understanding and the implementation of STEAM education must occur. STEAM stands for Science, Technology, Engineering, Art, and Mathematics, and is a framework that encourages the development of connections between subjects through cross-disciplinary collaboration. In other words, the ideas and concepts taught in one class transfer to the others, and this transfer is made explicit. For example, students learn about the different types of symmetries in math; meanwhile, in art students use symmetry to create mosaics; while in science, students use symmetry to describe the petals of flowers. In engineering and technology courses, students create parts on a CAD program using symmetry. When coupled with STEAM, the LESRA model provides more opportunities for students to connect math to the problems they want to solve, thus placing math inside contexts relevant to students.

By using the LESRA model and STEAM in tandem, math educators have the method for transforming math education. Yet, one obstacle still stands in our way, ourselves. Without proper training as pre-service math educators, any future math educator would struggle to use STEAM and the LESRA model effectively. Currently, pre-service math educators receive extensive training in their content area as they must complete math course covering a range of topics – algebra, geometry, statistics, calculus, discrete mathematics and abstract algebra to name a few topics studied by pre-service math teachers. However, this thoroughness may not apply to education courses. For example, at the University of Wisconsin Whitewater, my alma mater, pre-service math teachers only need to take seven semester long courses, not including field studies and student teaching, related to education; seven courses out of thirty-eight. Of these courses, only one course specifically talks about methods for teaching mathematics and none specifically talk about the use of technology and/or STEAM in the math classroom. For future math educators to use the LESRA model and STEAM, additional courses for specifically related to teaching mathematics and implement technology and STEAM must be included in the required coursework. However, changes cannot stop at adding additional courses. Future math educators must be able to connect with peers from different subjects to explore, experiment and share ideas related to STEAM and technology, which can occur within a lab specific specifically designed with STEAM and technology in mind.

These recommendations come from my own experiences. As a PST, I sought additional courses, such as a STEM methods course, besides those required by the university to learn more about implementing STEM/STEAM ideas into my classroom. I became a member of EdIT student organization, which enabled me to explore and experiment with technology, such as 3D printers, robotics, development boards, Minecraft, etc., and STEAM ideas. In addition, EdIT enabled me to connect with educators from different fields, such as English, social studies, special education, art, etc., to share ideas and experiences, thus enhancing my ability to use technology and STEAM in my classroom. With this background, I was recruited to teach courses that use Minecraft and STEAM to teach middle school students math concepts, while developing problem-solving, collaboration and technology skills.

Moving forward, I will take the experience I gain from teaching this class to further my ability as a math educator engage my students in relevant tasks and encourage students to seek mathematics as a means for solving problems important to them. In doing so, I hope that I will never have to answer that infamous question, "When will we ever use this?"

Conclusion

At a time when teacher education programs are increasingly coming under fire for not adequately preparing future teachers (Kelly, 2013; NCTQ, 2016), these three rising educators provide a counter argument. Certainly, these essays provide three purposefully selected examples and the limitations abound. However, my purpose here is to spark conversation about specifically tapping into the power of enrichment (or supplemental) experiences to supplement shortcomings in our programs – not just education programs, but any program at the post-secondary level. To be successful, students require access to the tools *and to the practices* associated with digital media, they need mentoring and a safe space to tinker and play with these tools. Sometimes, educators need to provide the resources, step back and empower our students (who are adults) to take charge of their own learning.

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Corresponding author

Elizabeth King can be contacted at: emking29@gmail.com