Embracing failure in a first-year technology course

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Abstract

Although students might expect a technology literacy course to provide them with tool-driven educational experiences, first year students in a teachers college at Arizona State University in the United States discovered, instead, a course that would move them beyond technology use to reflective development and understanding. The course designers used Dewey's natural impulses for learning to create a course with a range of innovative assignments and pedagogical approaches. The resulting experience immersed future educators in exploration, scaffolded learning, provided multiple opportunities, and allowed for intellectual and personal growth. In this paper, we will describe the conceptual structure of the course, provide examples of assignments and activities, and describe the use of technology both for pedagogy and instructor interaction and design. We will include samples of students' work and a description of their experiences based on their reflections.

Key words: course design, resilience, failure, innovation, technology, teacher education.

Resumen

Si bien los estudiantes de primer año de la Facultad de Educación en la Universidad Estatal de Arizona en Estados Unidos esperaban que un curso de alfabetización tecnológica les proporcionase experiencias educativas realizadas con herramientas digitales, descubrieron en cambio un curso que los llevaría más allá del mero uso de la tecnología, hasta un proceso de desarrollo reflexivo y comprensión de esa misma tecnología en el ámbito educativo. Los diseñadores del curso utilizaron el concepto de impulsos naturales de aprendizaje de Dewey para crear un curso basado en actividades y con un enfoque didáctico innovador. La experiencia resultante sumergió a los futuros educadores en la exploración, el andamiaje o scaffolding, les brindó múltiples oportunidades de aprendizaje y les permitió su crecimiento intelectual y personal. En este artículo, describimos la estructura conceptual del curso, proporcionando ejemplos de tareas y estrategias didácticas, así como describiendo el uso de la tecnología tanto para la aproximación didáctica, como para la interacción con el docente y el diseño de la experiencia. Se incluyen también ejemplos del trabajo de los estudiantes y una descripción de sus experiencias en base a sus reflexiones.

Palabras Clave: diseño didáctico, resiliencia, fracaso, innovación, tecnología, formación docente.

1. Introduction

Teacher education programs have increasingly come to recognize the necessity of addressing educational technologies. As a consequence, technology literacy courses have become integral to teacher preparation programs (Graham et al., 2004; Skophammer & Reed, 2014). Most preservice educational technology courses teach future teachers how to use current technologies with the hope that they will be able to apply what they learned directly to their future teaching (Hasse, 2017; Instefjord & Munthe, 2016). In pursuit of that, technology integration courses tend to focus on decontextualized technical knowledge such as how to use specific technology platforms or software programs to develop websites, put data in spreadsheets, and insert multimedia into presentations. Course activities lack a broader context and purpose, and preservice teachers do not have clear models that help them apply what they learn to actual class practice (Yigit, 2013; Willis, 2015).

The decontextualized model of technology integration courses does not match what research has demonstrated about how preservice teachers learn. Developing technological literacy is not just learning to use particular tools; rather, it is the application of new technologies to intentionally engage with the world, such as collaborating and communicating with others (Graham et al., 2004; Hasse, 2017). Furthermore, given the rapid pace of technological change, learners need to develop the skills to learn newly-invented technologies which often requires a willingness to try new things, take risks that may sometimes lead to failure. Given this, technology literacy courses should include contexts that value collaborative knowledge creation, risk-taking, creativity, and student choice, while acknowledging the value of productive failure (Mosca et al., 2019; Simpson & Maltese, 2017; Turner, 2015; Vito, 2013). Traditional approaches, where students work individually in computer labs, creating decontextualized digital products, provide few opportunities for this type of learning. Such learning experiences are like toiling through workbook exercises in a typing class: lonely, uncreative, and with limited student agency. Clearly, this approach for teaching preservice teachers about technology is unlikely to develop the requisite skills preservice teachers need to be productive, creative educators.

We believe that these introductory technology courses can be reimagined to become powerful educative experiences—experiences that can both shape students' thinking about the role of technology in teaching and learning and, through that, affect their future educational practices. This reimagining, however, requires us to select a new frame, a frame that removes technology from the center and focuses on the deeper motivations for why and how we learn. Our frame takes inspiration from John Dewey's four key impulses for learning, which he placed at the foundation of the curriculum. The key educational challenge, Dewey (1956) argued, is to nurture these impulses for lifelong learning:

> These fourfold areas of interest—the interest in conversation, or communication; in inquiry, or finding out things; in making things, or construction; and in artistic expression—we may say they are the natural resources, the un-invested capital, upon the exercise of which depends the active growth of the [learner] . . . What are we to do with this interest—are we to ignore it, or just excite and draw it out? Or shall we get hold of it and direct it to something ahead, something better? (p. 48)

Dewey's four impulses form a compelling structure for a technology literacy course. The flexible framework enables a technology-agnostic structure, one open to revision and redefinition as newer technologies emerge. In other words, the four impulses provide a pliable skeleton that moves the emphasis from the latest tool or technology to the "un-invested capital…[for] the active growth of the [learner]." This is a generative frame, allowing for the design and implementation of a range of assignments and activities even as tools evolve.

In this article, we describe our design of a new technology literacy course based on Dewey's four impulses for first-year teacher education students in Mary Lou Fulton Teachers College at Arizona State

University. We begin with a review of literature on today's students and technology, the status of teaching technology literacy to future educators, and experiential learning methods. Following the literature review, we describe the course design elements, which include the pedagogical approaches, the course structure, and the assignments. Thereafter, we detail the course experiences for both instructors and students.

2. Literature Review

Teacher education, just like all education, is oriented toward the future, with the goal of preparing the next generation of educators. In the sections below, we review the literature on developing future-ready educators, particularly in their technology literacy. In addition, we will dig deeper into Dewey's ideas of experiential learning and how they could be applicable to an introductory educational technology course.

2.1. Developing future-ready educators

We face an interesting paradox when designing learning experiences for today's students. At one level, many of the generation often identified as Generation Z (students born in the 1990's) have lived in a world awash with digital, networked technologies. At another level, however, members of this generation may not fully understand how to maximize the affordances of current digital technologies and apply them to either their own learning or to designing learning experiences (Mosca et al., 2019; Swanzen, 2018).

This paradoxical factor is relevant to any educational technology intervention we create for preservice teacher education. Mosca et al. (2019) argued that promoting effective understanding and application of technology in learning should be part of preservice coursework that includes "hands-on experiences, along with collaborative activities with other students, which allows for the exchange of knowledge" (p. 67). Additionally, Mosca et al. appealed for student-centered experiences that allow for student agency (such as providing multiple paths for exploration as well as various methods for demonstrating understanding) as an approach that would allow students to develop greater mastery. Students find more success from learning experiences anchored in creativity, collaborative group work, problem-solving, and opportunities for inquiry.

Purposeful experiences that promote agency may develop from particular activities. For example, students who learn to combat failure (Turner, 2015) can achieve a powerful understanding of their abilities. Courses should include activities in which students struggle with problems and learn how to address and surpass barriers. Additionally, today's learners may benefit from an emphasis on creativity and the exploration of new technologies (Swanzen, 2018) as grow capacity for learning.

The above characteristics are deeply connected to Dewey's idea of learning from experience. Dewey argued that the essential role of educators is to provide students with immediately valuable experiences which contribute to a broader purpose. Each experience should be meaningful, both in the moment as well as in the longer term. Dewey (2007) noted that not all experiences are equally educative writing that, "The belief that all genuine education comes about through experience does not mean that all experiences are genuinely or equally educative" (p. 25). This calls for intentionality in designing learning experiences such that they provide both structure and flexibility—to guide students while still allowing them to take risks and fail, supporting the development of new knowledge, skills, and resilience. A key component of this is the idea of learning through reflection. Dewey argues the value of an experience emerges only through reflecting on it.

2.2. Current Approaches to Technology Literacy in Teacher Preparation

The research on technology literacy in teacher preparation programs revealed a range of arguments for the integration of content and learning activities. Research indicated limiting knowledge to using a specific technology in one context—particularly, tool-based use—often produces instances of educators using that technology after introductory training but then lacking the ability to adapt to replacement technologies that ultimately overtake the original. For instance, Hasse (2017) found that preservice teachers, although frequently adept at implementing technology in personal use, were unable to consider the consequences of teaching with technology and often resorted to mere "button pushing" (2017, p. 375). Muilenburg and Berge (2015) argued this emerged from "technology transience," (p. 94) which they defined as "the rapid proliferation of technology tools, the frequent update of such tools, and their ever-shortening lifespans" (p. 94). Thus, growing the capacity to cycle between various technologies depending on objective and context becomes an important requirement for educators. Muilenburg and Berge posited the cultivation of a "positive mindset" (p. 101) and developing "resource fluency" (p. 102) were integral strategies for learning educational technology in teacher preparation programs. Thus, understanding technology on a broad level and building resiliency to tackle the swiftly shifting evolutions of technologies would help future educators establish appropriate mindsets eager for exploration, testing, and application.

Literature related to educating preservice teachers often suggests the need to increase resilience through failure, where failure is defined as "a process of falling short of a goal, or falling short of a standard for the process that leads to the goal" (Athanassoulis, 2017, p. 358). If students had multiple opportunities to maneuver failure and reflect on the processes, they could develop strategies for viewing difficult situations as beneficial.

Learning how to understand and apply unfamiliar technologies often includes frustrations and challenges. Hasse (2017) noted a lack of technology use resulted from teachers' inability to manage the "complex diversity" (p. 375) that accompanies rapidly evolving devices, disconnected or new applications, limited access, and frequent troubleshooting when integrating technologies in learning. Thus, providing future educators with strategies for approaching these challenges and supporting a positive perception of failure could lead to more effective technology integration. Educators who build resilience, do not fear risk, and who are open to testing new situations may perceive technology as a positive resource rather than a problem.

Athanassoulis (2017) discussed the benefits of courses which included navigating "constructive failures" (p. 354) because students will fail but must learn to consider failure as transformational and acceptable rather than forbidden. These experiences, then, assist preservice teachers in viewing frustration and mistakes as part of the learning process. Athanassoulis argued these opportunities resulted in more effective learning experiences due, in part, to students' reasoning and reflection. Discovering how an application works through trial (and sometimes error) can become commonplace, natural when uncertainty produces continued attempts instead of cessation. Therefore, guiding professionals through discomfort during exploratory activities could transform their approaches to failure (Simpson et al., 2018). Overcoming setbacks can lead to expansive thinking about problems as challenges require creative solutions. Learning from failure encourages just this type of thought (Darabi, et al., 2018; Simpson et al., 2018). Skills benefitting future educators' technology literacy align with opportunities to contemplate barriers and develop methods for surpassing them. Therefore, learning based in failure would contribute to preservice teachers establishing the mindset required for willingly engaging with rapidly-changing technologies.

2.3. Returning to Dewey

As we discussed in the introduction, Dewey's experiential learning framework offers an intriguing foundation for a technology course for today's learners. Dewey's ideas of "excitement" and "drawing out" appealed to our design preferences. Rather than focusing on technology, we hoped we could draw

out students' drives to inquire, communicate, construct, and express through digital technologies. The impulses (described in Table 1) would thrust students into action, and technology would provide the tools for exploration. Along the way, students would develop resilience, confidence, and perhaps even some new technology skills.

Table 1: Descriptions of the Dewey's Four Impulses for Learning

Impulse	**Description**
Inquiry	The urge to find things out. It is a curiosity-driven approach that actively seeks or investigates for truth, information and knowledge.
Communication	The urge to interact with others. It is the basis of exchanging ideas, thoughts, opinions, and information through speech, symbols and media.
Construction	The urge to make things. This is connected to making, building or devising, often complex structures (physical or conceptual) by putting together simpler elements.
Expression	The urge to put the personal / aesthetic touch. It is concerned with representing (often in deeply personal ways) ideas, feeling, spirit, character and emotion.

Each of these impulses is deeply human—in fact, one can argue the impulses are what make us human. Each can be mapped onto different tools and technologies we use yet is not restricted to just current tools and technologies. The framework provides a generative and flexible map for creating powerful learning experiences.

3. Course Design

Our teacher preparation program in Mary Lou Fulton Teachers College previously offered a technology literacy course much like the one we outlined in the introduction—full of decontextualized activities with little intrinsic value and an emphasis on mechanical learning of certain technologies, which was appropriate and effective at its inception. Research about current learners' dispositions, their proficiencies with technologies, and technology literacy for future educators suggested the need to revise the course.

We redesigned the course to better prepare students for future educational careers that reflect the growing need for authentic and contextually-relevant uses of technology. We built the course around Dewey's four natural impulses of learning and included ample opportunities for exploration, critical reflection, and productive failure.

The new course was initially taught face-to-face by core teacher-education and adjunct faculty. Class sizes ranged from 20-35, with most students being first-year teacher education students. The course was embedded within a newly-developed first-year learning communities model. Learning communities were cohorts of students that took pairs of courses together. In this instance, students in each section

were also together in another course, providing a sense of camaraderie and connection across the program.

4. Pedagogical Approach

The redesigned course used Dewey's four impulses as a flexible curricular skeleton. Though technologies will change, the underlying framework would still be applicable. Additionally, the course provided authentic learning experiences through flexibility and personalization, particularly by allowing students to apply their personal interests and contexts (whether that of being a student or a future teacher/educator).

5. Course Structure

As designers, we strove to model effective uses of technology in education as part of the intentional course design. We invested a significant amount of time planning the course structure to support a rhythm of student experiences. The components of the course were designed to create a sense of consistency, predictability, and comfortability in course structure, leaving space for challenge and failure in assignments and activities. In other words, although the module topics and technologies were new and assignments were challenging, the overall structure grounded the student experience and tried to minimize stress.

Essentially, the course followed a cyclical structure with six modules: an introductory module, four modules based on the Deweyan impulses, and a concluding module. This organization allowed for adaptability to various course schedule formats. While the first offering of this course covered a full semester (or 16-week timeframe), the design lends itself to condensing to a term course (eight-week timeframe) without loss in the course rhythm.

5.1. Introductory module

The first week of class was designed to introduce students to the course content as well as prepare them to cope with failure and build resilience. Descriptions of activities are available in Table 2. The first module activities were designed to be challenging; they required students to work with unfamiliar technology in limited amounts of time. Consequences of failure were low; for instance, failure did not affect students' grades. To illustrate, during the first course session, students completed a timed group activity which involved producing a digital movie-poster with details from each group member. Instructors added pressure by placing students with unfamiliar classmates and limiting collaboration time. Students felt the stress from these conditions, and the instructor asked them to reflect on the experience and realize that they were successful, regardless of the results. Goals were to support students in coping with this micro-failure and help them understand they could produce a quality product within the constraints available.

Table 2: Theme, Topics, and Activities for Introductory Module

Theme	Discussion topics	Example in-class activities
Addressing failure	Improving public education Professionals who have failed Recognizing failure and related lessons	Timed technology scavenger hunt Timed group technology adoption movie poster creation
Building resilience	Identifying critics Building self-worth	Timed, restricted video creation

5.2. Impulse modules

The bulk of the course included four modules, one for each of Dewey's impulses. Each impulse module included a project, readings and videos for discussions, in-class activities, an in-class critique section, and a brief reflection paper. Figure 1 depicts the recurring content cycle. Table 3 outlines projects, topics, and activities for each impulse module. In the critique sessions, students shared project drafts with several peers and received feedback. Students then revised their projects and submitted them for instructor feedback. After submitting, students wrote brief reflections based on the following prompts: a) In 1-2 paragraphs describe in detail your plan to revise your project based on the feedback you received. Identify elements that you were able to modify, as well as any that were not reasonable given time, expertise, and cost etc., b) Looking back over your project and feedback, describe in 1-2 paragraphs what you have learned about the process of revision and iteration. Based on your experiences, describe how you might approach this same project if you started again—what would you do differently, the same, etc.?, and c) In 1-2 paragraphs describe how the technology you focused on for your project might be used in a way you had not initially considered? What are some real or hypothetical use cases of the technology that we haven't considered?

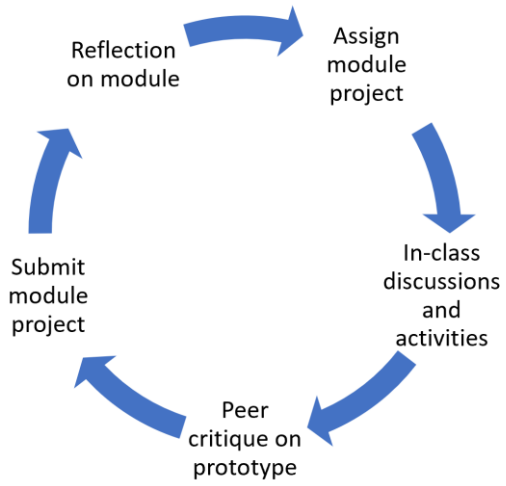

Figure 1. Format of Impulse Modules

Note. This figure displays the repeated cycle of consistent content students connected with in each impulse learning module. This cycle repeated four times during the course.

As Table 3 demonstrates, each module had students engage with multiple technologies and tools, always within the context of the particular impulse. The assignments were usually open-ended and collaborative, forcing students to work together to find solutions to relatively-complex problems. Thus, learning of the technologies was scaffolded through engaging with deeper ideas of motivations for learning: namely inquiry, construction, communication and expression. The instructors also emphasized that, though described independent of each other, these four impulses often were intertwined and that teasing them apart is not easy.

Table 3: Impulse Module Projects, Topics, and Activities

Impulse	Project	Discussion topics	Example in-class activities
Inquiry	Investigate and report on emerging technologies (mixed reality, artificial intelligence, internet of things)	Searching and evaluating resources Trusting online sources Using online content and learning with digital tools Using online content responsibly Future of technology and inquiry	Tracking, graphing, and evaluating personal technology use Addressing a question through an effective online query Video vignette creation
Communication	Podcast	Technology's influence on communication Social media and podcasts Managing personal information online Choosing the right medium Future of communication and technology	Debating merits of social media Analyzing podcasts Recording two podcast segments Creating podcast cover art
Construction	Application Prototype	Constructing with coding and 3D printing Constructing with mixed reality Constructing with artificial intelligence Principled innovation and emerging technologies Future of AI, mixed reality, coding, and more	Developing flow charts and storyboards Experiencing artificial intelligence Considering utopian/dystopian learning futures
Expression	Express personal teaching philosophy	Digital media Photographic art Creativity Digital art Future of digital art	Creating digital art Altering photographic codes to create new images Building and sharing learning or educational philosophies

5.3 Concluding module

The final module consisted of a final reflection and a discussion on the future of learning and technology. For the final reflection, students reviewed their reflections from the impulse modules and identified themes of their learning experiences. Suggested reflection topics included problems and challenges, changes in students' attitudes toward technology and education, comparing projects across the semester, elements students appreciated in peers' projects, students' thoughts about changing their previous projects, and their future learning goals.

6. Course Experience

In this section, we describe the instructors' experiences and students' experiences. We delve into instructors' introspections related to community-building, opportunities for creativity, and methods for assessing the course's success. The student experience includes examples of reflections students shared

during their coursework. These responses depict learning challenges and celebrations. Specifically, this portion focuses on students' approaches to learning and developing technology fluency through choice, often based on their own motivating factors. We conclude this section with a description of the challenges this course faced that need to be addressed in the next revision of the class.

6.1. The Instructor Experience

As this was the first instantiation of the course, instructors worked together to create new activities and refine assignments. In this section, we focus on how the instructors built a community of practice and how this community supported instructor creativity.

6.1.1. Community-building

Six instructors and one teaching assistant were responsible for teaching a total of 13 sections, which they delivered face-to-face at three geographically separated campuses. One instructor had taught the previous version of the course. Since this was the initial implementation of a newly designed course with faculty members teaching at different locations, all had access to an online community of practice in Slack, a newly-adopted university tool. Instructors were experiencing a new course and new way to converse and connect about the course with other instructors.

As instructors contributed ideas, assignments, resources, examples of student work, and anecdotes, they developed a community open to formal and informal exchanges. Formal additions came from some instructors who shared their daily slide deck presentations for all to reuse and/or remix. Others contributed occasional assignments created to supplement or replace content in the developmental course shell. The two primary course designers were two of the instructors; however, the content and assignments they contributed were but a portion of the additions to the online community. Their supplements, combined with the creations of other instructors, became a repository of materials to enhance students' learning opportunities for the current course installation and future offerings. Informal elements were good news posts, celebratory gifs, and posts of praise or thanks for instructors who shared their work or advice to benefit all.

6.1.2. Creativity

At the beginning of the semester, the content, structure, and major assignments of the course were complete; however, instructors had autonomy to incorporate their preferred instructional strategies to meet course objectives. Although the course focus was technology literacy, using technology was not a necessity. For instance, one instructor created an activity in which students wrote short poems that captured the main ideas covered in that session. Students worked in groups to discuss the day's knowledge then picked a few significant ideas to craft into a piece of verse to share with the entire class. In another activity, students debated social media's role in today's world. Students reviewed related content before class without knowing they would participate in a debate. When they arrived to class, they were assigned a perspective. They quickly reviewed the readings, gathered additional information, and planned their arguments. The activity was another opportunity for students to perform in a high-pressure situation with low-stakes consequences.

Another example of instructor creativity was in ways that supported low-risk ways of helping students learn new technologies. The final project for the communication module was the production of a podcast. To both introduce students to simple audio recording techniques and to provide another opportunity for them to build resilience by successfully completing a high-pressure activity, some instructors asked student groups to record two three-minute podcast segments using only their own devices within one class session. The intention was to assist students in overcoming hesitation or fear related to developing their own podcasts. Asking them to cooperate with others to spontaneously create these segments served as an innovative approach to meet multiple objectives. At the conclusion of the activity, students were far more prepared to complete the actual assignment in a low risk manner.

6.1.3. Measures of achievement

Assessing the effectiveness of a course often comes from student responses from course evaluations. Instructors did consider this as one measure to appraise the experience. Some students also used the final reflection assignment as a forum for sharing their opinions of the course, which allowed instructors to gauge the course's effectiveness. The student voices captured below point to the anecdotal measures of achievement collected from course evaluation comments:

> Some of what we learned . . . was very applicable to our future careers as educators, however, some was not.
>
> Most projects and assignments throughout the course were not very difficult, but did require a lot of intellectual ability through creativity and work ethic.
>
> It was challenging to work out the modules but it was a good challenge. I liked it.
>
> I really enjoyed this class and feel I learned a lot. I see how this course is relevant to my life now and as a future educator.
>
> [The professor] constantly gave us interactive activities to do in class to make it engaging and fun. She . . . helped me change my opinion on technology. I thought I was horrible using it and I didn't really like it but after her class, I feel like I can learn how to use anything technological.
>
> The course is focused on allowing students to use their talents and interests in projects to explore the technology.

The selections following are excerpts from students' final reflections. Although overall course reviews were not explicitly part of the assignment, a number of students provided appraisals of their semester-long experiences, which allowed the course designers to determine whether the structure and content influenced students as intended.

> I believe this course is essential for all future educators… even though we are younger and did grow up with these technologies… We weren't 'forced' to use these technologies, but this class was the push . . . needed to start thinking about our purpose as future educators… We live in a society where technology continues to grow, we need to either grow with these technologies or we will be left behind.

Instructors discovered some students benefitted from scaffolding and developed resilience, which were integral in the course design.

> With each project, I learned new things and used my past knowledge to make it better.
>
> Over the course of the semester I started to take more risks with my projects and try new things because of the constructive criticism I had received from prior projects.

7. The Student Experience

We explored the student experience by further analyzing students' final reflections. Forty-four students gave us permission to use their reflections as research data. After compiling the reflections, we coded them with a combination of inductive and deductive approaches (Saldana, 2016). First cycle coding focused on applying descriptive codes to identify main topics and themes. Deductive codes focused on the main pedagogical elements of the course: problem solving, creativity, exploration, collaboration, reflection, critical thinking, and failure. As we read the reflections, we added descriptive codes representing common topics such as student choice, communication, and personal growth. We also coded challenges identified by students. Following the initial coding, we used an iterative method to organize codes into categories and then compared across categories. Here we report on the most salient themes identified in the reflections.

Perhaps most significant in the reflections was what was not discussed. Students rarely discussed specific technological tools or specific knowledge or concepts they gained. Rather, reflections centered on elements of personal growth and positive shifts in attitudes toward technology. In fact, 25 of the 44 reflections included comments related to personal growth and 20 of the students described becoming more positive and open-minded toward educational technology. This, of course, begs the question "how did a course focused on technology literacy lead to personal transformation?"

7.1. Leaving the comfort zone

To understand the dynamics of students' experiences, we start with what was difficult. Several elements of the course led to unease: the requirement to teach themselves new tools, ambiguity and open-endedness of the projects, and peer critiques. Many students (18) described how the course pushed them outside their "comfort zone" or required they try new things.

First, students were expected to teach themselves how to use technological tools for inquiry, communication, construction, and expression. Instructors provided minimal guidance on tools, leaving students the responsibility of learning. Many students struggled with this aspect of the course. One student explained, "The biggest challenge is the uncertainties and ambiguities in the technologies that I have never really explored or made before. They caused much trouble and took a lot of time to solve." Several students mentioned the value of the experience. For example, one student explained:

> The most important thing I learned in this class was how to overcome learning new things and using them effectively to communicate ideas to others. By the time I reach teaching a classroom of my own the applications and uses of technology will probably more than double . . . I will always be able to trouble shoot and learn as I go to take advantage of new technologies.

Another student wrote:

> Before taking this class, I would have never imagined the skills that I have now after taking the class because I was scared to use technology I was not used to because I felt like I could never figure it out on my own. I was able to prove myself wrong, and I am so glad I took this class.

Second, students struggled with the open-endedness of the projects. Each project was designed to allow students choice as to topic and technology. Although students appreciated this (which we will discuss more below), some found it difficult. Students described struggling to decide what to do for projects and several self-proclaimed perfectionists mentioned they had to let go of their perfectionism.

Third, students had to participate in peer critiques of their projects. Many students were unaccustomed to this. Students' experiences in critiques varied—some found them useful while others felt they did not receive beneficial feedback. Some students learned how to get more effective feedback, like the student who noted, "I did not realize until almost the end of the semester that in order to get more helpful feedback, I needed to move outside my comfort zone and ask people outside my friend group for advice." Other students became more open to feedback: "I'm more accepting of negative feedback now and am willing to change my work if my peers think it isn't at its full potential." Students appreciated being able to see other students' work and hear their ideas during critiques.

Given these challenges — as well as the simple challenge of being a first-year college student — how did the course support personal growth? Next, we outline three elements that supported personal growth: (a) scaffolding; (b) choice, interest and motivation; and (c) creative technological fluency. Taking each in turn.

7.2. Scaffolding

Given the challenges of this course, scaffolding was necessary to help students through the uneasiness and ambiguity. Scaffolding was intentionally built into the course design through project plans, critiques, and reflections.

First, each module project included a distinct project plan that students received at the module's introduction. The plan was designed to guide them through the project's completion. The project plans helped students move from a general description to a specific plan and prepared them to articulate their project ideas during peer critique sessions. One student explained:

> When the modules were first explained, I was very confused and I usually had no idea how to go about the projects themselves. Filling out the project plan really helped me organize my thoughts and have a better understanding of the assignment.

Second, critiques helped students refine their projects and address their anxiety. As mentioned previously, students received feedback on their projects from others and were able to see their peers' projects during critique sessions. The critique sessions were not perfect—students did not always have drafts of their projects ready for critique, and some students felt they did not receive useful feedback. However, many students did comment that critiques helped them develop their projects.

Reflections provided a way for students to process their experiences and prepare for the next project. Comments on reflections included:

> [Reflections] helped me look back on what I learned and review on what challenged me by how I was able to move past it and continue on to finish the project.
>
> I found it to be very beneficial that we constantly did reflections after the end of each project. Not only did the reflections tie up the end of the module, but they also prepared us for the upcoming project.

Reflections allowed students to process learning and appreciate their projects. The reflection process provided a springboard for moving into the next module.

7.3. Choice, interest, and motivation

Despite the scaffolding, students still needed to push through challenges and unpredictability. Students were particularly motivated to do so because they were able to incorporate personal interests into each project. The combination of Dewey's impulses and personal interests created authentic, personally-relevant work. This supported student motivation—as one student said, "I found that I felt much more confident in my work when it was something I was very excited about it."

For example, several students indicated they were motivated to communicate their interests—such as a love of music or fashion—in the communication module podcast. Other students found motivation in expressing their visions about education. One student explained, "For the Expression Module Project I put in a lot of effort. I became passionate about creating an organized, effective, and interesting website and I put in extra work." Combining Dewey's impulses with student's own interests allowed for purpose-driven use of technologies.

7.4. Creative technology fluency

We started this section with significant course outcomes described by students in their final reflections: personal growth and positive attitudes toward technology, particularly in education. These outcomes are linked by an underlying theme: students applied digital technologies to accomplish authentic tasks about their passions. They used technologies to inquire, communicate, construct, and express their passions. Consequently, they worked with purpose and drive, connecting creativity, identity, and technology to accomplish personally meaningful tasks.

For example, consider this statement: "Once I became more comfortable using digital mediums for my construction module and podcast I focused more on the content and audience for my projects." In this example, the student moved beyond a focus on technology to centering on communication and expression. The technology became a tool for communication. Another student described learning to express personality:

> My first project seemed very bland like I couldn't show who I am . . . In my last one, the poem . . . I really let myself shine through; the project screamed my name. I let the creativity jump out instead of concealing it to conform . . . I've seen many people grow alongside me, letting their personalities flower from their projects.

Learning to express interests and identity through technology led to the personal growth referenced earlier. As described by one student:

> [The course] genuinely gave me so much more than simply 'tech literacy' and I'm appreciative of the personal growth I have been able to notice throughout this semester because of certain projects we were assigned. I did my best to reflect my growth through my final project, but by writing out just how much I feel I've improved personally and academically throughout this semester I have noticed a lot of that growth stemming from the thought I gave this class.

Together, the open-ended and challenging projects encouraged students to learn new technology tools and apply them directly to a task. Reflections allowed students to review their progress. As one student wrote:

> Every single project allowed me to be open-minded and really think to be creative and make something unique out of it. Each project seemed difficult and challenging until I completed them and reflected back on them with the new, useful technology tools I was able to discover throughout the process of the project.

The integration of creativity, challenge, technology, and reflection resulted in a powerful learning experience.

7.5. Challenges

Although student reflections described a mostly positive experience with the course, and most conflicts students described seemed to be productive, this course format included a few challenges. First, completing four major projects in a semester was difficult. Students felt they rushed through projects and were not able to give appropriate time to each. Some students related this to personal time management deficiencies—not unusual with first-semester college students—but the rapid cycling added to the difficulty.

Communicating the purpose of the course and each project was challenging as well. Many students expected to receive step-by-step instructions on how to use common educational technologies. Some contended with their understanding of how conversations around larger issues of technology and society were relevant and asked for more direct instruction in using educational technologies.

8. Conclusion

Developing technology literacy in future educators should be contextually relevant to students' interests and needs. Learning and expressing oneself should be primary, with technology playing a supporting role. In the technology literacy course we describe here, we provided students pathways to identify passions, preferences, and motivations in pursuit of meaningful outcomes. Students took risks, evaluated results—positive, neutral, or negative—and adjusted approaches. They came to realize their interests were more significant than devices or applications. As they recognized this, their methods for discovery and creation shifted. The processes of using unfamiliar tools became less challenging because students' cyclical creation, critique, and reflection experiences demonstrated that they could be successful with those unfamiliar tools and new, challenging tasks. Inquiry, communication, construction, and expression were the objective; technology was the mechanism. That transformation in thinking occurred through the pedagogical methods, learning activities, and reflection opportunities afforded students. Students viewed technology in a renewed way. Their knowledge of its purpose and use for learning evolved. This

is the revelatory knowledge they can pass onto their future students, who themselves will cultivate their approaches to learning in, with, and through impending technological environments.

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