Pre-Service Teacher Perceptions on Tpack Instructional Design Micro-Course: A Case Study in the Northeastern United States

Dr. Traci C. ESHELMAN, Ph.D.
Liberty University
ORCID: 0000-0003-0234-8759
TEshelman@Liberty.edu

Dr. Mark HOGUE, Ph.D.
Slippery Rock University
ORCID: 0000-0002-3939-9851
mark.d.hogue@gmail.com

Abstract
This case study aimed to discover pre-service teacher perceptions of a technology integration micro-course called TPACK_ID at XY University (pseudonym). The theories guiding this study were TPACK and the learner-centered education paradigm. TPACK_ID provided effective foundations for pre-service teachers to integrate technology using evidence-based technology best practices while applying 21st Century principles. This intervention combined evidence-based technology integration pedagogy, scaffolding, and a simplified instructional design model. Results demonstrated that TPACK_ID increased confidence in students' abilities to find, select, and integrate higher-order thinking educational technology applications. This single-case study used pre-course questionnaire responses from open-ended questions, course artifacts, and a post-course questionnaire's open-ended question responses. Results, implications, and future research will be discussed.
Keywords: TPACK, Triple-E Framework, simplified instructional design, teacher education, technology integration, educational technology, 21st-century learning, professional development, pre-service teacher preparation

Introduction

"Technology can amplify great teaching, but great technology cannot replace poor teaching" (Rodrigues, 2020, p. 24). Teachers must have the skills to control this tool because it will not automatically affect learning (Niess, 2017). Teachers must control and use the tool to benefit teaching, not replace teaching with technology. Technology is not an instructional strategy; it is a learning tool. Unfortunately, new teachers have little to no practical experience selecting and integrating technology. Research indicates that new teachers are not prepared to integrate technology effectively (Kopcha et al., 2020; Koh, 2018; 2019; Koh, Chai, & Natarajan, 2018; Niess, 2017; Voogt & McKenney, 2017). School districts spend millions of dollars for professional development on skills that teachers should have before entering the workforce.

Problem Statement

New teachers graduate with little to no practical experience in selecting and integrating technology. After 30 years of TPACK, PDs and teacher preparation programs do not adequately address its essential components and subcomponents (Hofer & Harris, 2019). Voogt and McKenney (2017) determined that teaching colleges do not provide pre-service teachers with technology integration experience and opportunities. Consequently, teachers lack technology integration practice, planning, and designing and confuse TPACK components favoring one over the other (Kessler & Phillips, 2019). PDs and teacher preparation courses fail to deliver authentic, intentional, active, constructivist learning that helps teachers integrate technology. These deficiencies produce ineffective teaching practices when integrating technology and limit teachers' confidence in implementing technology. Teachers' self-efficacy is a significant factor for successful technology integration (Yildiz Durak, 2021). This study aims to determine pre-service teachers' perceptions of a micro-course that combines TPACK principles, Triple E scaffolding, and CAFE's simplified instructional design (ID) model. The study investigates how pre-service teachers use an educational technology matrix that they create.

Teachers have struggled to integrate technology effectively for years, but COVID Closures exposed this deficit in technology integration skills and lack of instructional design competencies. During the Covid closures, teachers were baffled about what technology to use and how to use it (Wang, 2021). Educators struggled to organize content and what type of pedagogy they needed to embrace to deliver online and blended learning. Covid Closures impacted 1.6 billion students, or 91.3% of all learners in 194 countries (Wang, 2021). The situation left teachers dismayed and learners without sustainable and quality instruction. Covid Closures may have catapulted education into technology, but reflection after COVID Closures provide an opportunity for education to train teachers in effective and sustainable technology integration (Kaden, 2020).

TPACK

Mishra and Koehler (2006) expanded Shulman's (1987) pedagogical content knowledge (PCK) theory to aid educators in technology integration by adding technological knowledge (TPACK). TPACK requires educators to implement technology based on how each component in TPACK influences the other and then evaluate how the infused technology impacts other components. Each component impacts the other and must work together for effective and sustainable technology integration. According to Koehler, Mishra, and Cain, 2013, the fundamental TPACK components include technology knowledge (TK), pedagogical knowledge (PK), and content knowledge (CK). TPACK subcomponents include technological and pedagogical knowledge (TPK), technological and content knowledge (TCK), and content and pedagogical knowledge (CPK). The sweet spot for technology integration is when all elements intersect and combine knowledge in technical, pedagogical, and content combinations.

Since TPACK's inception, researchers have published 3200 studies that explored and evaluated teacher TPACK competencies (Kessler & Phillips, 2019). Although the premier model for technology integration, numerous issues remain with TPACK:

- Lack of a valid, reliable, and unchallenged measure of teacher TPACK skills
- Teachers' ability to connect and relate all TPACK components when applying its principles
- Lack of longitudinal studies on TPACK's effectiveness
- Empirical evidence that TPACK positively impacts student learning outcomes, achievement, and success.
- A valid and reliable instructional design framework to assist teachers in implementing technology in their lessons while considering the lack of expertise, time, and resources
- Technocentricity (Papert [1990] coined this phrase which refers to teaching that focuses on technology and neglects learning objectives, content, and pedagogy.

A fundamental challenge in applying TPACK in the classroom is conflicting definitions of TPACK components and their importance. Willis, Lynch, Frandale, and Yeigh (2019) de-emphasized content knowledge in their study, which contradicted several original studies that stated the importance of content knowledge when integrating technology (Mishra & Kohler, 2006; Kohler, Mishra, & Cain, 2013). CK, PK, and TK should not conflict. Content and pedagogy should play an equally important role in selecting technology, but the current literature pulls these constructs apart and often argue the importance of one over the other (Harris, Mishra, & Koehler, 2009; Koh, 2018; Koh & Chai, 2016). Mishra (2019) updated the TPACK model by stressing the need for context to envelop all TPACK constructs. Many experts agree that context and pedagogy drive technology integration (Avci et al., 2020; Mouza et al., 2017; Niess & Gillow-Wiles, 2017; Rodrigues, 2020; Willis et al., 2019). Mishra and Kohler (2006) stressed that each component is equally essential, and educators must look at how they all impact each other for technology integration to be effective. Unfortunately, professional development and TPACK learning still emphasize one component or subcomponent over another.

Teacher TPACK Competencies

Research indicates teachers lack instructional design skills, experience, and confidence which is essential to weaving technology into their lessons (Koh 2018; 2019). Teachers also struggle with finding and selecting appropriate technology based on content, context, student characteristics, and culture (Neiss, 2017). Additionally, educators find aligning technology to their standards and learning objectives (Kopcha et al., 2020). Further, implementation represents educators' most significant technology challenge (Kopcha et al., 2020).

Design drives quality technology integration and implementation, which is why educators struggle with TPACK (Wang, 2020). COVID Closures exposed frustrated and confused teachers that lacked instructional design skills to guide them in transitioning to blended and online learning. A significant factor in teachers lacking instructional design skills is the lack of a validated and simplified instructional design model (Koh, 2018; 2019). New models are emerging, but validation and reliability are questionable. Koh, Chai, and Natarajan's (2018) study illustrated educators' lack of design experience and TPACK confusion. The researchers hosted a two-day workshop intervention on technology integration. The researchers found that teachers still gravitated to using technology for presenting (direct instruction) and communications rather than designing student-centered lessons that fostered creative thinking and collaboration. Teachers expressed a desire to improve reflective-, authentic-, collaborative-, and active learning with technology, yet only 1.94% of participants' lessons with technology included simulation.

Even with the workshop, the participants' lessons lacked reflection, visualization, internet searches, peer feedback, assessment, and concept analysis.

Kopcha et al. (2020) agreed that most teachers use technology for delivering and presenting content. The researcher stressed that even with TPACK training, educators need help to switch to a student-centered approach to technology and emphasize higher-order thinking with their technology integration. Koh, Chai, and Natarajan (2018) added that teachers still cannot leverage technology to enhance critical thinking and creation and depend on technology mainly for rote-learning exercises. Wang (2021) and Kolb (2019; 2020) agreed that teachers' lack of design experience would lead to inefficient and ineffective technology use.

Kopcha et al. (2020) concluded that for efficient and effective technology integration, educators must see value in technology. Willis et al. (2019) agreed that teachers must have a technology buy-in and have confidence in using it. Niess (2017) added that teachers must select technology based on learning objectives. The technology must be simple and not require significant time to learn. The user must see a benefit in using the technology, and professional development must demonstrate how to apply it, not just how to use it. PDs should include context, culture, and design. Finally, PDs must instruct TPACK to value each component equally and not favor one or subcomponent over the other.

Technology Integration

Teachers struggle to integrate technology because of time, resources, support, clear objectives, and the lack of modeling, pedagogy, and leadership (Rodrigues, 2020). Despite increasing technology knowledge (TK), teachers struggle to find and select appropriate technology (Koh, Chai, & Natarajan, 2018). Although educators know they must shift their pedagogy from teacher-centered to learner-centered, they continue to integrate technology using ineffective, teacher-centered pedagogy. Koh, Chai, and Lim (2017) contended that TPK is the weakest construct and has contributed to teachers' confusion and challenges with technology.

According to Kopcha et al. (2020), classrooms are constantly changing, so technology must be flexible. Willis et al. (2019) added that technology must be purposeful, flexible, and pedagogical, and the educator must implement it with clear expectations and objectives. Willis et al.'s (2019) study on the best technology integration predictors found that more technologically savvy teachers are more successful at aligning the technology to learning objectives, content, and context. The researchers confirmed that successful technology integration included interactive, immersive, and collaborative learning environments. According to this study, the ultimate predictor was the teacher's belief that the technology would improve student outcomes.

Various researchers recommended a technology matrix to aid educators in technology integration (Kopcha et al., 2020; Niess, 2017; Willis et al., 2019). Niess (2017) stressed providing multiple and diverse technologies to teachers and describing technologies' affordances, how they will enhance learning, create a student-centered and collaborative environment, and address students' needs and learning preferences. Kopcha et al. (2020) stressed that teachers must know their students' abilities and characteristics before integrating technology and should consider remediation before attempting to apply it. Niess (2017) added that educators should create a technology system of numerous technologies and pedagogies based on learner characteristics, learning goals, and objectives. Kopcha et al. (2020) suggested Kolb's (2020) Triple E Framework, which focuses on aligning technology to learning objectives. In addition to supplying various technologies to teachers, PDs must provide a variety of methods of delivering these technologies based on teachers' comfort levels and students' characteristics (Niess, 2017).

Professional Development and Preservice Challenges

Avci et al. (2020) observed that current TPACK and technology integration PDs were ineffective. After completing TPACK and technology integration PDs, teachers lacked resources, skills, and knowledge and had negative attitudes toward technology. The teachers tended to resist change in pedagogy and technology because the PDs focused on technology rather than instruction that uses technology to enhance learning. Willis et al. (2019) confirmed that PDs should not focus on content or be teacher-centered but should focus on the participants' needs and characteristics. Acvi (2020) argued that PDs should focus on content. Koh, Chai, and Lim (2016) agreed with Acvi (2020) that PDs should focus on content.

Papert (1990) coined the word technocentric to describe how educators get caught up in using technology and forget the original purpose and application. Avci et al. (2020) described today's PDs as technocentric. Rodrigues (2020) confirmed in his study that current technology integration PDs are technocentric. TPACK and technology integration PDs still focus on using the technology itself rather than applying it, aligning it to the learning objectives, and seamlessly weaving it into the lesson. Koh (2018, 2019) agreed that TPACK PDs are ineffective and not taught appropriately or effectively. Koh (2020) added that PDs lack TPK success because teachers need to shift their focus away from singular TPACK components and look at how all of the components work together. PDs must guide educators on how the technology will impact the pedagogy or content. Professional learning needs to convey how pedagogy and content will affect technology. PDs need to direct educators on how each component and subcomponent impacts the other and advise educators on how to apply the technology for the most impactful learning outcomes. Koh (2020) also stressed that a one size fits all technology integration PD will fail. Educators, their students, the culture, environment, and context differ. PDs must be tailored to context, content, learning objectives, subject matter, culture, and preferred pedagogies.

According to Koh (2018; 2019), of all TPACK components and subcomponents, educators struggle the most with the technology and pedagogy intersection (TPK). Koh and Chai's (2016) quantitative study illustrated this TPK deficit which confirmed that teachers only considered TPK .95% of the time when planning lessons. Kolb (2019; 2020) agreed that teachers struggle with TPACK intersections, subcomponents, and interrelatedness. Kopcha et al. (2020) explained that educators are confused and naturally prefer one TPACK component over another rather than seeing TPACK as a unified and interdependent body. This attitude results in technocentricity and isolates the technology rather than integrating it as part of the lesson. After PDs and workshops on technology integration, teachers' perceptions of TPACK are negative because they still feel uncomfortable with new pedagogical practices which shift due to the technology. Hofer and Harris (2019) found the opposite in their study on teacher design and saw their teachers completely ignore technology. Their study found that teachers emphasized content, learner characteristics, and activities but not technology when designing lessons using TPACK to integrate technology. These results conflict with focusing on technology and disregarding everything else.

PDs have failed to shift teacher-centered learning to student-centered learning, a TPACK cornerstone. Educators feel unprepared to transfer the skills because they lack the confidence to apply TPACK principles. Koh (2018; 2019) attributed these deficits to a lack of a validated design model to integrate technology. Avci et al. (2020) agreed that technology integration PDs fail because they do not include instructional design nor tailor the PD to participants' needs, context, and characteristics. Avci et al. (2020) worried that teachers do not have enough time to play with the technology and reflect on ways to integrate it during PDs. Koh's (2018; 2019) participants also stated they wanted more time for discussion and meaningful reflection on the technology they were integrating. Further, the PDs have been unsustainable, inflexible, and lack reflection of the participant's voice. Finally, Avci et al. (2020) found that the skills did not transfer to the classroom because the PDs did not include active participation.

Mouza (2017) was one of the few researchers that addressed pre-service teacher courses on TPACK and technology integration. The researcher indicated that pre-service teachers have only a superficial understanding of using technology according to TPACK, and the American university system does not prepare pre-service teachers to find, select, align, and implement educational technology. Buss (2018) stressed that pre-service teachers must graduate with the skills to integrate technology. Students should be ready to transform learning through technology on their first day of class, but unfortunately, universities do not prepare students to do so. Kaplon-Schilis and Lyublinskaya (2019;2020;) stressed that teacher prep programs must teach effective technology integration by explaining how TPACK components interconnect. Each component has a purpose but will only work effectively if the educator considers all the other components. Niess (2017) agreed that teaching colleges in the United States do not systematically prepare teachers to integrate technology. Niess added that teacher prep programs do not address new learners' characteristics like instant gratification, visual nature, need for graphics, networking, or their propensity to gaming, multi-tasking, and active and authentic learning practices.

Buss (2018) conducted a two-year longitudinal study to measure pre-service teachers' TPACK progress. The research discovered that students graduated without TPACK competencies and lacked the skills to integrate technology effectively. Buss (2018) envisioned the problem as the teacher prep programs did not provide modeling, observing, or practicing technology integration. Students could describe TPACK but not apply it. Kaplon-Schilis and Lyublinskaya (2019;2020;) experienced similar results in their study on math teachers. They observed that pre-service math teachers felt unprepared after graduation to integrate technology.

PD and Pre-service Course Requirements

Koh, Chai, and Lim (2017) stressed that the goal of technology integration professional development is to help teachers leverage technology to improve students' critical thinking, multicultural communications, cognitive skills, innovation, problem-solving, and organizational skills. Effective technology integration learning requires three components, evidence-based andragogy, TPACK, and simplified instructional design. Figures 1 and 2 display evidence-based approaches and content for pre-and in-service professional learning.

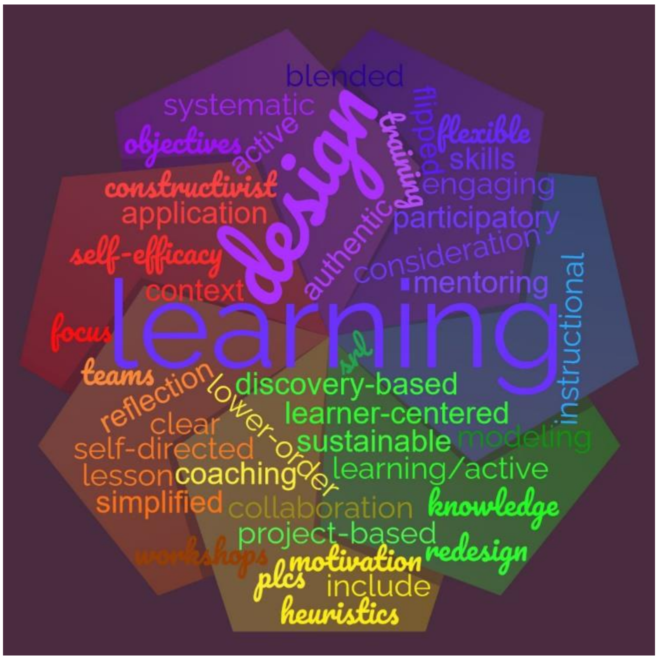

Figure 1: *Professional Development Approach for Integrating Technology*

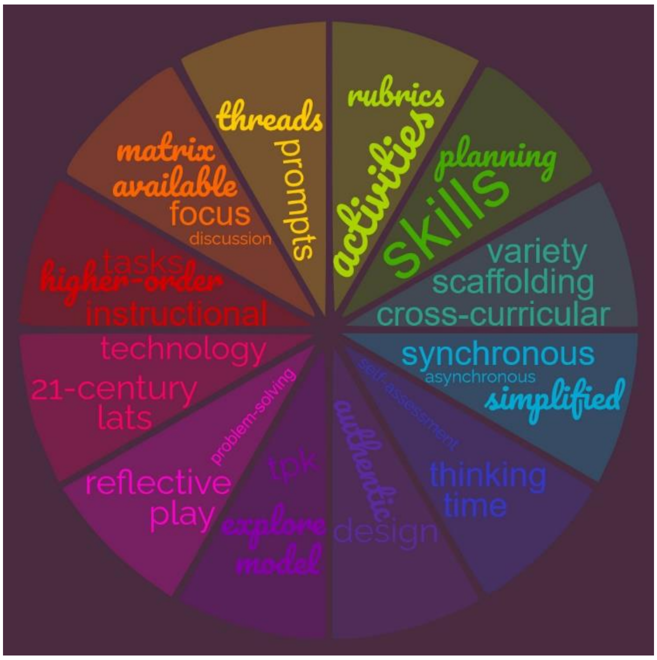

Figure 2: *Professional Development Content for Integrating Technology*

Kopcha et al. (2020) stated that an effective PD "is about supporting teachers in developing a robust perspective on what is possible with technology while improving their ability to anticipate results and successfully meet their goals in the future" (p. 742). PDs must promote active learning and higher-order thinking, measure goal attainment, provide authentic problem-solving situations, and promote collaboration (Koh, Chai, Lim, 2016). PDs must be systematic, have administrative support, have a technically strong facilitator, and address participants' context, culture, and needs (Koh, 2018; 2019). Wang (2021) added that PDs must be sustainable.

Andragogy

Andragogy originated with Knowles's adult learning theory. Teaching TPACK depends on adult learning theory's best practices, like participant-centered, sustainable, and self-directed learning (Buss, 2018). Rodrigues (2020) embraced Active Training to teach technology integration because it is dynamic, flexible, reflective, participatory, collaborative, project-based, engaging, reflective, and a flipped model. Wang (2020) suggested that adult learning should include simplified instructional design models, scaffolding, clear instructions, motivation, piloting, and chunking. Rodrigues (2020) found that PD participants experienced increased motivation and self-regulation when the PD leveraged Active Training. Yildiz Durak (2021) also noted increased motivation when providing authentic learning opportunities, which increased transference.

Koh (2020) recognized in her research using a one-on-one model that the trainer should address different degrees of participant TPACK skills. Trainers should focus on modeling for the novice TPACK learner. PDs should offer the emergent learner a pedagogical realignment toward TCK and provide a deeper dive into TPACK for the experienced learner. Although Koh (2018; 2019) recommended collaborative learning, her 2020 study recommended individual coaching and training. This individualized learning approach conflicts with all other studies that promote collaborative learning for all professional development (Rodrigues, 2020). In Koh's (2020) study that recommended individualized training, she also recommended collaboration. Koh's (2020) preferred approach remains unclear.

Professional Development Content

PDs' content should encourage teachers to design their lessons and embrace TPACK principles while integrating technology and enhancing 21st-century learning (Koh, Chai, & Lim, 2017). Wang (2021) encouraged TPACK professional development to include online discussions, persuasive arguments, summaries, collaborative projects, synthesizing constructs, and offer synchronous and asynchronous learning options. Koh (2018; 2019) stressed scaffolding in the form of rubrics, a lesson plan rating system, guided practice, and revised pedagogy which would improve teachers' TPACK confidence. Lee and Kim (2017) added that scaffolding improves teacher self-efficacy and shifts pedagogy from teacher-centered to student-centered learning.

Harris, Mishra, and Koehler (2009) First introduced learning activity types (LATs) to improve technology integration. Rodrigues (2020) asserted that LATs should include quiz builders, concept maps, flashcards, Facebook page creation, website creation, digitizing worksheets, and e-Books. Digitizing worksheets and flashcards conflict with many researchers because these activities only use technology rote learning functions (Reister & Rook, 2021). This lower-order thinking is counter-intuitive to 21st-century skills (Chai, Hwee Ling Koh, & Teo, 2018; 2019).

Design heuristics and a simplified instructional design model are essential to effective TPACK PDs. After their study, Koh and Chai (2016) demanded that TPACK include another knowledge component, design knowledge (DK). The design must include context, student characteristics, learning objectives, content, and tasks. Wang (2021) argued that PDs must include a simplified instructional design model because teachers do not have the skills, training, or practice in the instructional design field. PDs must consider the lack of skills when introducing design into PDs.

Wang's (2021) simplified instructional design model includes content, activities, facilitation, and evaluation (CAFÉ). Suggested content should be systematic, organized into modules, straightforward, and presented with an outline or table of contents. Activities should include LATs and have clear instructions all streamlined on the LMS. Facilitation encompasses learner-learner and learner-instructor engagement, regular and various communications, and a regular instructional time or calendar of events. Further, the instructor should group students by demographics, skills, and content area. Finally, educators should leverage the LMS platform's evaluation options and include peer evaluations, assignments, formative quizzes, and summative assessments.

It is interesting to note that Koh, Chai, and Lim's (2017) study on TPACK-21C interventions demonstrated positive results in all domains except math. These results correspond with Kaplon-Schilis and Lyublinskaya's (2019;2020) study on integrating technology with math teachers. The two studies agreed that math instructors' confidence and skills are lacking when integrating technology. Koh, Chai, and Lim's (2017) study that included design, self-regulation, collaboration, and reflection positively impacted most teachers. The intervention showed that clear pedagogical goals improved learning outcomes, and collaboration, discovery-based learning, and design-by-learning increased teacher confidence in integrating technology. The researchers noted that their rubric parameters should have been more explicit, and their participants lacked content knowledge. Koh's (2020) study also highlighted learning by design as a valuable component of TPACK skills building and technology integration.

Triple E and CAFÉ Frameworks

Kolb (2019; 2020;) stressed that technology could not stand alone. The researcher developed a framework for educators that includes scaffolding and pedagogy that addresses TPACK challenges. Wang (20201) observed the lack of design elements for teachers that TPACK needs for successful technology integration. Combining the Triple E and CAFÉ frameworks could provide educators with a clear, simplified, and time-saving way to weave technology into lessons while considering all primary and secondary TPACK components.

Triple E
Triple E consists of three equally important elements, engagement, enhancement, and extension. Engagement involves time on task, valuable, not distracting technology, and technology that supports social learning. Enhancement includes higher-order cognitive skills, selecting technology that makes learning more straightforward, not more complicated, and technology that adds value to the lesson. Finally, extension describes how technology should humanize learning, including P21 skills building, and how it needs to connect learners to authentic, meaningful, contextual, and culturally relevant learning experiences.

Engagement means students are actively learning with technology, not distracted by it. To promote engagement, educators must have clearly defined learning objectives and provide opportunities for students to be social. Kolb (2019; 2020) leverages andragogy and TPACK PD strategies for effective technology integration using these principles of engagement. Engagement emphasizes social learning, which addresses evidence-supported andragogy, including peer-to-peer collaboration, participatory learning, motivation, exploratory- and discovery-based learning (Avci et al., 2020; Buss, 2018; Koh, 2020; Koh, Chai, & Lim, 2016; Koh, Chai, & Natarajan, 2018; Niess, 2017; Rodrigues, 2020). Kolb (2019; 2020) suggests the following specific strategies to foster engagement:

- Turn and talk
- Partnering
- Visible thinking routines
- Reflection
- Modeling
- Think, pair, and share
- Turn and teach

Kolb cautions practitioners with evaluating engagement, stressing that time on technology is not equivalent to time on task. The best measure of effective technology is the student's level of engagement in achieving the learning objective. Time on task trumps time on the device.

Kolb (2019; 2020) encourages practitioners to choose technology based on collaboration and social affordances. Bells and whistles are insignificant and can be a distraction to learners. Instead, technology should encourage collaboration and social interaction. If technology does not have all these affordances, Kolb advises that educators can still use it. Still, they must adjust their approach to facilitate collaboration and social learning.

Enhancement encourages the practitioner to ask, *Does technology add value to traditional learning methods?* Technology should simplify and streamline learning, not make it more complicated (Kolb, 2019; 2020). Technology should enhance learning by offering new perspectives or ways to reach learning goals and fostering 21st-century skills. Enhancement also means the technology should encourage exploration, questioning, and discovery and foster differentiation and critical thinking. Educators must select flexible technology that provides scaffolding for the learning objectives. Educators should provide clear instructions on the purpose and usage of the technology so the focus remains on attaining learning goals. Finally, for technology to enhance, it must be able to personalize learning. According to Kolb (2019; 2020), if educators see value in technology that does not possess these attributes, they can still use it; they need to adjust their approach (TPK).

The final component of TPACK, extension, capitalizes on ways technology transfers learning outside the classroom (Kolb, 2019; 2020). Research indicates authentic learning aids transfer (Buss, 2018; Koh, Chai & Natarajan, 2018; Niess, 2017; Yildiz Durak, 2021). The Triple E framework embraces authentic learning LATs. Contextual learning also encourages transfer (Koh, 2020). This third component proves ways to foster contextual learning. Enhancement also involves flexibility, scaffolding, clear learning goals, higher-order thinking, and multiple rubrics to encourage extended learning with technology (Kolb, 2019; 2020).

Kolb (2019; 2020) stresses that educational technology should be free, accessible on all devices, and bridge learning from the classroom to the home. Technology should personalize the learning experience and humanize the learning. As with engagement and enhancement, if the technology possesses only some of these extension attributes and educators see value in it, they should adapt their pedagogy to use the technology.

Unfortunately, only one study validated the Triple E Framework and is not peer-reviewed. Schatzke's (2019) dissertation validated Kolb's (2017) rubrics to confirm if the rubrics aided instructors in using appropriate educational technology tools. The study also determined the Triple E framework's rubric reliability. Results were positive and provided evidence that the Triple E rubrics were valid and reliable. Unfortunately, no other known peer-reviewed studies exist regarding implementing the Triple E framework in pre-service coursework. This research also limited the evaluation to iPads and did not consider other forms of educational technology. Further research needs to occur to gain insights into Triple E's impact on pre-service teachers and apply it to various technologies.

CAFÉ

Kolb's (2017) Triple E framework provides scaffolding and technology integration guidance, but Wang's (2021) CAFÉ adds a simplified instructional design process that TPACK lacks. CAFÉ stands for content, activities, facilitation, and evaluation. Wang (2021) recommends that instructors systematically organize their lessons' content for easy access and flow. The researcher suggested organizing content for lessons into modules on an LMS and aligning additional resources with the main content. Wang (2021) also recommended providing a concise list of lessons, course content, and location.

Activities correlate to TPACK's LATs and include reflective, productive, synchronous, and asynchronous activities (Wang, 2021). Wang stressed that LATs' instructions must be clear with obvious learning objectives. Finally, Wang (2021) recommended piloting the LATs before initiating them.

Facilitation refers to peer-content, peer-peer, or instructor-peer delivery of instruction (Wang, 2021). The researcher suggested frequent and various communication methods and regular virtual office hours for students. The researcher also advised instructors to establish regular instruction times for consistency. Finally, instructors should create learning groups to foster collaborative learning.

Evaluation, the final CAFÉ element, should include the LMS assessment. Evaluation should include peer evaluations, graded assignments, projects, and participation ratings. Wang (2021) also suggested formative quizzes and summative assessments.

Given the various research, a clear design gap exists when applying TPACK principles of technology integration (Koh, 2018, 2019). Teachers lack time, resources, experience, and practice to use effective instructional design techniques to create lessons. Although Wang's simplified instructional design model shows promise for educators, the researcher could only provide anecdotal evidence. Further qualitative and quantitative research must determine the framework's effectiveness. Further, no research on this simplified instructional design model exists for pre-service teachers, nor does any evidence exist on potential synergies between the Triple E and CAFÉ frameworks.

Gap in Research

Several gaps and conflicts exist in recent literature. One conflict is the disagreement regarding TPACK definitions and components' weight. The discord creates confusion among educators and course developers. Further, Chai (2018; 2019) uncovered challenges with validated instrumentation to measure pre-service teachers' perceptions of TPACK. Teachers' perceptions determine the success of integrating TPACK principles and transferring skills to the classroom.

Additionally, existing TPACK instruments are self-reports and only measure participants' confidence, not TPACK competencies (Kaplon-Schilis & Lyublinskaya, 2019;2020;). Kaplon-Schilis and Lyublinskaya (2019;2020;) agreed with Koh (2020) that current instruments that measure TPACK have questionable validity and reliability. Kaplon-Schilis and Lyublinskaya (2019;2020;) suggested that the current studies measure each TPACK component rather than applying technology using all components succinctly. A mere measure of individual components does not give a researcher the data to determine educators' TPACK competencies.

Koh, Chai, and Natarajan (2018) noted a lack of comparative studies on TPACK PDs, pre-posttest TPACK interventions, longitudinal data on PDs, and incorporating context. Saubern, Henderson, Heinrich, and Redmond (2020) recommended the following additional research: (a) how teachers transfer TPACK skills to the classroom; (b) how teachers collaborate on technology integration; (c) how metacognition improves teaching and learning with technology; (d) how teachers organize technology-related projects; and (e) how multidisciplinary TPACK improves teaching and learning.

Most research has covered in-service professional development courses, but the literature lacks TPACK undergraduate pre-service courses. All but one study on university TPACK and technology integration courses are at the graduate level. Further, none of the pre-service or in-service studies included student learning outcomes or longitudinal data (Saubern et al., 2020). Saubern et al. (2020) lamented the lack of research on TPACK's application and how it transferred to the classroom. No studies included the time it takes for teachers to design programs or methods they use to design lessons for integrating technology. The body of literature also lacks data on how teachers find, select, align, and apply technology (Kopcha et al., 2020). Koh (2018; 2019) stated that TPACK and technology integration research to date is inconclusive.

Another gap in the literature includes a lack of research on effective simplified instructional design models. Wang (2021) and Kolb (2020) present educators with a simplified instructional design model for integrating technology; however, little evidence exists regarding their impact. Koh (2018; 2019) contended that no validated design model exists to help teachers integrate technology. Koh is the only researcher to provide validated evidence on scaffolding and using rubrics to teach TPACK. In her study, Koh (2018; 2019) admitted that she did not differentiate scaffolding, did not account for student preferences, domains, and design heuristics, and did not develop LATs according to context. In all, further research needs to occur regarding the impact of a TPACK intervention that includes a simplified instructional design model.

Research questions

Central RQ

What are undergraduate pre-service teachers' perceptions of a technology integration micro-course based on TPACK and the Triple E and CAFÉ frameworks?

RQ1

What are undergraduate pre-service teachers' perceptions of using a technology matrix they synthesize with their peers (authentic, collaborative, and participatory learning)?

RQ2

What are undergraduate pre-service teachers' perceptions of using a simplified instructional design process?

RQ3

What changes in attitude on technology and lesson design did pre-service teachers experience after taking the micro-course?

Methodology

A single-case study was appropriate for this investigation because the investigation required a granular group of participants with specific characteristics. Researchers chose purposeful sampling techniques because the population required specific characteristics. (Stake, 2004). The participants needed to be undergraduate education majors with no field experience. Participants also were taking their first education course, so they had no prior academic experience with lesson planning, pedagogy, or applying content.

Researchers collected qualitative data from the open-ended questions on the pre-course questionnaire, weekly discussion group threads, comments from the technology matrix, and the post-course questionnaire's open-ended questions.

All participants were enrolled in XYU's Spring 2022 semester's EDUC XXX introductory course in the foundations of education and had no prior field experience or had worked with TPACK or ID. Participants submitted a questionnaire on demographics and any prior experiences with TPACK concepts. Before starting the micro-course, students took a pre-test to determine TPACK and ID knowledge and skills. Upon completion, participants initiated the six-week asynchronous micro-course. After finishing the micro-course, participants completed a summative post-test aligned with the pre-assessment. Students also submitted a post-course questionnaire reflecting their experiences in the course. D2L served as the platform for all communications, instruction, and assessments.

Ethical considerations

Both researchers have CITI certification and had no financial or other outside benefits from conducting this study. Participants did not receive any financial reward for participating in the study.

Participants

Upon IRB approval, researchers submitted participation requests to 72 students in two Educ XXX courses at XY State University (XYSU). Initially, 34 students signed consent and submitted the pre- TPACK_ID questionnaire, and 24 finished the micro-course and took the post-course survey. Sophomores comprised 48% of the participants, followed by 29% first-year students, 14% juniors, and 9% seniors. English and social studies dominated the subject area with 43,% followed by middle-level education (29%), math and science (23%), music and art (9%), and global languages (3%). Most students resided in the Midatlantic state where XYSU is located, and Educ XXX was the first education course most students had taken.

Development of course
This micro-course aimed to equip pre-service teachers with TPACK and a simplified instructional design model so they can develop blended, hybrid, and online classroom content with fidelity. Evidence has demonstrated teachers' challenges with grasping TPACK and applying it, so the micro-course leveraged two powerful frameworks, Kolb's (2017) Triple E technology integration framework and Wang's (2021) simplified instructional design model CAFÉ. XYSU provided the LMS, D2L, to host the micro-course, and the students took TPACK_ID coinciding EDUC XXX. The learning objectives of the six-week asynchronous intervention were:

- Using TPACK, Triple E, and CAFÉ, students will find and select a minimum of two educational technology applications that will add value to their content and pedagogical approach to a lesson of their choice.
- Students will align these educational technology applications to state and ISTE standards and learning objectives.
- Students will incorporate appropriate evaluation tools leveraging technology to confirm that their students will have achieved the learning objectives.
- Students will align technology, LATs, and assessment to learning outcomes, content, context, and culture and use student-centered pedagogy that fosters critical thinking and 21st-century skills.

The micro-course adhered to evidence-based best andrological practices, including providing multiple communication options and regular updates in the form of news and announcements (Niess, 2017; Yildiz Durak, 2021). The course built upon lower-level skills, which used explicit teacher-centered strategies and leveled up to higher-order thinking tasks that demanded collaboration, creation, and synthesis (Buss,2018; Koh, Chai, & Natarajan, 2018; Niess, 2017; Yildiz Durak, 2021). LATs were authentic, relevant, participatory, and explicit instructions with clear learning objectives (Avci et al., 2020; Buss, 2018; Koh, 2020; Koh, Chai, & Lim, 2016; Koh, Chai, & Natarajan, 2018; Niess, 2017; Rodrigues, 2020).

Course content
Before students could log into the course, they took a pre-course survey which included demographics and questions regarding students' educational experience, educational technology, and course design. The course lasted six weeks and consisted of an estimated two hours per week to review course content and complete the LATs. On Thursday of each week, the course required students to answer a discussion group prompt. On Sunday, the students responded to at least two peers. The students followed the parameters of the discussion group rubric.

Each week of the course contained one module and followed a consistent outline:

I. Welcome and overview of the week's module
II. Review of the last week's content
III. Pre-test of course content
IV. Introduction to new content
V. LAT(s)
VI. Discussion group thread
VII. Post-test

The instructor provided announcements and regular feedback using videos, emails, instant LMS messages, and the LMS announcement system. Students needed to create a one-hour lesson plan within their domain that incorporated a minimum of two educational technology tools. Students also collaborated to synthesize a matrix of technology that became a working document within the course and was available using Google Sheets. Students shared ideas and exchanged valuable information on the technology they had used before or had seen and were classified by domain and recommended grade.

Module 1 & 2
Module 1 welcomed students to the course with a video from the instructor explaining the course expectations and objectives. Students introduced themselves and shared what they wanted to accomplish by taking this micro-course. Module 2 focused on TPACK's foundations and definitions. By the end of the module, students had to identify each primary and secondary TPACK component and explain the intersections and alignments. Students had to start visualizing their lesson and brainstorming ideas for a one-hour lesson incorporating at least two educational technology tools.

Module 3: The Triple E Framework
By the end of this module, students needed to identify Triple E's main components and explain how to adapt technology that had value but did not meet all the Triple E requirements according to the rubrics. LATs included simulations of students applying various instructional strategies that would enhance educational technology. The Triple E presentation included an interactive video using Edpuzzle to increase student engagement. Students also read about available instructional technologies and ways to foster student-centered learning.

Module 4: Analyze & Design
Before introducing students to Wang's (2021) simplified instructional design model, students needed to have an introduction to the foundations of instructional design and its implications for technology. By the end of this module, students needed to find appropriate educational technology for their lesson, evaluate their technology selections and compare them, and align them to the learning objectives they identified for their lesson. Students updated the collaborative educational technology matrix. Students should connect the design process to lesson planning and educational technology.

Module 5: Instructional Design CAFÉ
In this lesson, students identified components of CAFÉ and described the simplified instructional design process. The students aligned TPACK, The Triple E framework components, and CAFÉ's design process to develop their lesson plans. Students created a rough draft of their lesson. The instructor presented the fundamental content in the form of an interactive presentation. Students collaborated on the technology matrix and shared their rough draft lessons for peer review.

Module 6: Reflection
Students reviewed TPACK, Triple E, and CAFÉ concerning their lesson, two of their peers' lessons, and reflective discussion group questions. Students also took a summative assessment equivalent to the pre-tests given throughout the micro-course. Finally, students completed a post-course questionnaire based on Chai, Ko, and Teo's (2019) instrument to measure TPACK competencies for 21st-century learning. The researchers adapted this instrument to reflect the American language and courses offered at universities' education departments.

Data collection and analysis
Out of the 34 participants, 24 remained throughout the study. Data were collected before, during, and after the micro-course. Participants submitted data from (a) a pre-course questionnaire with open-ended questions; (b) discussion group comments; (c) a participant-created technology matrix; (d) a pre-test taken before each module; and (e) a post-course questionnaire including open-ended questions.

Researchers used Atlas.ti qualitative data analysis software to improve objectivity and trustworthiness. The researchers uploaded 94 documents to the software program and created 187 codes, 511 quotations, one memo, and seven networks. Researchers employed a deductive process of coding (Denzin & Lincoln, 1994). Following Stake's (1995) recommendation of direct interpretation, researchers used Atlas.ti to conduct multiple coding iterations, themes and patterns emerged, creating commonalities regarding students' perceptions of TPACK, ID, and the Triple E framework.

Findings

This study described pre-service teacher perceptions of the TPACK_ID micro-course. The data demonstrated that pre-service teachers' perceptions of their ability to find, select, and integrate technology into a lesson exceeded their expectations. Further, the Triple E framework of scaffolding and the simplified instructional design model empowered the participants to become designers of their lessons which aligned with the research (Avci et al., 2020; Koh, 2018; 2019; Koh, 2020; Mishra and Koehler, 2006; Wang, 2021).

Theme 1 Teacher Pre-Post Course Perceptions
Pre-service teacher TPACK perceptions before the course were scattered. Table 2 displays the differences in opinions on TPACK components.

Table 2: *Pre-Course TPACK Perceptions*

Student TPACK Component Preference	TPACK Attitude
CK most important	2
CPK	1

PCK	2
PK	4
TK	2
TPACK components are equally important	11

Note: *n*=22; data from two participants is missing.

Before the course, 11 students believed the TPACK components were of equal value, but the other half displayed a bias for one or more of the components or subcomponents. Most students who did not envision all TPACK components working together believed pedagogy was the more critical element when integrating technology. Pricilla explained,

> I believe the most important component of TPACK is pedagogy. You must have a good preferred instructional strategy to get your students engaged. If you know your content, but your pedagogy is boring, or your students do not understand the content, you must reevaluate and find different ways to connect the students with content.

PCK and CK were also more critical to four other students than the overall equal value of TPACK components. Benjamin argued for CK,

> I believe that content knowledge is the most important component of TPACK. I believe that content is most important because to have effective teaching and to know what technology best fits your classroom, a teacher must be a borderline expert in their field. When you have so much knowledge about a certain topic, I feel as though teaching that topic could become second nature over time. For example, before technology (in modern society, social media, computers, etc.) a good teacher would be a teacher that could effectively teach content knowledge solely based on prior understandings of said knowledge. In today's classrooms, content knowledge is enhanced by using technology to help understand the pedagogy.

Post-course results were resounding. Figure 3 shows the results of students' TPACK attitudes after the six-week micro-course.

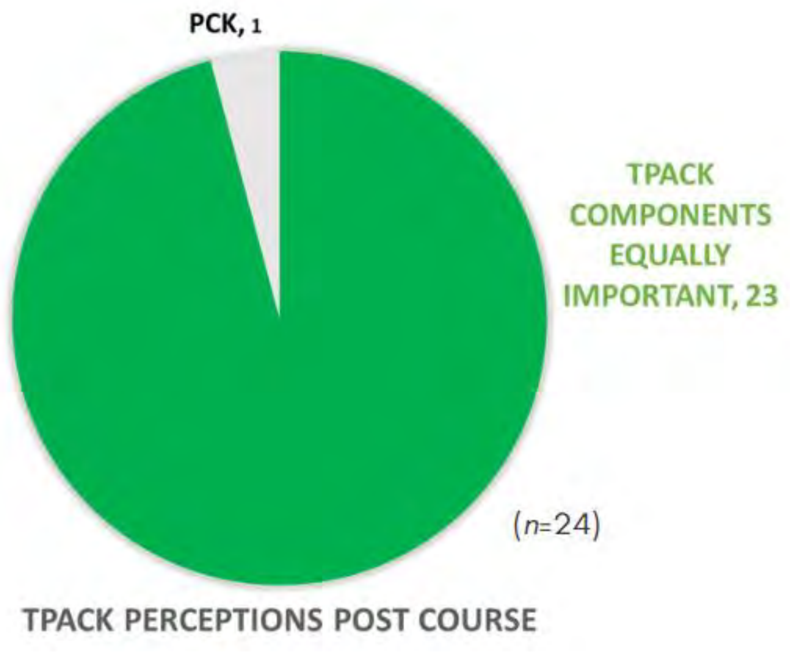

Figure 3: *Post-Course TPACK Attitudes*
Note: *n*=24. Post-course data includes two additional students.

All but one student valued TPACK components equally. John best described the class' consensus,

> I think TPACK itself is going to benefit me after learning about it. Understanding the simple fact that there is a sweet spot and that TPACK is interdependent makes me realize that you need to perfectly design the content technology for the students. If you don't ensure that your pedagogy, content, and technology are all working together properly to inform your students, then one of them could be hurting the other. And the students will not come to grasp with the content as well.

This attitude from most students conflicts with the extant research lamenting that pre-and in-service teachers can identify each component of TPACK but view each component as a separate entity rather than working together (Hofer & Harris, 2019; Kessler & Phillips, 2019; Voogt and McKenney, 2017).

Only one student argued that pedagogical content knowledge was more significant in applying technology to the classroom. His argument was compelling, and he presented evidence from Mishra and Koehler (2006) that could be interpreted as content and pedagogy being more critical than the technology because he stated that the technology needs to be applied based on pedagogy and content; however, what he missed was that pedagogy and content also rely on technology.

Figure 4 represents students' thoughts regarding leveraging TPACK and employing a simplified instructional design model in their lesson plan development.

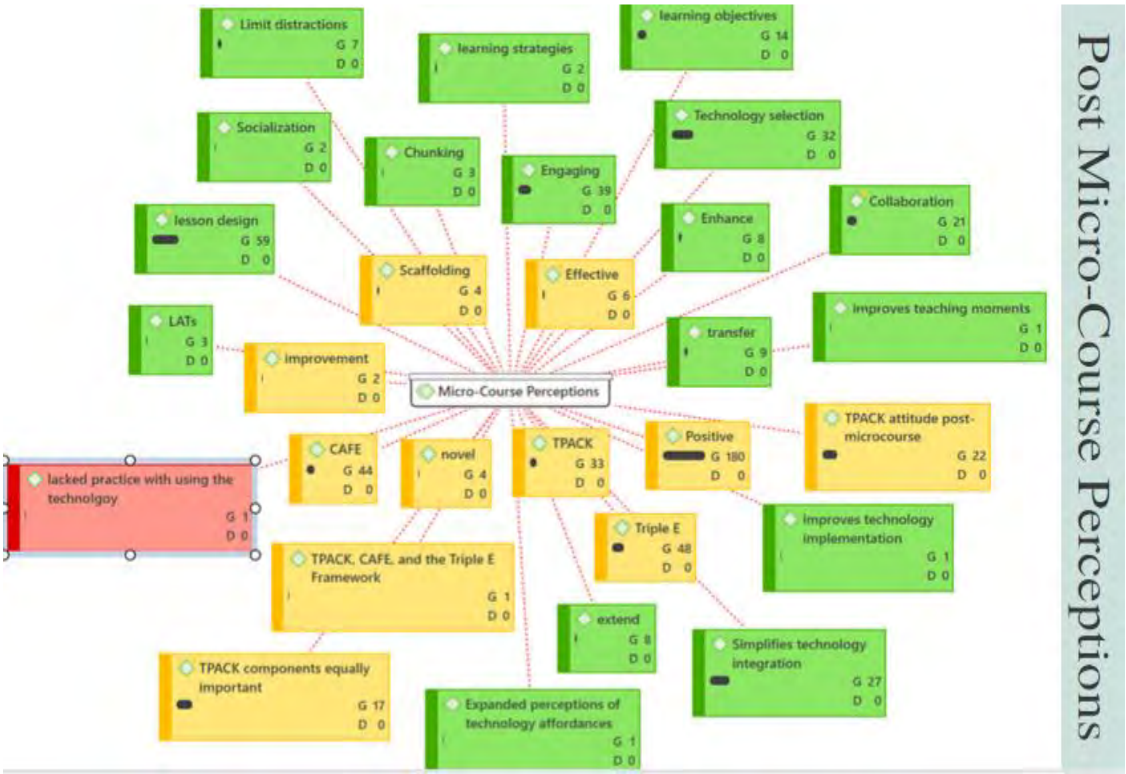

Figure 4: *Teacher TPACK and ID Perceptions Post-Course*

Most students believed they could design a lesson with the new skills they obtained through the micro-course. The research produced 180 positive quotes on the micro-course and its elements and one negative quote. Hope explained,

> This micro-course definitely improved my skills on integrating technology into lesson plans because I didn't know half of the websites, simulators, and other tech stuff that my peers mentioned and throughout each video or document given to us. I thought I knew a lot about technology and how I can use it for teaching, but this micro-course showed me wrong to be honest.

The participants stated they were confident in selecting technology, could apply elements of the simplified design process, and integrate the selected technology. This positive and confident attitude conflicted with the research that indicated pre-and in-service teachers lack the confidence and skills to design lessons (Buss et al., 2018; Kaplon et al., 2019; 2020;)

John believed the Triple E framework would verify that the educational technology he selects would be appropriate and effective,

> The idea of Triple E Framework will be very valuable for my pre-service teaching education. I feel this way because each segment within it: engage, enhance, and extend, is all clear-cut ways to determine if your technology will benefit your students.

Participants believed they could leverage technology to make the lesson engaging, improve collaboration and socialization, and align their tasks and technology to the learning objectives. Claire expounded,

> This micro-course improved my skills on integrating technology into lesson plans by giving me some better understanding of how technology can be incorporated in teaching and how it could still keep students to be engaged with their peers, as well as learn more about the certain subject being taught.

Students valued their new skills of aligning TPACK to learning objectives and strategies and were confident these new skills would enhance learning. Multiple participants noted a new awareness of the possibilities of technology being a distraction. Finally, students saw value in using chunking to improve learning. Daniel explained, “This micro-course showed me how to incorporate different aspects of TPACK into learning objectives and how they all work interchangeably.”

Theme 2: Scaffolding and Simplified Instructional Design
The most significant takeaways involved the Triple E Framework and the affordances of its scaffolding, rubrics, and templates. Figure 5 illustrates students’ confidence in using their new skills.

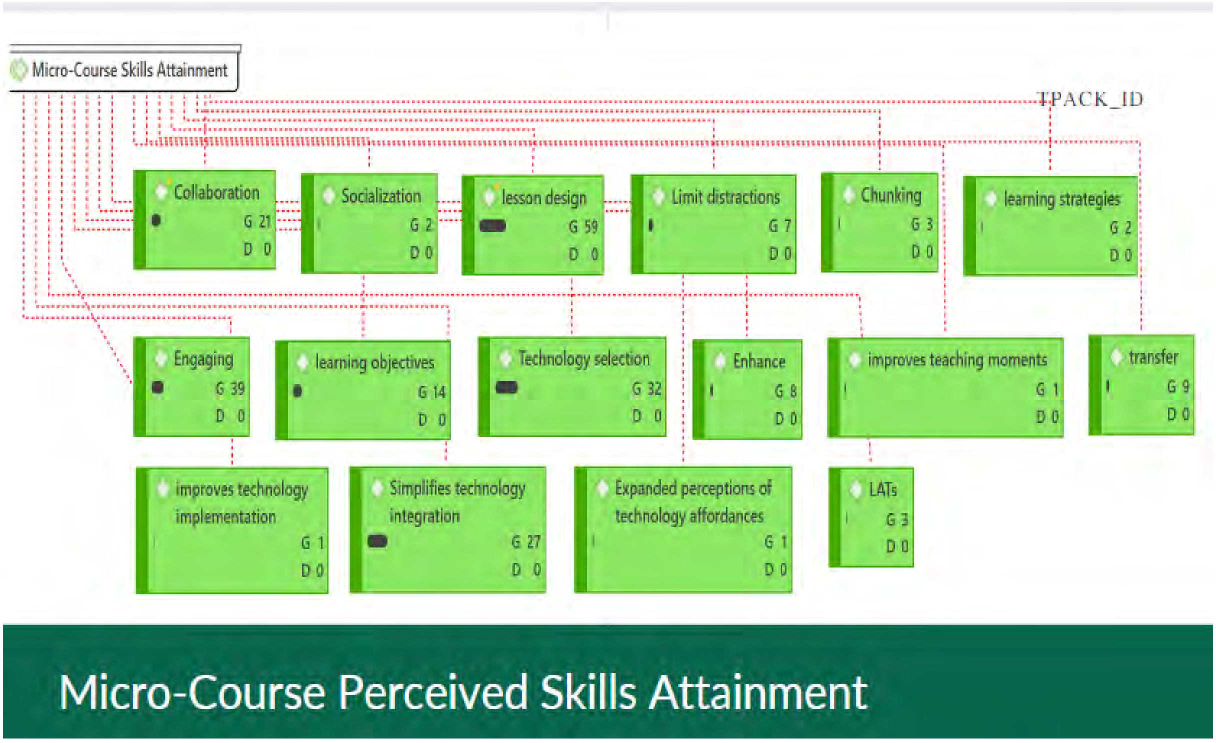

Figure 5: *Participants' Confidence in TPACK_ID Skills*

The students also highly valued the simplified instructional design model CAFE offered. Hope contributed,

> What I found to be the most interesting and valuable concepts for my pre-service teaching education is the CAFE lesson. I just found this to be so interesting, as I have never heard about it before and my mom is a teacher, but this is valuable to me because there is just so many things I can do with it, and incorporate all those aspects to a lesson.

This data negates the previous research that pre-service teachers feel unprepared to design a lesson using technology (Kolb, 2019; 2020; Koh, 2018; 2019; Wang, 2021).

Participants believed that their TPACK would improve their lesson design and plan to apply these principles when teaching. The code "lesson design" appeared 59 times in open-ended responses to students' reflections and post-course questionnaires. Rachel's response typified most of these quotes,

> There are many aspects from the design models that will improve my lesson planning. I have learned how the components of TPACK rely on each other in order to be strong and will use that make my lessons strong. I will select technology that aligns with my learning objectives.

These results align with Koh's (2020) and Wang's (2021) studies demonstrating that lesson design is a critical element of integrating technology into the classroom.

Overall perceptions of elements within the TPACK, Triple E, and CAFE frameworks were positive. The coding included 180 positive comments versus one negative comment. The only negative comment regarding the course was that there needed to be more time to practice using the technology discussed. Abigail stated, "I think if we had more hands-on work with potential technologies it would have been beneficial." The course intentionally left out explicitly teaching the technology students would be using, according to Kopcha et al.'s (2020) research. The course objectives were to provide the foundations of educational technology rather than teach how to use the technology. Given the rapid technological changes, this strategy was important so students would be empowered and capable of selecting any technology, iteration, and application (Kopcha et al., 2020). The course did encourage students to play with and become familiar with the technology, but this student wanted more time embedded in the course to learn about the technology itself. A course focusing on "how-to" is technocentric, and research shows it is counterproductive (Avci et al., 2020; Willis et al., 2019). Students learn how to use the technology but never learn how to find it, select it, and integrate it appropriately. Still, the research also states that teachers are frustrated because they do not have enough time to learn and play with the technology (Avci et al., 2020). Perhaps we need a sweet spot- a balance of using and applying technology. Further iterations of this course could provide insights into allowing more time to learn the technology during the course.

Theme 3 Types of Technology Participants Selected
The collaborative project of creating a sharable technology applications matrix provided a glimpse into the type of technology participants chose. Students demonstrated a variety of new and emerging educational technologies. The educational technology matrix listed the educational technology applications by domain and included the technology's perceived benefits. This matrix improved students' technology integration confirming the extant research (Kopcha et al., 2020; Neiss, 2017; Willis et al., 2019).

Most students who selected the lower-order thinking skills applications re-tooled them to make them collaborative, engaging, and creative and employed creative-thinking best practices (Kolb 2017; 2019). In essence, the students employed 21st-century skills by adapting lower-order thinking applications, one of the course's objectives that aligned with Koh (2018; 2019). Libby described adding a poll to a presentation to make it more interactive and engaging,

> Powerpoint is a way for students to understand that it is now time to learn, and it is also a way for students to be interactive. I can put polls up where students can vote on their phones, and I can use links to videos or games for students to play.

Libby's example of adapting lower-order thinking applications illustrates the Triple E framework's intent to re-tool educational technology to foster higher-order thinking (Kolb, 2017; 2019).

Theme 4: Pre-Service Math Teachers' Perceptions of Integrating Educational Technology
An interesting theme that emerged was the pre-service math teachers' perceptions of integrating technology. Figure 6 displays pre-service math teachers' perceptions of technology before and after the course.

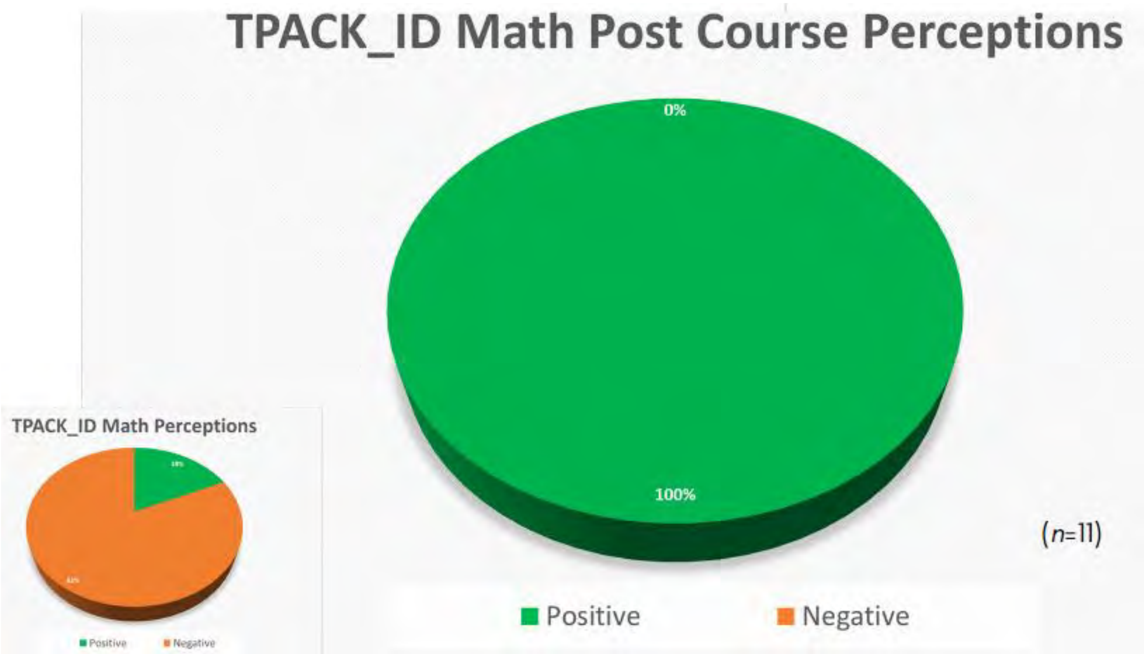

Figure 6: *Pre-service Math Teachers' Technology Perceptions Pre-Post Course*

Before this course, most math pre-service teachers had a negative attitude toward teaching with technology aligned with the literature (Kaplon-Schilis & Lyublinskaya, 2019;2020;). Students referenced using paper and pencil to teach and learn math. Abigail suggested before the course regarding adding technology, "We could use pencil and paper or type in Microsoft Word."

Students willing to integrate technology were more interested in lower-order thinking educational technology applications like digitizing worksheets, cloze exercises, and using videos to teach lessons. Ruth elaborated,

> I feel that it would be very important to use technology to make worksheets that have definitions, fill in the blanks and problems that are left blank so that when I teach I can project the worksheet onto a touch board and fill them in during lecture.

The applications pre-service math teachers promoted before the course were individual rote-learning math games like "Math is Fun." These students also cited sedentary and teacher-centric applications like Khan Academy, YouTube, Excel, and PowerPoint, which aligned with the literature (Kaplon-Schilis, & Lyublinskaya, 2019;2020;).

Phoebe noted that secondary and post-secondary math classes do not incorporate technology except for PowerPoints or videos. Phoebe continued,

> Most of my math classes have used little to no technology in any part of the semester. The teacher would have a sheet of paper with notes written down, which they would transfer to the dry-erase board, which you as a student would copy down into your notes.

Hope was vehement about using technology in the math classroom,

> I would be against anything like Ipads or chrome books, as those can be a distraction to the students unless they have blocked websites or such. For this age group, I would say a projector in the classroom would be appropriate. Math majors agreed that elementary school was too young to incorporate technology but thought middle school or secondary education would be an appropriate time to introduce technology.

This reluctance to use technology aligns with the research (Kaplon-Schilis & Lyublinskaya, 2019;2020;). Students explained that they learned math with paper and pencil; their professors still teach math with paper and pencil, and just like the literature states, they will teach the way they learn comfortably.

Post-course results were remarkable. By the end of TPACK_ID, all pre-service math teachers displayed a positive attitude regarding using technology in the classroom. Further, pre-service math teachers contributed more educational technology applications than any other domain indicating a significant change from preferring paper and pencil to innovation. Pre-service math teachers promoted applications that empowered learners to create. Phoebe explained how one of her educational technology applications would work to help students be creative while learning math, "The student will create shapes of symmetry will be addressed in the Symmetry Artist activity on math is fun by allowing them to access a higher level of learning and actually create something."

Like the general population, the pre-service math teachers also adapted technology to incorporate 21st-century skills. Students adapted individual rote-learning educational technology games to be collaborative and played among teams. Almost all students incorporated Kahoot into their lesson plans because, as students, they enjoyed the program and found value in the gamification of learning. Elizabeth noted Kahoot would "get students thinking on their feet in a more competitive way."

Discussion

This research is significant because, empirically, little to no qualitative research exists on TPACK's transfer (Avci et al., 2020; Koh, 2020; 2019; Saubern et al., 2020). Most of the research is quantitative, and the instruments used are self-reports limiting their trustworthiness. This study provides rich and thick details on pre-service teachers' perceptions of applying these concepts to lesson plans. By incorporating the micro-course concepts into the micro-course, the instructor could model the TPACK, Triple E, and CAFE concepts the participants needed to use in their lessons. The micro-course embraced collaborative, engaging, interactive, and higher-order thinking educational technology and pedagogy displayed positive results, which aligns with the research (Avci et al., 2020; Buss, 2018; Koh, 2020; Koh, Chai, & Lim, 2016; Koh, Chai, & Natarajan, 2018; Niess, 2017; Rodrigues, 2020). Since the micro-course modeled best practices, students incorporated similar technology and pedagogy into their content area. The data confirmed the research regarding the importance of modeling, and the students' comments post-course reflected this modeling.

No research exists on an intervention that combines TPACK, evidence-based scaffolding, and a simplified instructional design model. The extant literature quantitatively and separately demonstrates that each model aids teachers with technology integration, but no research study combines the TPACK principles, scaffolding, and a simplified ID model. Research confirms the need for all elements (Kolb, 2017; Mishra & Koehler, 2006; Wang, 2021). Mishra and Koehler (2006) stressed that teachers must be designers to integrate technology effectively. This micro-course demonstrated how applying scaffolding and a simplified ID model to the TPACK principles guided pre-service teachers in creating effective lessons.

Theoretically, very little peer-reviewed research exists on an exceptional model that provides scaffolding for teachers leveraging TPACK and effectively integrating technology (Koh, 2019). No research exists on Wang's simplified instructional design model that he developed for emergency online learning during COVID. The initial responses to Wang's CAFE model were positive and encouraging.

Implications

Given the results from the pre-service math participants, elementary, secondary, and post-secondary math instructors should consider incorporating higher-order thinking educational technology applications. Modeling is important because research shows that students tend to embrace the pedagogy that helped them learn. When math students do not see value in adding technology because their previous teachers did not embrace it, the likelihood of them using technology in their classrooms diminishes.

Teaching colleges must incorporate TPACK, scaffolding, and instructional design into their curriculum. Research provides multiple ways universities can incorporate technology (Buss, 2018; Kaplon-Schilis & Lyublinskaya, 2019;2020;). This micro-course provides one way universities can provide skills coinciding with a foundation in education course. By incorporating this micro-course into a foundation of education class, professors could incorporate concepts into the main course, which would enhance learning and help students embrace technology. The micro-course also provides exceptional scaffolding, modeling, and a simplified lesson design process using technology.

Limitations of Study and Future Research

The nature of a case study is not generalizable. The study was limited to a medium-sized university with pre-service teachers in their first education course. Further investigation with universities of multiple sizes and varying levels of students is needed. Further, limited research exists on in-service teacher interventions using a combination of scaffolding and simplified ID to integrate technology. Future research should extend this study to in-service teachers.

Incomplete data and attrition were limitations of this study. Two of the participants did not submit their pre-service questionnaires. The researchers extracted their data from the discussion threads that contained similar questions. Further, many students dropped out of the study mid-way into the course due to other commitments. Some of these students were very active in the discussion threads, and rich data had to be eliminated.

Future research should focus on quantitatively measuring TPACK skills attainment. All current instruments are self-reports that lack trustworthiness. Future quantitative research should also investigate the effectiveness of the Triple E frameworks' templates and rubrics. Multiple research studies call for scaffolding, and this study provided detailed positive responses to using these rubrics and templates. Quantitative research would verify the effectiveness of Triple E's scaffolding.

Finally, further research should measure the effectiveness of Wang's simplified ID model, CAFE, and verify the one research study that validated the Triple E framework (Schatzke, E. (2019). At the time of this study, no quantitative or qualitative research verified or extended Wang's model. Schatzke (2019) was the only peer-reviewed study to validate the effectiveness of the Triple E framework, and the research was conducted on in-service teachers. Further research would validate Schatzke's (2019) research and confirm the effectiveness of a simplified ID model that pre-service and in-service teachers could effectively use to integrate technology.

Conclusion

Pre-service teachers graduate with little to no practice in integrating technology. Further, pre-service and in-service have a skewed perception of educational technology and its appropriate use. Many educators have a techno*centric* or techno*phobic* view of technology in the classroom, but few see the importance of weaving technology into the lessons. This research study suggests that by combining TPACK, the Triple E framework, and CAFE, pre-service teachers had the necessary tools to design, develop, and evaluate a lesson incorporating effective technology and pedagogy based on learning objectives. Further, TPACK_ID dispelled the technocentric attitude most teachers report by encouraging participants to design their lessons with all TPACK components working in harmony.

As the findings from the data constrained to this research uphold, combining the TPACK, the Triple E framework, and CAFE models enabled participants to consider technology, pedagogy, and content in their lesson plans. While further research will provide insights into data outside the scope of this work, these insights will prove to inform the trajectory of future data collection, research, and programmatic recommendations.

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