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# The effects of a gamified online course on pre-service teachers' confidence, intention, and motivation in integrating technology into teaching

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## Abstract

Teachers are gatekeepers of technology integration in the classroom. Pre-service teachers' attitudes, confidence, and competence in exploring emerging technologies play a critical role in teachers' adoption of technology in teaching. This study examined the effects of a gamified technology course on pre-service teachers' confidence, intention, and motivation in integrating technology into teaching. A sample of pre-service teachers (N = 84) at a Midwestern university in the United States in the academic year of 2021–22 was surveyed. The regression results revealed that the gamified course significantly and positively influenced pre-service teachers' confidence in using technology in education, intention to adopt gamification, and motivation to explore more emerging technologies for teaching, after controlling for gender. In contrast, gender did not affect pre-service teachers' confidence, intention, and motivation in integrating technology into instruction after controlling for the gamified course effects. Suggestions on gamifying course design while leveraging quest-based learning and active learning principles to enhance student positive attitudes and motivation to explore technology integration are discussed.

**Keywords** Teacher preparation · Technology education · Quest-based learning · Pre-service teachers · Gamification · Gamified · Online course

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## 1 Introduction

Teachers are gatekeepers of technology in the classroom contexts of teaching; and their choice, curation, safeguarding, and implementation of technology directly impact how students approach the task of learning. Theories and practices notwithstanding, pre-service teachers' ongoing development of knowledge, confidence, and skills in integrating technology into instruction during teacher preparation is of critical importance because their experience in learning about technology sets the foundation for competency-building and affinity toward technology integration.

When a teacher preparation technology course is poorly designed and taught, pre-service teachers may become misinformed about the utility and role of technology, placing too much value on the adverse effects of technology, losing confidence in navigating technologies, and shunning the use of technology in future teaching. Ideally during teacher preparation, teacher educators should guide pre-service teachers in technology integration where emerging technologies are leveraged in meaningful and creative ways to assist in teaching and learning.

## 2 Research purpose

Zooming in on the scope of technology education in teacher preparation, the purpose of the study is to examine pre-service teachers' confidence and motivation resultant from taking a gamified technology course. The course titled "Technological Applications in Education" is a required course for all pre-service teachers seeking to complete requirements for the state teaching licensure. The course instruction is designed based on a gamification pedagogy that integrates quest-based learning and active learning approaches. The current study aims to examine whether this gamified course and gender influence pre-service teachers' confidence, intention, and motivation to use technology in teaching.

The following research questions guide the investigation of this study:

1. Does the gamified course significantly affect pre-service teachers' confidence in technology integration, intention to adopt gamification, and motivation to explore emerging technologies for teaching?
2. Does gender significantly affect pre-service teachers' confidence in technology integration, intention to adopt gamification, and motivation to explore emerging technologies for teaching?

### 2.1 Benefits of gamification

Gamification refers to the incorporation of game-design elements or mechanisms, such as points, badges, rewards, leaderboard, and competitions, in non-game contexts with an objective to motivate users or encourage specific behaviors (Blok et al., 2021). As a strategy to encourage students to learn as they play, gamification is

gaining popularity in education, as it adds elements of fun and entertaining to the learning process and make learning enjoyable and memorable (Huang & Soman, 2013). Many educators and researchers believe that integrations of well-designed game-based learning and gamification in education may have the potential to revolutionize teaching and learning.

Gamification has been adopted to support learning in a broad spectrum of educational contexts, such as business, education, and physics, computer science, etc. A Google Scholar search of 'gamification in education' generated more than 30 million entries. A growing body of research has documented that gamified learning has the potential to promote motivation and engagement (Chan et al., 2019; Facey-Shaw et al., 2017), enhance knowledge retention (Harrington & Mellors, 2021; Woolwine et al., 2019), encourage positive attitudes towards learning (Frącz, 2015; Varannai et al., 2017), and increase resilience to failure (McGonigal, 2011; Nussbaum, 2013). Of crucial importance is the clear connection between these positive impacts of gamification and enhanced student learning. As Gabe Zichermann noted, cited by (Giang, 2013), that the use of game mechanics improves the abilities to learn new skills by 40%. Although there are successful gamification examples, many gamification projects fail due to poor design. Despite the importance of thoughtful design of gamification, the gap of gamification literature persists as previous research on gamification in education has not paid sufficient attention to the design aspect, focusing on whether adding one or more game elements makes any difference (An, 2020).

### 2.2 Quest-based learning and gamification pedagogy

According to Van Eck (2015), there are four implementation approaches for digital game-based learning. While using teacher-designed and student-designed games are more labor and time-intensive approaches, he recommends using the gamification mechanism as a starting point, and it is the approach that is gaining steam in many realms, including corporate, military, and education settings (p. 22).

By definition, quest-based learning (QBL) is an "instructional design theory of game-based learning that focuses on student activity choice within the curriculum" (Haskell, 2012, p. vi). Hirumi et al. (2010a, b, c) and Yilmaz and Cagiltay (2016) discussed the intersections between instructional design and game design and advocated game-based learning as an engaging mechanism to facilitate learning for students. The challenges lie in maintaining learner motivation and designing effective assessment in the game-like learning environments. Snelson (2021) summarized QBL as a form of gamification where game elements are applied to the learning context as a form of game-based learning to motivate and engage learners, or simply as quest-based learning. Philpott and Son (2022) studied 89 participants in an English as a foreign language class in Japan and found QBL overwhelmingly boosted their intrinsic motivation to learn English and they perceived QBL positively, for reasons being QBL made learning suitably challenging, interpersonally meaningful, and supporting autonomy through quest choice.

The total number of quests has increased from 14 to 26 to mirror the changing landscape of educational technology and the expanding scope of emerging technologies

for teaching and learning, including exploratory themes such as the Internet of Things, artificial intelligence, educational coding, and 3D printing. The 26 quests introduce students to an array of technology tools useful for conducting presentations, video conferencing, graphic design, website development, assessment, and social networking, to name a few. The increment in quest choices also gives students more freedom of choice and personalized instruction in terms of pursuing quests that introduce technologies appropriate to each student's unique context of teaching. Students can choose quests to complete based on interests and expertise, and they don't need to do all 26 quests to pass the course. For instance, special education pre-service teachers have gravitated toward completing the assistive technology quest, as the quest addresses the needs of special education students. The Google quest has been popular among students, as the majority of them have pre-existing familiarity with the Google suite of tools from their schooling experience in high school. The coding quest, game quest, and Google form quest offer advanced options so students, driven by intrinsic motivation, may delve deeper into educational game design tools or use poll results and analyze student learning outcomes. The design and implementation of QBL by the instructor/research of this study resonate with the gamification principle where it "creates multiple assignment options—more points are required to demonstrate mastery—and creates frequent assessment opportunities that are graduated in difficulty" (Van Eck, 2015, p. 22).

As a gamification mechanism, the course uses experience points (Exp) as the basis for assessing student learning. The rationale is that students, in completing assignments, can work their way up (level up) in accumulating targeted experiences as they explore self-selected quest technologies potentially useful in their classroom teaching. The quests are optional in the sense that students can choose to take on the quests that appeal to their interest and background of expertise. Students can curate their learning experience by interest, by return on investment (via evaluating what technology is worth their time investigating and what works in their teaching), and there are multiple routes to achieving success, this personalized learning experience being another prominent feature of gamification.

Students never fail in the course, because they can always revise (revive in the game terminology) and re-submit assignments to earn back deduced credit or to obtain extra credit, equivalent to taking on an in-game challenge again and again until they succeed, with a heightened sense of accomplishment. Digital games are built with optimal challenges to encourage players to return repeatedly to obstacles until they overcome them (Gee, 2003). By the same token, students in a course are not punished for submitting sub-par work but are given, if not more, unlimited opportunities to "play again" and be guided by the instructor to success. One should note that by allowing students unlimited re-submissions, a teacher's workload on grading will substantially increase. Nevertheless, the accrued benefits of such mechanism on student motivation and learning outweigh the labor.

### 2.3 Active learning and gamification pedagogy

Active learning is defined "in contrast to the worst of traditional teaching in which teachers actively present information and students passively receive it" (Meyers &

Jones, 1993, p.19). Active learning can be any instruction method that engages students in the learning process, including problem-based, discovery-based, inquiry-based, project-based, and case-based approaches (Cattaneo, 2017). Regardless of the various approaches, a pedagogy for active learning focuses on learner-centered and team-based instructional methods to engage students in learning. The benefits of active learning have been evidenced in teaching and learning across a diversity of disciplines. Students were found to have a better understanding of new knowledge, higher levels of cognitive achievements, improved knowledge transformability, and increased critical thinking abilities (Michael, 2006; Revell et al., 2020). Rincon-Flores and Santos-Guevara (2021) found two gamified undergraduate courses designed with a reward system motivated students as active learners and improved their academic performance in the synchronous online modality during the academic confinement of Covid-19 pandemic. Allsop et al. (2020) conducted a quasi-experimental study on 45 undergraduate students and found in addition to engagement and participation, active learning classrooms promoted added aspects of learning in communication, interactivity, satisfaction, flexibility, and connectedness.

The core elements of active learning pedagogy are twofold. First, course activities are designed to make students direct their learning and actively acquire knowledge rather than passively receive knowledge (Major, 2020; Chi, 2009; Petress, 2008). Active learning is based on the constructivism framework, where students build new knowledge based on their previous knowledge through critical thinking and learning experiences (Cattaneo, 2017; Ford, 2010). Accordingly, the instructor's role needs to be as coach and mentor, but not a leader and dictator. Instructors need to design a course with learner-centered objectives in mind. Second, teaching and learning activities engage students mentally and physically in the learning process. These activities include but are not limited to small groups, inquiry-based instruction, problem-solving tasks, self-regulated learning activities involving exploration and reflection, and cooperative/collaborative student projects involving students' interaction and collaboration (Michael, 2006; Nguyen et al., 2021).

The QBL assignment structure in the gamified technology online course promotes AL because students self-direct learning by exploring both required missions and also self-chosen quest technologies unique to their context of teaching and target audience. The instructor of the course takes on the role of facilitator with the aim of providing just-in-time and on-demand information to students needing course-related assistance. In essence, the principles of QBL and AL work in tandem in the online technology course, as students are spurred to actively make decisions and take ownership over their paths in creatively learning the world of technologies, whereas the facilitating instructor provides the multi-route roadmap, prompt guidance and feedback, and limitless encouragement as strategies to sustain the fun and momentum in learning.

## 3 Course contents

The undergraduate-level course, "Technological Applications in Education," is the only required technology-themed course for pre-service teachers during their four years of teacher preparation, amplifying the importance of this sole course in

gearing teachers with the understanding of technology integration in the classroom. It is designed to equip pre-service teachers with a developing toolset of technologies appropriate for classroom instruction and a malleable mindset of coping with issues in technology integration.

Over the years of iteration, the instructors have collectively designed contents, updated technologies, and improved assessment structure. Delivery modality of the course used to be hybrid with a mixture of face-to-face and online sessions but has recently morphed into fully online due to the ongoing COVID-19 pandemic. Synchronous online sessions were conducted to enrich instructor and student interactions, and asynchronous online sessions were used to provide flexibility and facilitate pedagogy of the flipped classroom.

The course contents align well with the requirements of the International Society for Technology in Education (ISTE) standards for educators, with the aim to prepare pre-service teachers in becoming technology leaders who can model usage and promote utility of technology in their school settings. The course encompasses effectively identifying, locating, evaluating, designing, preparing, and efficiently using educational technology as instructional resources in the classroom as related to the principles of learning and teaching in an inclusive classroom. Students learn to use a variety of technology to develop and enhance classroom instruction, communication, and classroom management. Students demonstrate their knowledge by completing a culminating project and comprehensive portfolio on livetext.com.

By completing this course, students are able to:

- Use technology applications commonly found in educational settings and how to apply these applications.
- Develop both confidence and competency in the use of computers in various learning environments.
- Demonstrate how technology is used to increase the effectiveness, efficiency, and appeal of instruction to diverse learners.

Accordingly, pre-service teachers' confidence in using technology, intention to adopt gamification, and motivations to explore more emerging technologies in teaching were used as the dependent variables in the current study.

## 4 Gamified course design

The main principle of course design and instruction lie in gamification pedagogy while combining tenets of quest-based learning (QBL) and active learning (AL). Below are discussions regarding how class assignments designed with QBL and AL tenets are used as formative assessments to enhance pre-service teachers' confidence and motivation in using technology.

In this course, students are required to complete five missions including:

1. Lesson planning—Core activity for teachers to complete as pre-service, internship, and in-service teachers.

2. Design a professional website—Design work to engage out-of-class professional use of web resources, create digital presence, and network.
3. Create an online course introductory video—Develop a fundamental skillset in video production and managing learning managing system (LMS) in teaching online as an alternative when in-person teaching is undesirable.
4. Weekly reflection—Deep learning occurs when teachers engage in a habitual practice of reflection-in-action and post-action.
5. Livetext portfolio—Culminating project requiring students to thoughtfully compile evidence of learning based on completed assignments that speak to their growth in technology integration while concurrently addressing ISTE for educator standards.

The five missions were designed to reflect the quintessential activities teachers will undertake on a daily basis. They are termed as missions and not quests because the intent is to require students to complete all five missions to gain skills in lesson planning, building a digital portfolio, conducting reflection in teaching, whereas quests are self-selected in accordance with pre-service teachers' interest, subject area expertise, and personalization. The five missions are required tasks that aim to help pre-service teachers develop a lens through which they learn to leverage information and communication technological applications for the purpose of reflecting on and improving practices of teaching and learning.

## 5 Method

The current study used a series of multiple regressions to examine whether students' perception of the gamified course design and gender significantly affect undergraduate pre-service teachers' confidence in using technology in teaching, intention to adopt gamification in teaching, and motivation to explore more emerging technologies for teaching, respectively. Accordingly, pre-service teachers' gender and perception of this gamified course were the independent variables, whereas pre-service teachers' confidence, intention of adoption, and motivation were the dependent variables.

### 5.1 Sample and sampling

Pre-service teachers who took the course titled *Technological Applications in Education* in the Fall, Spring, and Summer semester in the academic year of 2021–2022 were invited to participate in this study on a voluntary basis. Enrolled students in the course included, by and large, an evenly distributed proportion of freshman, sophomore, junior, and senior undergraduates majoring in early childhood education, adult, and young adolescent studies, integrated social studies, special education, middle childhood education, language arts, etc., in the Department of Teacher Education in a large Midwestern university in the United States.

### 5.2 Instrument and administration

A self-developed survey with 14 items was used in this study, with 8 items measuring pre-service teachers' perception of the gamified course, 5 items measuring students' confidence in using technology in teaching, 1 item measuring pre-service teachers' intention to adopt gamification in teaching, and 1 item measuring pre-service teachers' motivation to explore more emerging technologies for teaching (see Appendix A). All items used a 5-point Likert scale with "1" indicating "strongly disagree" and "5" indicating "strongly agree." The survey was administrated online via Qualtrics. A link of the online survey was sent to participants at the end of each semester. A total of 84 pre-service teachers completed the survey.

### 5.3 Reliability and validity

After the first author developed the 14-item survey, the two co-authors reviewed all items for face validity and content validity. Feedback was incorporated to improve the survey items of the study. The internal reliability analysis results indicated that the Cronbach's alpha based on standardized items was as good as 0.74 for the scale of course design and 0.82 for the scale of confidence. Therefore, scale scores were generated by averaging all item scores across each scale and were used in the following regression analysis in SPSS28.

## 6 Results

In the sample, female pre-service teachers took up to 69% (N = 58), whereas male pre-service teachers took up to 31% (N = 26). The mean was 4.62 on a 5-point scale for pre-service teachers' perception of the gamified course design, 4.58 for pre-service teachers' confidence in using technology in teaching, 4.49 for pre-service teachers' intention to adopt gamification in teaching, and 4.57 for pre-service teachers' motivation to explore more emerging technologies for teaching.

### 6.1 Correlations of all variables

The correlation analysis results (Table 1) showed that the bivariate relationship between pre-service teachers' perception of the gamified course design and confidence in using technology was the largest at.72 ($p < 0.001$). The correlation between course design and motivation to explore more technologies was as large as 0.62 ($p < 0.001$), whereas the correlation between course design and pre-service teachers' intention to adopt gamification was still strong but slightly smaller at 0.53 ($p < 0.001$). Gender had no significant relationship to any other variables in the study.

**Table 1** Bivariate correlations of all variables in the study

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 1 Gender | – | | | | |
| 2 Gamified Course Design | –.16 | – | | | |
| 3 Confidence | –.21 | .72** | – | | |
| 4 Adoption | –.10 | .53** | .48** | – | |
| 5 Motivation | .01 | .62** | .62** | .49** | – |
| *Means* | | *4.62* | *4.58* | *4.49* | *4.57* |
| *Standard Deviations* | | *.37* | *.49* | *.70* | *.65* |

$N = 84$; ** indicating $p$-value < .001

### 6.2 Factors of pre-service teachers' confidence in using technology

The effects of gender and the gamified course design on pre-service teachers' confidence in using technology in teaching were examined using multiple regression techniques (see Table 2). The results indicated that there was no gender difference in pre-service teachers' confidence in using technology in teaching ($p > 0.05$), after controlling for the course design effect. By contrast, pre-service teachers' perception of the gamified course design significantly and positively predicted their confidence in using technology in teaching ($b = 0.92$, $p < 0.001$, $R^2 = 0.53$), after controlling for the gender effect. The R square was as large as 0.53, indicating approximately 53% of the variances in pre-service teachers' confidence in using technology were explained by this gamified course.

### 6.3 Factors of pre-service teachers' intention to adopt gamification

The effects of gender and the gamified course design on pre-service teachers' intention to adopt gamification were also examined using multiple regression (see Table 3). The results showed no gender difference in pre-service teachers' intention of adopting gamification in teaching ($p > 0.05$), after controlling for the course design effect. In contrast, the course design positively and significantly predicted pre-service teachers' intention to adopt gamification ($b = 1.00$, $p < 0.001$, $R^2 = 0.28$), after controlling for the gender effect. The R square at 0.28

**Table 2** Multiple regression results on pre-service teachers' confidence in using technology

| | Unstandardized coefficients | | Standardized coefficients | | |
|---|---|---|---|---|---|
| | B | SE | Beta | t | *p*-value |
| Gender | –.11 | .08 | –.10 | –1.32 | .19 |
| Course Design | .92 | .10 | .70 | 9.05 | < .001 |

Constant = .46; $F(2, 81) = 44.84$, $p < .001$; $R^2 = .53$

**Table 3** Multiple regression results on pre-service teachers' intention to adopt gamification

| | Unstandardized coefficients | | Standardized coefficients | | |
|---|---|---|---|---|---|
| | B | SE | Beta | *t* | *p*-value |
| Gender | –.03 | .14 | –.02 | –.17 | .87 |
| Course Design | 1.00 | .18 | .53 | 5.51 | < .001 |

Constant = –.08; F (2, 81) = 15.71, $p < .001$; $R^2 = .28$

**Table 4** Multiple regression results on pre-service teachers' motivation to explore technologies

| | Unstandardized coefficients | | Standardized coefficients | | |
|---|---|---|---|---|---|
| | B | SE | Beta | *t* | *p*-value |
| Gender | .15 | .12 | .11 | 1.20 | .24 |
| Course Design | 1.10 | .15 | .63 | 7.18 | < .001 |

Constant = –.70; F (2, 81) = 25.75, $p < .001$; $R^2 = .39$

indicated about 28% of the variances in pre-service teachers' intention to adopt gamification were explained by this gamified course.

### 6.4 Factors of pre-service teachers' motivation to explore technologies

The effects of course design and gender on pre-service teachers' motivation to explore more emerging technologies in teaching were examined using multiple regression analysis (see Table 4). The results indicated no gender difference in pre-service teachers' motivation to explore more emerging technologies for teaching ($p > 0.05$), after controlling for the course design effect. However, course design significantly and positively predicted pre-service teachers' motivation ($b = 1.10$, $p < 0.001$, $R^2 = 0.39$), after controlling for the gender effect. The R square results indicated approximately 39% of the variances in pre-service teachers' motivation to explore more emerging technologies were explained by this gamified course.

## 7 Discussions

According to the results of the study, this gamified course based on quest-based learning (QBL) and active learning (AL) has largely and positively influenced pre-service teachers' confidence, intention, and motivation to use technologies in teaching, implying the great success of gamification pedagogy in constructing pre-service teachers' optimal attitudes toward technology integration in their future teaching.

Collectively, the online technology course design rendered principles of QBL in gamification and promoted AL by placing more responsibility on the learners. Many pre-service teachers came into the course indicating their lack of confidence in using

technology in teaching, but they did not realize that their existing technology skills in information and communication technology (ICT) can serve as a good foundation upon which they can build skills in integrating technology in educational settings. The gamified online course bridged the gap by allowing pre-service teachers to digitally sample, experiment, evaluate, and reflect on a range of emerging technologies and their role and utility in the classroom. QBL gives students options on assignments, personalized learning, multiple routes to success, and unlimited chances to revise work. AL helps students take ownership and responsibility to learn course contents on a self-regulated pace. Through routine weekly technology explorations, these pre-service teachers were able to accumulate experience and boost confidence in using technologies in education; subsequently their motivation to look into more technologies pertinent to their unique context of teaching would increase. The gamified structure of the online technology course is the first model/experience of gamified instruction for almost all of these pre-service teachers, and their overall positive experience of this gamified course may in turn enhance their intention of adopting gamification in course design in their future teaching.

Pre-service teachers are novices when it comes to pedagogy and skills in using technology in teaching. Their lack of experience in real-time classroom teaching is a given and should not be treated as a deficit but as an opportunity to foster a sound base of content knowledge, instructional strategies, and technology integration skills. The gamified design of the technology course for pre-service teachers has proved effective in multiple modalities in face-to-face, online, and hybrid instructions. Therefore, like-minded educators can adopt and apply QBL and AL in their teaching in higher education.

The instructor/researcher of this gamified technology course does not subscribe to the notion that pre-service teachers are empty receptacles to be fed with knowledge. Instead, these pre-service teachers have valuable personal experience with ICT that can be leveraged to their advantage in learning about educational technology. For instance, some pre-service teachers are apt at video production via recreational usage of TikTok and uploading videos to YouTube, and their familiarity with such tools gives them an edge in online education, where they can pre-record video lectures and facilitate the flipped classroom model of instruction. Pre-service teachers prone to art and design can use synchronous concept mapping tools to facilitate class discussions. They can use graphic design and web-authoring tools to design websites to engage students in learning outside of the classroom. Some pre-service teachers found coding tools useful and designed games that can teach content. These instances speak volume about the evidence of empowerment of our next generation teachers who are tech-savvy, adventurous, and creative explorers of emerging technologies.

Findings of this current study indicated that both males and females are by and large at a level playing field, after taking the gamified technology course, as both genders were found to be positive in increased confidence in using technology, intent on adoption of gamification, and motivation to explore more emerging technologies in future teaching. Participants' perception of this gamified course was as large as 4.62 on a 5-point scale and with a small standard deviation at 0.37. Participants'

comments in teaching evaluation attest to their positive perceptions of the gamified technology online course:

> Allowed us to complete quests that we chose from. Had clear instructions and always sent an email every week!
> Very positive, encouraging attitude. The Google pages that contained all of our course content was incredibly organized.
> The real-life applications the different tech tools we explored were very helpful in understanding technology's place in the classroom.
> A low stress class with a highly valuable outcome!
> I really enjoyed this class and found the different quests fun and a great thing to implement into teaching in the future.

Within the confines of this current study, the pedagogical approach of gamification incorporating QBL and AL proved to be effective in inducing these 84 pre-service teachers' increased confidence in using technology in teaching, intention to adopt gamification in teaching, and motivation to explore more emerging technologies for teaching. The finding that no gender difference was found for this group of 84 pre-service teachers was intriguing and countered prior literature where findings indicate females have less positive attitudes and utility toward technology (Cai et al., 2017; Goswami & Dutta, 2015; Park et al., 2019; Yau & Cheng, 2012). Prior research found that compared to males, females tend not to enjoy ICT and digital games as much, and consequently do not support the role for such technologies in classroom teaching (Marangunić & Granić, 2015; Teo et al., 2015; Venkatesh & Morris, 2000).

Limitations of this study include a small sample size and self-developed measures, rendering the generalizability of the study limited. The researcher-developed instrument needs to be tested in more studies for validation, and multiple items should be developed to replace the single-item measurement of intention and motivation to using technology.

## 8 Conclusion

Though in the current study, the gamified pedagogy seems to be effective, a full-scale digital game-based learning approach seems a logical step/experiment further in increasing the efficacy of using game-ful pedagogy to teach generic topics of technology. The game is not over yet, as the work in preparing teachers to teach with technology is certainly not done. Potential improvements for the gamified course are raised by study participants in the following areas:

1. Setting specific due dates for quests—This is an interesting notion, as the nature of the quests was optional and self-paced. However, some students do not enjoy open-ended quests, tend to procrastinate, and prefer to work with "strict" pre-

determined due dates. A midway checkpoint requiring quest completion will be implemented to alleviate the problem.
2. Weekly reflections should relate more to missions and quests—Though there is some overlap between the technology explorations students completed in weekly reflections and the quests, the instructor can make the connections more apparent and relatable.
3. More quest choices and points—Students mentioned some of the quests were only worth 10 points and should be worth more considering the effort required to accomplish the work. More quest choices involving technologies useful for digital storytelling and data visualization are to be offered in a future iteration of the course.

It is safe to assume that, for the researcher/instructor, there are still many mysteries and areas of improvement that can be explored in the gamified approach to teaching technology to pre-service teachers. One voice calls for the ecological design and construction of an entirely virtual persistent world where pre-service teachers play as avatars and freely explore the open world of educational technologies in a sandbox environment filled not with bordered classrooms but interdisciplinary learning spheres brimming with low-stakes opportunities to experiment with technology integration. Another voice shouts for attention to how pre-service teachers could be optimally assessed on their technology literacy, while another distant voice questions the sufficiency of a single technology preparation course and urges multiple technology-themed courses to be taken during field experience, observation, and internship phases of teacher preparation so that learning about technologies can be more closely situated and associated with learning to teach in any given context.

Extant literature evidence gamification as a thriving mechanism as it is effective in inducing student motivation and learning outcome and also beneficial for teachers who would like to promote student-centered instruction and transition to technology-enhanced teaching. Manzano-León et al.'s (2021) systematic review on 14 experimental and quasi-experimental yielded evidence that educational gamification can positively impact student academic performance, commitment, and motivation. Zourmpakis et al. (2022) proposed a gamification training to enhance preschool and elementary school teachers' usage of adaptive gamification in science education. Saleem et al. (2022) conducted a meta-analysis of gamification studies published between 2015 to 2020 and concluded the most common gamification elements used to boost student learning outcome in e-learning are points, leaderboards, badges, and levels. A systematic literature review done by Lampropoulos et al. (2022) indicated that teachers assessed gamification positively as it has potential to create collaboration and personalized learning experiences and students could develop cognitive and social-emotional skills in gamified learning environments. All in all, when pre-service teachers are adequately prepared to teach using gamification during teacher education, they will be at a vantage point as in-service teachers to leverage the power of gamification to engage students in approaching the task of learning actively, creatively, playfully, and meaningfully.

## Appendix

Learning Experience of Gamified Technology Course Survey

5-Point Likert Scale
5 = Strongly Agree
4 = Agree
3 = Neutral
2 = Disagree
1 = Strongly Disagree

Survey Items
Full Name: _____

1. I think having options in deciding which quests to take on is a positive learning experience
2. I think the weekly reflection helps me reflect on what I've learned and build connections between technology and classroom teaching
3. I think the weekly technology exploration allows for self-guided learning and helps me contextualize the role of technology in the classroom
4. I think the range of 26 quests helps me understand the potential scope and integration of information and communication technologies in classroom teaching
5. I think the quests with advanced option motivates me to challenge my technology and design skills
6. I think the point-based system motivates me to complete more missions and quests
7. I think having unlimited opportunities to revise and resubmit assignments motivates me to want to do better in class
8. I think the online format of the course allows for flexibility
9. I think the online format of the course allows for opportunity to pace my learning
10. I think I have developed confidence in integrating technology into teaching in face to face and online environments after taking the course
11. I think I have developed competency in demonstrating how technology can be used to facilitate teaching and increase student learning after taking the course
12. I think I am better able to consider technology issues such as privacy, equity, digital divide and other implications after taking the course
13. I feel motivated to explore emerging technologies for teaching and learning in the immediate future after taking the course
14. I think the following areas can be improved in this gamified technology integration course: _____ (open-ended response)

**Data availability** The datasets generated and analyzed during the current study are available from the corresponding author on reasonable request.

**Declarations** The authors of this study do not have any financial or non-financial interests directly related to this work. There are no competing interests and no funding was received for the preparation of this manuscript.

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