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Optional embedded microlearning challenges: Promoting self-directed learning and extension in a higher education course

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ABSTRACT: In higher education, learners often look to instructors to guide their learning process along a prescribed path. This case study explores how 85 students, and their 5 instructors, experienced a microlearning system consisting of microlearning challenges and corresponding micro-credentials. These microlearning challenges were embedded in a higher education course to engage learners in brief, self-directed learning tasks that served as extensions of course content. The microlearning system in this case study, called "tech-flex challenges," was optional and implemented across five sections of an educational technology course for preservice teachers at a public university in the United States. Findings show that students had favorable perceptions of the system, but low participation rates. Students who completed microlearning challenges enjoyed them and were more likely to engage for learning purposes than to earn a micro-credential. Instructors also viewed the challenges favorably, but suggested that they should be woven into the course as a mandatory element to foster greater attention and participation.

Keywords: Digital badge, Higher education, Micro-credential, Microlearning, Self-directed learning

1. Introduction

Microlearning offers people the opportunity to pursue individual interests and learn in "short, manageable bursts" (Corbeil et al., 2021, p. 4). People engage in informal microlearning all the time, pursuing knowledge as best suits their needs and available time. However, in a formal learning setting, where the objectives and duration of the overall learning experience are institutionally predetermined, microlearning may take a different approach. A microlearning approach might be embedded in formal learning, used to chunk required content in ways that work within the curriculum (Kohler et al., 2021) and motivate learners through gamified elements (Salas, 2021). It can also be used to approach competency development with learner feedback focused on mastery as individual competencies are attained (Zhang & West, 2020). Conceptually, the integration of microlearning in a formal context challenges students and instructors to briefly isolate and focus on small chunks of learning content, whether skill or knowledge-based, which can later be woven together with other course content at a macro level.

In this study, we explore how *optional embedded microlearning challenges* (OEMC) can be designed and implemented with students in an undergraduate level educational technology course at a large public university in the United States. This OEMC system, called *tech-flex*, was designed to help preservice teachers build and extend their educational technology skills. Recognition of student accomplishments via the OEMC were recognized via micro-credentials, which took the form of digital badges. These OEMC encourage students to extend knowledge and skills developed in the regular curriculum through guided participation in co- and open-curricular activities (Kohler et al., 2021). The brief, focused nature of these challenge-based learning opportunities along with the opportunity to immediately apply the new knowledge and skills via small challenge projects and to integrate them into course assignments aligns with the general definition of microlearning (Taylor & Hung, 2022). By focusing on student engagement and perceptions as well as instructor experiences implementing the system, this study offers insights for future embedded microlearning systems.

2. Literature review

2.1. Defining microlearning

There is no single accepted definition of microlearning, although Taylor and Hung's (2022) scoping review of 13 microlearning studies suggests a few critical characteristics of the instructional approach. They note that microlearning focuses narrowly on a specific topic, can be accomplished in a brief time, and may immediately be applied by the learner. Additionally, microlearning ideally incorporates some sort of assessment (Fennelly-Atkinson & Dyer, 2021). The specific duration of a microlearning episode is unclear, with definitions including 5 minutes or less (Nikou & Economides, 2018; Paul, 2016), 2-15 minutes (McNeill & Fitch, 2022) and 5-18

minutes (Dolasinski & Reynolds, 2020). These times are assertions or represent choices made in specific studies; per Dolansinski and Reynolds (2020) an ideal duration for a microlearning episode has yet to be empirically established.

2.2. Microlearning approaches

Microlearning is not constrained by an expected medium or instructional strategy. Examples of microlearning applications include activities focused on content consumption, such as brief educational videos (Cheng et al., 2017; Rahman et al., 2021), along with more interactive ones like questions and answer activities (Sichani et al., 2018) and videos combined with short quizzes (Triana et al., 2021). Because of the brief duration and applied nature of some microlearning, use of mobile devices as a delivery medium has been heavily explored (Lee, 2021).

Microlearning has been designed and implemented in different ways and diverse contexts. A recent systematic review found that the most frequent setting for microlearning research has been higher education, with the frequency of publications growing quickly since 2016 (Sankaranarayana et al., 2022). In higher education settings, microlearning modules have been well received by students, who enjoyed the short, focused nature of the approach (Dolasinski & Reynolds, 2021). Studies have shown that learning in this way is not only effective in terms of immediate application, but learners also perform well on a delayed post-test (Lee et al., 2021). Small, focused modules can also reduce cognitive load (Major & Calandrino, 2018) and help learners consume and retain information more efficiently (McNeill & Fitch, 2022). Learners may perceive that they have greater control over microlearning modules, enhancing retention, motivation, confidence, and achievement (Taylor & Hung, 2022).

Microlearning can be highly self-directed, with learners engaged autonomously and making choices about what they learn and how they learn it. In formal learning contexts, learners who appreciate informal and flexible learning activities with real-life meaning may react favorably to microlearning (De Gagne et al., 2019). Visions of workplace learning in the future offered by Hamilton et al. (2021) rely heavily on self-directed learning activities performed just-in-time and at small scale. The Internet has made it possible for people to freely create and share microlearning modules as open educational resources (Olivier, 2021; Word & Dennen, 2021), making it possible for learners to easily find resources for their own learning and providing instructional designers with inspiration, examples, and learning objects to adopt or adapt.

2.3. Microlearning design

In terms of design, microlearning draws from the same process model of instructional design as any other approach, cycling through some version of analysis, design, development, implementation, and evaluation (Dolasinski & Reynolds, 2020). The process is likely iterative if the goal is to make formative improvements to the design. Similarly, microlearning content and learning activities can be designed just like any other instructional content and activities, just at small scale. The same principles and strategies apply, such as Mayer's multimedia principles (Tufan, 2021). Additional considerations may be necessary depending on context, such as articulation among modules and sequencing for a microlearning-based curricula and specific technology issues for mobile microlearning (Jahnke et al., 2020).

However, designing microlearning is not a matter of breaking longer lessons into shorter ones. Although microlearning modules can be situated within a larger learning context (e.g., learners completing several related microlessons in either a formal or informal setting), the decision to use microlearning should reflect discrete learning outcomes and content that can be addressed in a brief time frame. Eldridge (2017) cautions against attempting to chunk larger units into microlearning modules simply to follow the microlearning trend. In other words, the focus of learning should not be on the scale or duration of the learning episode, but rather on what makes sense in terms of content. Even if articulated within a larger curriculum, the ability for a microlearning module to be self-contained and logically function on its own is a critical part of the approach.

2.4. Micro-credentials

Microlearning can and should be assessed, and micro-credentials are a means of acknowledging a microlearning accomplishment. They include a visual element as well as metadata that provides information about the learning activity (Gibson et al., 2015), which means they simultaneously function as motivators, pedagogical tools, and

credentials (Ahn et al., 2014). Micro-credentials are used in a variety of ways in higher education across diverse disciplines including but not limited to education (Schürmann & Quaiser-Pohl, 2022), business (Pothier, 2021), programming (Facey-Shaw et al., 2020), and visual arts and design (Fanfarelli & McDaniel, 2017). In these learning contexts, micro-credentials function to support student motivation (Peacock et al., 2020), skill development (Pothier, 2021), and course participation and interaction (Chou & He, 2017). They are not generally considered on par with formal course credit or a degree, although it has been argued that they have the potential to hold such currency should employers choose to accept them.

A familiar form of micro-credential is the digital badge. In some higher education contexts, digital badges provide a simple way to acknowledge learner accomplishments. The meaningfulness of these badges may be personal and context driven, and they may be the digital equivalent of receiving a gold star sticker on a paper, especially if the badge is merely a visual marker of progress and lacks full micro-credential metadata.

2.5. Microlearning context and design

This study is a design case that examines a microlearning system in a higher education context. In this system, optional microlearning challenges were embedded in a course with micro-credentials, in the form of digital badges, issued upon completion of each microlearning challenge. During the Spring 2022 term, 26 optional embedded microlearning opportunities were presented to students in an undergraduate educational technology course for preservice teachers. Called *tech-flex challenges* within the course, they were initially introduced during the Fall 2021 term, modeled on a similar embedded microlearning initiative implemented in a graduate level course (Arslan et al., 2022). The challenge system was revised based on instructor and learner feedback and relaunched during Spring 2022. Specifically, challenges that were timely and no longer relevant were removed and we sought to balance challenges across weeks of the course. The final list of challenges offered optional opportunities to engage in microlearning activities that were directly relevant to the course topic.

The common element of each tech-flex challenge was that students were required to "flex" their educational technology skills by independently learning something new. This challenge-focused microlearning system differs a little from other microlearning systems. Rather than providing students with learning content (e.g., a video or reading material) and then concluding with an assessment, students are given a target accomplishment, which serves as the item to be assessed, and "challenged" to develop the knowledge and skill on their own. The Internet is a vast resource, full of content and tutorials in various media formats, and one of the course objectives was for students to develop self-directed learning strategies for learning new technologies. Given a target outcome, each tech-flex challenge required students to develop and demonstrate knowledge or skills autonomously in a chosen target area.

The large number of challenges was intended to offer choice to the learners. The challenges fit under three different categories: design, technology, and networking. For design challenges, students developed their design knowledge and skills (e.g., typography, color). For technology challenges, students learned to use new tools and tool features. For networking challenges, students independently identified and interacted with people and learning resources that would enhance their careers.

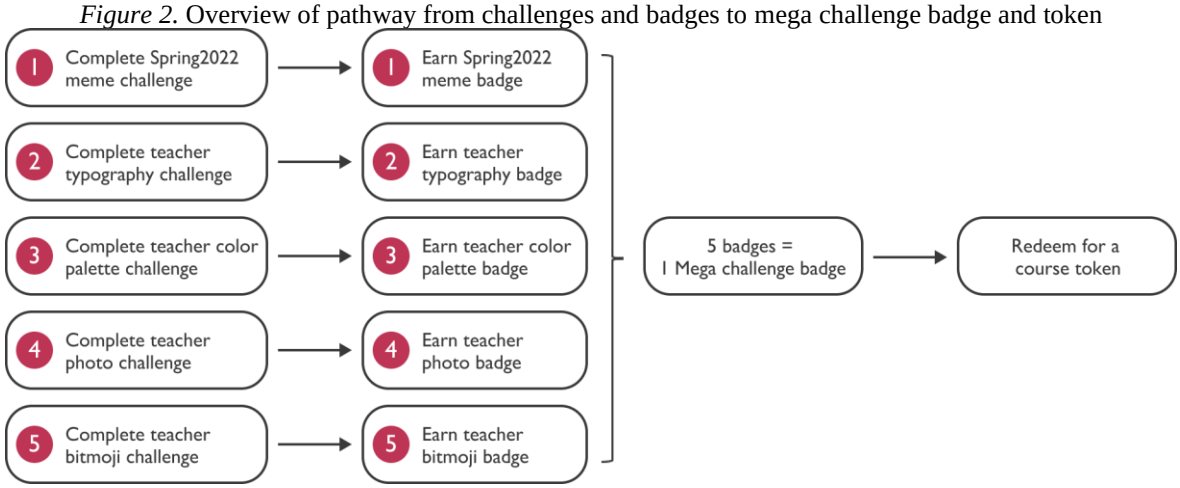
Figure 1. Sample badges

In most instances, the challenges could be completed in about 15 minutes or less, fitting Torgerson's (2021, p. 20) definition of microlearning as "an educational experience that is focused, short, and effective," although a few challenges were more involved. For each challenge, students produced an artifact and posted it to their blog

journal so their instructor and peers could see it (see Appendix A for a challenge, badge, and an instructor-created example). These artifacts were not formally graded, but students were offered digital badges for each completed challenge (see Figure 1).

If students completed five challenges, they were eligible to earn a mega tech-flex badge (see Figure 2 below for the pathway to earn this badge). This mega badge not only marked a student's involvement in multiple tech-flex challenges, but also could be exchanged for a token. The class used a token economy system that allowed students to self-regulate and submit tokens to excuse late work, revise work that did not meet assignment specifications, or excuse minor assignments such as graded in class activities (see Dennen & Bagdy, 2020 for more information about the token system).

Figure 2. Overview of pathway from challenges and badges to mega challenge badge and token



3. Research questions

In this study we evaluate the effectiveness of the microlearning system design from the perspectives of the students, the instructors, and the course designers. The research questions guiding this study were:

- How and why did students engage in the opportunity to complete optional embedded microlearning challenges?
- How did students perceive the opportunity to complete optional embedded microlearning challenges?
- What did instructors perceive as the advantages and disadvantages related to using optional embedded microlearning challenges?

4. Method

This study uses a single case study research design to examine the effectiveness of the *tech-flex* OEMC system as implemented concurrently across five sections of the same course. As recommended by Yin (2003), multiple sources of evidence are used to build the case study. Although this type of study does not lead to generalizability, it provides details that help understand how and why specific outcomes (e.g., the success or failure of a project) came to be (Yin, 2013). The research design incorporates mixed methods as part of the case study, with a convergent approach, which is common among studies of this type (Guetterman & Fetters, 2018).

4.1. Participants

Participants in this study are 85 undergraduate students enrolled in five sections of a technology course for preservice teachers at a large public university in the United States, along with their five instructors and the course designers. Although gender and race data were not collected for this study, historical data from the course shows that in a typical term 60-80% of the enrolled students are female and white. Almost all students who enroll in the course are younger than 25 years old.

The course is primarily intended for preservice teachers, although during a typical term one-third of the enrolled students come from other colleges. The course also meets the university's general education computer skills requirement, which is a major reason why the non-education majors enroll. The course is taught in a fifteen-week term, and there are three sections taught in a computer lab on campus and two sections taught online in an asynchronous mode. Each class section is capped at 19 students. The study was approved by the researchers' Institutional Review Board. Participants provided informed consent.

4.2. Instruments and data collection

Data for this case study were collected from multiple sources. To address the first research question, data from the instructors' tracking spreadsheet were used to determine levels of microlearning engagement. This spreadsheet documented each time a student completed a challenge and was awarded a badge.

An end-of-course survey was used to collect data about student engagement (research question 1) and perceptions (research question 2) using Likert style items. The survey opened with demographic items and questions about prior student familiarity with micro-credentials and engagement in *tech-flex* during the class. If students did not complete any challenges, they were tracked out of the survey. If students reported completing challenges, they were asked to respond to four sets of Likert-style items. These questions focused on the importance of different *tech-flex* activities, perceptions of these activities, perceptions of micro-credentials (adapted from the Intrinsic Motivation Inventory; Center for Self-Determination Theory, n.d.), and desire to use challenge and micro-credential systems in the future. Specific survey items are documented in Tables 3-6 below.

The survey was completed by 27 students (response rate = 31.7%). Although the overall survey response rate was low, likely due to the voluntary nature of the survey and the timing at the end of the semester, the response rate for students who participated in microlearning was higher (72.2%).

Additionally, student blog posts were used to capture perceptions and reasons for engagement. Blogging was a continuous, required activity in the course, and two of the weekly blog posts related to this study. Specifically, the study considers a post in which students discussed their familiarity with micro-credentials in general at the start of the term and another with their final impression of the *tech-flex* microlearning system at the end. Participation in blog posts was high (75 of 85 students; 88.2%).

Semi-structured interviews were conducted with the course instructors and designers to address the third research question to fully capture the study context. These interviews focused on their experience and perceptions of how the *tech-flex* system functioned in the class. The course design team's design and implementation notes and other related artefacts from the course were used to fully understand the underlying rationale for the *tech-flex* system and how the system functioned.

4.3. Data analysis

Data analysis for the first and second research questions focused on descriptive statistics from the student survey, counts of challenges completed and micro-credentials earned, and thematic analysis of student blog posts. Thematic analysis focused on student prior experience with and perceptions of microlearning in general, and perceptions of and reasons for engagement in the *tech-flex* system. Themes were then used to guide content analysis based on presence of specific themes, resulting in frequency counts using the student as the unit of analysis. To answer the third research question, interviews were transcribed, and thematic analysis was used to identify positive and negative aspects of the system as well as opportunities for future improvement. Finally, illustrative quotes were identified among the blog posts and interview transcripts.

5. Findings

This section weaves together data from different sources to address the three research questions. First, student engagement data are discussed, considering both participation levels in the microlearning experience and reasons for participation. Next, student perceptions of microlearning are presented, culled from blog posts and surveys. Finally, instructor perceptions of the microlearning experience are presented.

5.1. Student engagement in microlearning

At the beginning of the term, students were asked to write a blog post about their prior engagement with micro-credentials, which offered an opportunity to learn about their pre-course knowledge and experiences. The post focused on micro-credentials, and not microlearning more generally, because we assumed students would be most familiar with the concept of credentials, such as earning physical badges through youth scouting programs. Of the 85 students, 75 (88.2%) completed the blog posts. Although many students said they had not earned micro-credentials previously, 28 (37.3%) provided concrete examples of situations where they had earned micro-credentials. Among those situations were tales of achievement recognition from fitness trackers, games, mobile apps, and scouting. Two students had experience earning micro-credentials related to learning in formal contexts while earning computer certifications.

5.2. Microlearning engagement levels

Across the five sections of the course, 18 students (21.2%; range 15.8% - 23.5% within each section) engaged in microlearning and earned a total of 63 micro-credentials. An additional 3 students completed *tech-flex* challenges, but they did not request the associated micro-credential upon completion. Among the students who completed microlearning challenges, the number of challenges completed ranged from 1 to 14. Table 1 below shows the breakdown of micro-credentials earned in each class section.

Table 1. Micro-credentials earned by class section

	Participating students	Total micro-credentials earned
Section 1 (On campus)	3	26
Section 2 (On campus)	4	7
Section 3 (On campus)	4	9
Section 4 (Online)	3	8
Section 5 (Online)	4	13
Total	18	63

There were 26 microlearning challenges issued to students, and 19 were attempted by at least one student. The seven most popular challenges are summarized in Table 2 below. Instructors reported that the students who participated in microlearning were among the top performing students in their classes.

Table 2. Most popular tech-flex challenges

Challenge	Brief description of task	Students completing challenge
Meme	Find a meme creator and create a meme about how the term is going so far. Share it to the class Slack channel.	8
Teacher Typography	Creating a typographic identity for use across all projects.	6
A Day in the Life	Research online what a day in the life of a teacher is like and create a video or infographic that addresses a day in the life.	6
Teacher Bitmoji	Create a teacher Bitmoji and post it to a blog.	5
Teacher Bio	Curate sample teacher bios and develop / post personal bio.	5
Badged Blog	Update blog sidebars, including class badge widgets.	5
Sharing “Good” Things	Use Miro and sticky notes to share on a digital whiteboard	5

5.3. Reasons for engaging in microlearning

Students shared various reasons for engaging in microlearning in their blog posts. Some students saw the connections between the microlearning challenges and other assignments, as expressed in these comments:

I feel like the [challenges] thus far have given me the opportunity to better understand the projects we have. Doing so has allowed for me to put the skills I learn during the lesson to use and better understand the functions of the program we are using. [Final blog post]

These weekly challenges gave us additional practice with technology and the subjects we covered in class. … The issue I found with the tech-flex challenges is that after a certain point, I stopped doing them because my other classes got a bit intense. However, I still think they are fun and could be implemented in my classroom down the road. [Final blog post]

Other students found the outcomes of the microlearning system motivating. Although only one student earned and redeemed a token through their microlearning participation, 17 students (22.7%) mentioned in their blogs that they liked the ability to earn a token by participating. The student who earned the token shared, "I have thoroughly enjoyed the various little activities and challenges that I had to complete."

Time and workload were commonly mentioned reasons for not participating in the microlearning activities, with 37 students (49.3%) indicating that they lacked time to complete (more) challenges and 11 (14.7%) commenting that they did not participate because it was optional. Finally, one student from an online section of the course was entirely befuddled at the end of the term, writing in their blog, "Tech flex challenges confuse me. At the start of the semester, I must have missed the section explaining tech flex challenges."

Thirteen of the students who completed the survey indicated that they had participated in *tech-flex* challenges, representing 72.2% of the 18 students who participated in microlearning during the course. These students shared their reasons for engaging in the challenges using a 5-point Likert scale ranging from *Not at all important* (1) to *Extremely important* (5). Their top reasons were to learn tools and earn badges (see Table 3 below). Students were least interested in seeing what classmates were doing, with 5 of the 13 rating that item as *not at all important*.

Table 3. Importance of different tech-flex activities for participating students (n = 13)

Item	Mean	*SD*
Completing tech-flex activities to learn a new tool.	3.77	0.70
Completing tech-flex activities to earn a micro-credential.	3.08	1.07
Seeing how many tech-flex activities I could complete.	2.92	1.07
Seeing how many micro-credentials I could earn.	2.62	1.21
Seeing how my classmates completed tech-flex activities.	2.15	1.17

Students also were asked about their motivation to earn micro-credentials. Most were very (4; 30.8%) or somewhat (7; 53.9%) motivated by the micro-credentials, with only 2 (15.4%) finding these not at all motivating. However, 5 students (38.5%) were not at all motivated by the mega challenges, which involved completing 5 microlearning challenges and could be rewarded via a course token.

5.4. Student perceptions of microlearning and micro-credentials

The second research question addresses student perceptions of microlearning. On the survey, students were asked to agree with statements related to how they perceived *tech-flex* activities using a 5-point scale from *Strongly disagree* (1) to *Strongly agree* (5). Overall, the 13 students who completed *tech-flex* activities felt they offered an effective approach for learning (see Table 4 below). All five items related to learning and achievement received mean ratings of 4 (*Agree*) or higher. The item with the lowest mean related to the importance of grades and suggests that students were not overly concerned with whether the *tech-flex* activities themselves received a grade. In this sense, it appears that students who completed the tasks either had a learning orientation toward the class or recognized that skills developed through these tasks might enhance performance on graded class activities. *Tech-flex* activities were deemed time-consuming by some students; those same students indicated difficulty deciding what to do for *tech-flex* tasks.

These 13 students were also asked to share their perceptions of the micro-credential earning experience using a 5-point scale ranging from *Strongly disagree* (1) to *Strongly agree* (5). As shown in Table 5 below, the students who earned micro-credentials recognized the voluntary, optional nature of the activities. For many of these students the micro-credentials held some value; the mean on items about value and being beneficial is above the midpoint. However, students were equally split on the question of whether they put a lot of effort into earning micro-credentials, with a mean at the scale midpoint and an equal distribution on each side of that midpoint.

Finally, students were asked to indicate their desire to engage in this type of microlearning experience again. As shown in Table 6 below, all but one of the students who tried the *tech-flex* challenges was open to having the student experience again. Interestingly, for some students there was greater interest in using microlearning and micro-credentials as a teacher than as a student. In that sense, the activity served as a model of an instructional strategy for these pre-service teachers. There was the least enthusiasm for using a microlearning system at work.

Table 4. Perceptions of tech-flex activities for participating students (n = 13)

Items	Mean	*SD*
Tech-flex activities are effective for learning new knowledge.	4.23	1.05
Completing tech-flex activities provides me with a sense of achievement.	4.08	1.00
Completing tech-flex activities helps develop class knowledge efficiently.	4.08	1.14
Completing tech-flex activities helps develop class knowledge effectively.	4.08	1.14
I learned something new while completing tech-flex activities.	4.00	1.11
I enjoyed completing tech-flex activities.	3.85	1.10
I am self-motivated by completing tech-flex activities.	3.54	1.28
Tech-flex activities are too time consuming.	3.38	0.84
I chose my tech-flex activities based on whatever would take the least time.	3.23	1.31
It was difficult to decide what to do for tech-flex activities.	0.08	1.00
Tech-flex activities are unimportant because they are not graded.	0.54	1.22

Table 5. Student perceptions of micro-credentials (n = 13)

Item	Mean	*SD*
I believe I had some choice about earning micro-credentials.	4.38	1.15
I earned micro-credentials because I wanted to.	4.31	1.14
I think earning micro-credentials could help me to learn something.	4.08	1.27
Earning micro-credentials was fun to do.	4.00	1.18
I believe earning micro-credentials was beneficial to me.	3.92	1.07
I would be willing to earn micro-credentials again because it has some value to me.	3.85	1.23
I put a lot of effort into earning micro-credentials.	3.00	1.24
I earned micro-credentials because I felt I had to.	2.00	0.96
There may be good reasons to earn micro-credentials, but personally I don't see any.	1.62	0.74

Note. Scale adapted from Intrinsic Motivation Inventory (Center for Self-Determination Theory (n.d.).

Table 6. Future interest in challenges and badges (n = 13)

Would you like to use a microlearning system again?	Not at all	Somewhat	A lot
As a student	1	9	3
	7.7%	69.2%	23.1%
As a teacher	2	4	7
	15.4%	30.8%	53.9%
At work	7	5	1
	53.9%	38.5%	7.7%
For personal/informal learning	4	5	4
	30.8%	38.5%	30.8%

Four students left open comments at the end of the survey. One indicated that they would have liked to earn extra credit rather than tokens. Another said they found it difficult to decide which challenges to do and what to do for them. A third shared that they struggled with time and felt a compulsion to complete the challenges in order, rather than picking and choosing among them, and as a result they gave up after three challenges even though some of the later challenges were tempting. The final comment was positive and stated that the system offered "a great opportunity to gain more real experience in different areas of technology to become better accustomed to them."

5.5. Positive perceptions from blog posts

On their initial blog posts, most students (47; 62.7%) solely reported positive sentiments toward micro-credentials. The remainder were negative (5; 6.7%), neutral (7; 9.3%) or mixed (16; 21.3%) in their sentiments. Students offering mixed sentiments made negative comments about micro-credentials, but counterbalanced these negative statements with acknowledgements that some people might like or see value in them. Students with a

neutral perspective wrote factual statements (e.g., *Badges can be used to reward achievements.*) without taking a stand about their value.

Most students with positive sentiments identified micro-credentials as a means of documenting accomplishments or achievements (59; 78.7%) and learning (48; 64.0%). Micro-credentials were also deemed fun (45; 52.9%) and cool (19; 25.3%). About one-third of the students (27; 36.0%) commented on the capability of micro-credentials to motivate learners; each of these students was also among the group of students describing micro-credentials as fun and/or cool.

5.6. Negative perceptions from blog posts

Negative perceptions frequently related to the meaningfulness of micro-credentials. One student commented:

"[They] are like getting a treat for reaching a goal. They have no real meaning but can make a person feel better and use a source more because they got rewarded. … I think it just tricks people into using a product or site more. While they can be effective I do not personally use them. [Initial student blog post]

Another student wrote, "For me, however, the idea of being rewarded for completing simple tasks via a digital badge is... demeaning. Needless to say, it is not a concept I will be implementing when I teach." Unsurprisingly, neither of these students engaged with microlearning in the class, with one commenting, "I'm not too concerned with knowing how to do all the little intricate things that technology allows for; only the stuff that I need to get by as an educator and individual." In all but one instance, negative comments came from students who did not engage in microlearning. That student stated:

I only did one [tech-flex challenge] this semester I think and it was honestly not my favorite assignment. I just don't really care about badges because I don't know where to put them and I don't think they really matter much outside of this class. [Final blog post]

Unfortunately, this student did not write more about why they chose to participate in optional microlearning that they did not enjoy, nor did they share which task they completed.

5.7. Instructor perceptions of microlearning

The instructors were familiar with the concepts of microlearning when the Spring 2022 term began. Three of the instructors indicated that they earned micro-credentials as graduate students during their coursework, and one had learned about it from a peer. All five instructors had implemented the first version of the *tech-flex* challenge system during Fall 2021 in their respective sections of the course and provided feedback for improvement at that time.

5.8. The participation challenge

All the instructors commented on low participation rates in *tech-flex* challenges, attributing it to the optional nature of the activities. Still, four instructors indicated that a subset of their students freely engaged in microlearning. The fifth instructor indicated that none of the students in her section, which was online and asynchronous, participated in microlearning of their own volition. Later in the course, she introduced some of the challenge activities as an alternate assignment for students who needed one for the subject pool participation assignment. Subject pool participation, in which students participate in 2 hours of educational research via a subject pool in the college, is a required and graded component of the course worth 2% of the final grade. Instructors are required to offer alternate assignment options to students who do not wish to engage in research. The general sentiment toward the value of microlearning challenges, despite low participation, was summed up by one instructor who commented, "I think it is good, it expands the learning opportunities, but it's based on their willingness."

The instructors were asked how their students reacted to the microlearning system when it was first introduced in their classes. Their experiences differed somewhat by modality. Instructors teaching campus sections of the course were able to present the *tech-flex* system during a class session and see the immediate reactions of their students. One campus instructor shared that students felt comfortable after they learned that *tech-flex* challenges would be optional. The instructor continued, "After I introduced the concept, [a student] mentioned that she was

familiar with it and she even shared what she produced… So that was fun." That student had experienced challenges in another course, and showed the class a photo of how she dressed her dog for a challenge that she participated in." The instructor continued, "I think saying that it is optional made them feel comfortable, at least what I sensed from the class." The other campus instructors also indicated that some of their students were interested in *tech-flex* challenges, although others did not react much.

In the online sections, *tech-flex* was introduced to students asynchronously. Information was provided to students in a module, with no guarantee that students would engage with the content. One of the online instructors indicated that she was unaware of student reactions, stating, "Actually, because I have taught … asynchronous online courses, I couldn't see the immediate reaction from the students. I'm not sure what they thought about it, because none of them actually sent me an email to ask about it." The other online instructor mentioned a mixed response from the students. Still, participation levels in the campus and online sections were similar (see Table 1).

5.9. Positive experiences of microlearning engagement

Throughout the term, instructors shared that when students completed challenges, the overall reactions were positive. One instructor stated:

There are some students, they are really interested in the tech-flex challenges. Actually, I also have at least four of them and they do some challenges. One completed at least 10 challenges. So that is very nice. [Instructor interview]

Another instructor mentioned how she enjoyed it when students included her in their challenges, referencing her instruction and the other course assignments, including creating a meme about her. She said, "These kinds of items were funny because it's like, they're not just completing this assignment, but they also think about the relationship with their instructors. I really appreciated those connections."

Students not only referenced instructors in challenges, but also noticed what their peers were doing. One instructor shared about an informal chat initiated by a student after class in which the student mentioned seeing micro-credentials shared in one of her classmate's blog journals, and asked how she could also share micro-credentials on her blog journal. The instructor commented that the interaction had been a highlight of the *tech-flex* experience, seeing a student motivated by a peer's accomplishments and asking to learn more about it.
Two instructors indicated that they also had new insights and learned new things from challenges and developed their ideas of how microlearning could be integrated in formal learning contexts. One instructor commented how teaching with the *tech-flex* system made her pay attention to microlearning and micro-credentials in everyday life and offered a connection point with students:

I knew the purpose behind it, but I think when I see my students are very active in earning badges and proud of earning these badges, it's motivated me to see badges in different ways. So for instance, when I finished a workout, I noticed I earned digital badges from my Apple Watch. And then I was so happy and shared with my students, and they also liked my post. So, I think it increased the interaction between me and students. [Instructor interview]

Another instructor shared her experiences with the Canva video challenge, which she chose to do on her own. She said, "if the procedure is really difficult to learn [students] just skip it and but I did it, it was so fun. So after that challenge, actually, I started to create a title page using Canva, inserted a video saying hello to students … I liked it."

5.10. Microlearning system limitations and recommendations

Instructors identified limitations with the overall microlearning system design and implementation and offered several ideas for improvement. Many of the limitations and recommendations surrounded optional participation and its effect on participation levels, a topic mentioned by all the instructors. One instructor recommended mentioning the *tech-flex* system in the syllabus and during the first class session to call more attention to it. Others pointed out that if microlearning is required and graded, students will pay attention. However, the instructors need to be motivated to focus on *tech-flex* too, with one saying, "So I actually didn't spend a lot of time on exploring the challenge items. But if this is part of the activities required for the class, I believe I will take my time to explore things."

Adding microlearning challenges as a required element of the class is possible, but perhaps not practical. With a weekly blog post assignment and other solo and group assignments, students were already submitting 1-2 items to be graded each week. In-class time is provided for working on some assignments, but instructors indicated great variability in the student experience. One instructor's experience was that, "it is easy for some students but for other students, they really need a lot of time." Another instructor was concerned about students feeling overloaded with tasks, stating, "I didn't want them to be stressed out so I emphasized that it is optional so that they cannot be confused with other assignments, and they don't get like overwhelmed by all the list of work that they have to do."

The instructors drew parallels between *tech-flex* challenges and an existing portfolio assignment. For their portfolio, students were asked to submit a digital portfolio twice during the term, providing evidence of specific technology skills they had developed. Although most of the portfolio items were prescribed, relating to skills students needed to demonstrate to meet the course objectives, others offered choice, much like the *tech-flex* challenges. One instructor suggested that the challenges, which she enjoyed, could be folded into the portfolio requirement.

Other recommendations offered by instructors related to having more structure and consistency in the *tech-flex* system. Specifically, they suggested: Start and end dates for each challenge; an equal number of challenges each week; an equal scope for each challenge; and a set difficulty level of each challenge. Due dates would help instructors plan for grading, because "I know it's not a like big workload, but it still takes some time and mentally it could be stressful [to keep up with]." Due dates might also motivate students to complete challenges. One instructor commented, "Lots of flexibility also confused them. So maybe it's also helpful for both of us if there is like an expected timeline."
Finally, tracking challenge completion and awarding micro-credentials was a limitation of the current system. All the instructors shared that they struggled with this task owing to the manual nature of the process and the lack of deadlines. Because challenge evidence was presented on students' blog journals, instructors did not get an alert in the learning management system (LMS) when there was a challenge item to be assessed. At least one instructor had overlooked a challenge submission and was alerted by a student to award the associated micro-credential. Additionally, monitoring blogs for challenge completion was a low priority activity because it did not relate to student grades.

6. Discussion

6.1. Student engagement and perceptions of microlearning

The first two research questions asked about student engagement and perceptions. Overall, student perceptions of the *tech-flex* challenge system were positive, whether students participated in microlearning or not. Most students who participated in challenges recognized them as an opportunity to learn something new. However, engagement was relatively low. Time and voluntariness were frequently cited as barriers to participation from both the student and instructor perspective. Motivating voluntary learners is one of the biggest challenges of any optional learning experience (Jones & Korula, 2021), and similar issues have been found with other optional microlearning implementations (Beste, 2023), as well as optional learning activities in other contexts (Ruipérez-Valiente et al., 2016).

An unanticipated benefit of the *tech-flex* challenges, whether students completed them or not, was greater awareness of how the required knowledge and skills being taught in class could be extended. This worked because the challenges were intentionally sequenced as recommended by Jahnke et al. (2020), complementing required course tasks. Merely reading the challenges exposed students to new ideas about what they could learn in a short period of time. Per instructor reports, much like with extra credit work (Harrison et al., 2011) and findings from other studies of microlearning in higher education (Reid et al., 2015), high performing students and students who valued learning completed the challenges, suggesting that students who were primed for extension activities used the challenges in this way. However, because students submitted their challenge work on their blogs, visible to their classmates, their classmates could benefit vicariously.

None of the microlearning challenges found in De Gagne's et al. (2019) scoping review – pedagogical discomfort, technology inequalities, and privacy concerns – were raised in this study. That may reflect the nature of the class, which already had students interacting online and heavily using technologies. In other words, issues of this nature were not unique to the microlearning activities in this course and were addressed and mitigated in the larger course design.

6.2. Instructor perceptions of microlearning

From the instructor perspective, which was investigated by the second research question, the idea of learning through challenges was never questioned, but the use of optional challenges was. Instructor recommendations focused on streamlining and structuring the system, as well as making it required. Although none of the instructors suggested abandoning the challenges, and they enjoyed seeing what students did for the challenges, they also raised issues about student workload and existing assignments. The issue here was not scope, but number of assignments.

From an implementation perspective, instructors did not emphasize *tech-flex* challenges with their students because they deemed required assignments more important – and rightfully so. Instructors were concerned with their students who needed more time and help to complete the regular assignments, and promoting and tracking challenge completion was a secondary priority. As an extra element of the class, an additional workload burden was created for instructors much like when extra credit opportunities are provided (Pynes, 2014). This burden could be somewhat alleviated by technology, although none of the existing LMS-integrated micro-credential tools were available for use in this course.

6.3. Evaluating the system

Philosophically a conundrum is raised by these findings. The system was viewed favorably for the just-in-time, small-scale, self-directed learning that it could inspire. However, in order to generate widespread engagement both students and instructors indicated that required participation is needed. Some instructors alluded to offering less choice, too. Requiring participation, however, would change some aspects of the *tech-flex* challenges. For example, students might expect explicit instruction if challenges were required, and could be reluctant to engage in self-directed learning and exploration. Also, student perceptions of the system might have been less favorable had it not been optional or had it not involved choice.

Critics are often quick to suggest that low participation is problematic, but in a non-compulsory system perhaps that value judgment should be reconsidered. There is precedent for reconsidering the importance of full participation or completion in the MOOC literature, recognizing that in voluntary learning contexts learners may find value in following their own paths or observing others (Dennen & Bong, 2017). In the *tech-flex* system, the optional activities represent extended application of learning concepts, not extra but ungraded practice that supports performance on course assessments. The consequences of not participating are low, and the value of participation is personal enrichment, much like informal forms of microlearning that occur outside of formal learning contexts. Low participation could be a reason to discontinue offering the challenges if supporting the system is burdensome for instructors, but if system maintenance does not require additional labor, then there is no harm done.

The *tech-flex* system was designed to support the development of self-directed technology learning skills, and choice and autonomy are hallmarks of self-directed learning (Brandt, 2020). However, autonomy is not typical in formal learning contexts. Participation and choice could be separated in future iterations of the *tech-flex* system. In other words, microlearning challenges could be integrated as a required element, and yet students could choose among the challenges they complete. This solution would scaffold self-directed learning, providing constrained choice and encouraging autonomy within those constrained choices. Providing student choice is established as a learner-centered principle and can motivate learners (Bonk & Dennen, 2003; Bonk & Dennen, 2007). Similarly, microlearning in authentic, everyday contexts involves choice. People choose what they want to learn or problems they want to solve and then identify their own learning paths. By requiring students to make choices about challenges, they would begin to learn how to navigate the paradox of choice associated with self-directed learning (Brockett, 2006). The use of challenges, as opposed to designed instructional modules, supports autonomy in a micro sense; learners must leverage their existing knowledge, skills, and the Internet to address the challenges. These supported challenge learning experiences could prepare students for the greater choice and autonomy that adult learners face in their everyday lives solving authentic problems.

6.4. Implementing microlearning

Microlearning system implementation is an important consideration for optional or required systems. In this study, instructors were given minimal directions other than to share the *tech-flex* system with their students, monitor progress, and award micro-credentials. Instructors were not given guidance about how to promote or talk about microlearning with their students. In particular, this issue arose as a shortcoming in online course sections.

Greater effort could be made to formally introduce the system at the start of the semester, as recommended by Facey-Shaw et al. (2020), even if challenges are not yet being issued.

In this study, the first time students were made aware of the microlearning system, was a few weeks into the course. The blog posts used as data in this study were written at that time, but they focused primarily on micro-credentials, reflecting both a reading assignment and corresponding prompt. Inverting the focus from micro-credentials to microlearning by providing readings about microlearning and directly showing how the challenges are a form of microlearning might be helpful to promote student awareness. Similarly, a brief reading and prompt about self-directed learning could help students understand why the microlearning challenge approach is being used.

6.5. Microlearning and motivation

Although motivation was not formally measured in this study, the findings nonetheless suggest that most students had relatively low extrinsic motivation to complete challenges and any intrinsic motivation was counter-balanced by a variety of competing, higher-priority tasks. Drawing from Keller's (1987) ARCS model, it becomes worthwhile to consider whether the challenges were noticed by students (attention) and whether students recognized how the outcomes of the microlearning activities related to bigger course assignments and their future activities as teachers (relevance). Seeing a model or a demonstration or having more structure to support microlearning might increase confidence. Finally, satisfaction might be a more difficult dimension to support, but for some students it may come from receiving attention or acknowledgement of their work. The micro-credentials offered through *tech-flex* challenges were meant to support student satisfaction, but they had little meaning beyond the class, and students were aware. Horstman et al. (2020) noted the importance of micro-credentials having value in other settings, but systemic change at a higher level would be needed to make that happen. Thus, micro-credentials may not be effective because they are not widely acknowledged elsewhere in the curriculum. However, portfolios could provide another means to document and acknowledge student microlearning accomplishments in a format that is more widely recognized in educational settings.

In future iterations of the system, there are opportunities to gain student attention by making the system required and introducing it on the first day of class. Relevance could be enhanced by connecting student microlearning accomplishments to courses later in the curriculum. A student showcase of microlearning projects is one idea that could generate satisfaction for some students, while giving others the confidence that they, too, could succeed at these challenges.

7. Limitations

This study has several limitations. First, the student response rate for the final survey was low. We were pleased that the response rate among microlearning participants was higher than the overall response rate, but would have still liked a greater response from students. Time and voluntariness were likely the reasons for lack of survey response and lack of microlearning participation, but nonetheless it would be helpful to know more about what might encourage these students to participate in challenges and whether they would feel satisfied by attaining the outcomes associated with the challenges.

We did not collect uniform data about the implementation of *tech-flex* across each class section, although we know that system introduction and awareness differed, particularly between the campus and online sections of the class. Online sections had lower awareness, which likely reflected the asynchronous nature of the course instruction. Online students had to purposefully engage with instructor-provided announcements and content to learn about challenges and badges, whereas campus students who attended class would be exposed to microlearning challenges so long as they paid attention.

Finally, there was potential for error in the tracking system. This system was manual due to the lack of a micro-credential platform integrated into the learning management system. Tracking student *tech-flex* accomplishments proved onerous and was secondary to grading assignments and other course tasks.

8. Implications

This study offers several implications for practitioners who wish to implement microlearning systems in their formal learning contexts. First, it is important to offer choice, but too much choice may be overwhelming to students. Choice might be structured slightly, perhaps by offering students categories of learning options (e.g., students must complete something related to graphics, but there are four options to choose from). Second, while micro-credentials may seem like an obvious way to reward students for engaging in microlearning, it is important to make sure that learning is the focus and not earning micro-credentials. This implication conflicts somewhat with Beste's (2021) recommendation that increased gamification might motivate participants, and is based on the general student disinterest in competitiveness in this study. Further, a microlearning system connected to grades might be more successful, allowing instructors to dispense with the complexity of micro-credentials and a secondary assessment system. Alternatively, students could have a minimum threshold to meet and then earn some form of extra credit or other recognition for each bit of learning above the minimum. Finally, optional learning opportunities should be temporally structured for students. In other words, the opportunities can be released to students when they correspond with course units or assessments, and then closed when those units and assessments have passed.

9. Conclusion

This case study demonstrates how microlearning challenges can be issued to students in higher education, encouraging them to use their self-directed learning skills and the Internet to accomplish the challenge tasks. With small-scale tasks, self-directed learning is manageable for university students, although if optional, these tasks will be a low priority. The use of micro-credentials to motivate learner engagement in microlearning challenges appears to be limited. Although some learners appreciate receiving the recognition, absent a larger system of academic recognition and currency, class designed and issued micro-credentials hold little meaning and might easily be replaced by other forms of achievement recognition, including grades.

This study adds to the existing body of research on microlearning in higher education by showing the role of microlearning as a form of course extension, providing structure and encouragement for students to explore knowledge and skills that lie just beyond or adjacent to regular course expectations. Future research might explore differences between self-directed microlearning, like the *tech-flex* challenges, and instructor-designed and prescribed microlearning, to explore differences in motivation and learning outcomes. Additionally, future research should determine if there is a connection between developing self-directed microlearning skills in a supportive environment like a university course and being able to successfully use microlearning to support professional development later in life.

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Appendix A: Challenge and badge example

Teacher Bitmoji

Show me your bitmoji! I'll go first...

Here are two bitmojis created by one of the EME2040 instructors, Ömer

Look at some of the resources below! You'll see that so many teachers are having lots of fun with bitmoji in and out of the classroom!

- Educators turn to bitmoji to build community and engagement (Links to an external resource)
- What's the "Bitmoji craze for educators" all about? (Links to an external resource)
- 5 reasons why teachers love the bitmoji classroom (Links to an external resource)

Well... if you don't have a bitmoji, let's create it together in this tech-flex!
Follow the directions below, complete the task, and earn the Teacher Bitmoji badge.

Directions

1. Create a bitmoji account.
   - Here's a resource that can help you create an account (https://support.bitmoji.com/hc/en-us/articles/360001493786-Create-a-Bitmoji-Account)
2. Design your teacher bitmoji.
   - Here's another resource that can help you get started with designing your teacher bitmoji (https://support.bitmoji.com/hc/en-us/articles/360001493806-Create-Bitmoji-with-a-Selfie)
3. Make a blog post about how you created your teacher Bitmoji. Don't forget to add your bitmoji to your blog!
4. Your instructor will be awarding this badge to your Cluster portfolio upon the completion of the task.