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Creating the conditions for professional digital competence through microlearning

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ABSTRACT: Teachers fostering future-ready graduates need to master updated pedagogical and technological knowledge, so teacher professional development (TPD) is essential. Conventional TPD activities such as seminars and workshops are limited as they require specific time blocks and lack flexibility. The current study investigated TPD through microlearning courses in online and blended learning modes as an innovative TPD approach in Hong Kong. We applied a qualitative approach and thirty-two preservice teachers in the English language education program participated. The data were collected using questionnaires, semi-structured interviews, and observations for data collection. The pre-service teachers' digital competencies were evaluated against an observation protocol based on the SAMR framework and TPACK model. The effects of microlearning and the participants' digital competence needs were also identified. The results revealed how preservice teachers perceived the integration of technology and the challenges they encountered (e.g., design of learning tasks and time management). Based on the findings, personalized and hands-on training is recommended to fulfill teachers' diverse learning targets in applying specific technology and deepen their understanding of technology use. Furthermore, as more conceptual frameworks for assisting microlearning in TPD are necessary, this study can help enrich the underpinning theories for the microlearning design of TPD.

Keywords: Microlearning, Pre-service teachers, Digital competence, Technology, Pedagogy

1. Introduction

The recent advancement of digital tools and related infrastructure in many educational contexts due to the COVID-19 pandemic has led to a rapid rise in the use of digital technology in English language lessons (Moorhouse & Kohnke, 2021). As a result, increasing attention has been paid to teachers' digital competence (Starkey, 2020) and ability to integrate technology effectively into their lessons (Hafner & Ho, 2020). There are many teacher professional development (TPD) models (e.g., Consuegra & Engels, 2016; Huang et al., 2022; Zhao, 2010); remarkably, only a limited number of studies focus specifically on online and blended learning (OBL) (Philipsen et al., 2019). Therefore, many teachers struggle to realise the full potential of OBL strategies and become proficient in them. This is partially because many models of TPD follow a linear approach and mode of delivery (e.g., short courses, workshops; Richards & Farrell, 2005) and assume all participants have similar starting points (Weston et al., 2018). One emerging approach, microlearning, has recently received attention because it can deliver tailored, meaningful, timely, self-directed TPD with small, highly focused learning objectives (Zhang & West, 2019). Microlearning typically comprises bite-sized learning nuggets (i.e., 1–6 minutes) that are based on multimodal input (e.g., infographics, videos), focused on a specific topic to prevent cognitive overload and accessible anytime and anywhere (Corbeil et al., 2021). To address the requirement that English language teachers adopt new approaches and stay current in their instruction, this study analyses data from pre-service teachers in Hong Kong who participated in a short TPD course on OBL delivered via microlearning. It aims to understand and conceptualise the effects of microlearning and its ability to create the conditions for professional digital competence in teachers' future practices.

1.1. Teacher professional development with microlearning

The goal of TPD is to foster instructors' knowledge and skills in their respective fields (Desimone, 2009; Kennedy, 2016). Specifically, in Hong Kong (the context of the current study), the Education Bureau of the Government of the HKSAR (EDB,2020) divided TPD into three areas: (1) professional competencies, (2) professional values and conduct, and (3) aspiration for self-advancement through self-reflection. Of the TPD training events devised for teachers, mentors, and school leaders, participatory activities (e.g., workshops, observation/evaluation of lessons, and professional development days) are considered the most effective (Policy

21, 2017). However, barriers to engaging teachers in the activities have also been mentioned. These include: (1) lack of time to attend the activities because of a heavy workload, (2) scheduling conflicts with fixed events, and (3) undesirable activity venues (Policy 21, 2017). To relieve these issues, the current study considers microlearning (specifically, microlearning delivered online), which is an emerging framework introduced in the early 2000s (Hug, 2005) that promotes "chunking" to reduce the cognitive overload that comes with exposure to new information (Gobet, 2005).

Microlearning aims to convert complex data into bite-sized, easily-digestible units of learning, each of which has a single objective (Corbeil et al., 2021). It allows learners to learn on demand, anytime and anywhere, using mobile-friendly platforms (Kohnke, 2021; Kohnke & Foung, 2023). Accordingly, TPD on OBL can be delivered in small chunks that address a single learning concept and can be accessed using technology (Zhang & West, 2019). For example, microlearning can include image-based learning (e.g., infographics, memes, animated GIFs), audio-based learning (e.g., podcasts), and video-based learning (e.g., screencasts, vlogs) (Kohnke, 2023). Activities can be made adaptable and flexible by embracing technology and multimodal features. Earlier studies have found that microlearning can enhance satisfaction, motivation, and learning performance by providing autonomy, encouraging self-directed learning, and maximizing efficacy (Kohnke et al., 2023; Nikou & Economides, 2018). With the potential benefits of microlearning, such as faster learning, higher engagement and interactivity, and personalized learning experiences, the aforementioned issues with TPD on OBL may be relieved. Therefore, the current study aims to use microlearning to facilitate TPD which promotes digital competence.

To integrate microlearning into TPD training, the current study has considered previous TPD models. The conceptual framework developed by Desimone (2009) – addressed in many previous studies (e.g., Didion et al., 2020; Whitworth & Chiu, 2015) – proposed methods to engage teachers in the learning process and enhance the sustainability of TPD. The framework identified five features (i.e., "content focus," "active learning," "coherence," "sustained duration" and "collective participation") to consider when designing TPD activities (Desimone & Pak, 2017; Desimone, 2009). The framework suggested that the learning content should be subject-specific, consider the methods students use to learn, and align with the expectations of multilevel systems (e.g., teachers, schools, and governments; Desimone, 2009). Meanwhile, it posited that TPD is sustainable when it supports better educational practices and the activities are consistent with the policies and goals of the school (e.g., aligned to the curriculum, suitable in terms of duration and frequency; Desimone & Stuckey, 2014). As microlearning is limited to a few minutes and can be designed and delivered online, learners are free to choose their study time and the learning content can be edited quickly and easily if school policies change.

Furthermore, Kennedy (2016) suggested that focusing on TPD design features may not be sufficient to guarantee that it will yield positive results. For example, focusing on content knowledge exclusively may not lead to positive performance, as expected – the actual design of the learning experience should be considered systematically (Kennedy, 2016). Similarly, after analyzing the interactions of three subsystems (i.e., teacher, school, and activity), Opfer and Pedder (2011) proposed that there is not only one way to achieve a learning goal: actual results are affected by the specific learning context, which is a dynamic system. Therefore, the methods of connecting different stakeholders and encouraging them to participate in TPD became a core issue.

Subsequently, an iterative design for TPD was proposed. This approach aims to use teachers' feedback to modify and improve the design of TPD activities; the new activities are then implemented to obtain additional feedback. It is accompanied by collaborative learning (e.g., Fishman et al., 2013; Voogt et al., 2015). The assumption is that TPD can be made sustainable and scalable by combining iterative design with collaborative learning, as this will allow TPD to be adapted to specific contexts (Clarke & Dede, 2009). By engaging various stakeholders to participate in the design and evaluation processes, the learning content of microlearning will become more aligned with schools' and teachers' needs (see Section 1.3).

In short, to sustain and scale up the transformation of TPD, previous models have emphasised the importance of interactions among different stakeholders, alignment between the content and the expectations of various actors (e.g., teachers, school leaders, schools, and governments), and modifying the content using iterative design. Therefore, microlearning content should be established on an online platform that allows different stakeholders to edit and comment quickly and synchronously. Meanwhile, microlearning should not be designed as a single source that both delivers and evaluates teachers' professional knowledge – in the iterative design of TPD with microlearning, learning results should be evaluated based on actual practice (e.g., teaching performance) as well.

1.2. TPD for digital competence

Over the past three years, as institutions worldwide transitioned from a face-to-face to a virtual learning environment (Hodges et al., 2020) teachers have been required to acquire new skills and knowledge and quickly expand their digital competence (Moorhouse & Kohnke, 2021). Furthermore, this transition altered their beliefs about technology-infused teaching and their pedagogical roles (Moorhouse et al., 2022). Although schools offer regular TPD on OBL to develop teachers' digital competence, it tends to focus on *how* to use technology rather than *why* to do so or how to integrate it with existing course materials (Tondeur et al., 2015). Previous studies have established that teachers' pedagogical beliefs determine how they use technology in the classroom (Eickelmann & Vennemann, 2017) and they tend to only integrate technology if this aligns with their concept of effective teaching (Ertmer et al., 2015). As a result, TPD activities may be ineffective if they fail to connect with actual teaching practices or offer a clear vision of how technology can complement and support learning (Lim & Wang, 2016). To address this issue, personalised TPD is a crucial way to increase teachers' digital competence and bring about positive change in their practice (Shamir-Inbal & Blau, 2020). Furthermore, Lim et al. (2021) suggested incorporating professional learning communities as a form of TPD, so teachers can receive continual support while developing their digital competence.

1.2.1. Technological, Pedagogical, and Content Knowledge (TPACK) model

Another of the most widely adopted models in previous studies (e.g., Jen et al., 2016; Schmid et al., 2021) is the Technological, Pedagogical, and Content Knowledge (TPACK) model proposed by Mishra and Koehler (2006), which aims to promote the application of technology and enhance students' learning performance. The TPACK model proposes a framework of the knowledge required for teachers to integrate technology into education (Koehler & Mishra, 2009; Yeh et al., 2021). Technological knowledge relates to handling digital tools and integrating them into the instructional process. Pedagogical knowledge refers to the practice of imparting knowledge. Content knowledge refers to the understanding of a specific subject. The combination of the three elements leads to a comprehensive consideration of instructional design. For example, pedagogical content knowledge considers how particular teaching approaches apply to specific material (Koehler & Mishra, 2009).

The TPACK model has been used to design courses equipped with digital learning tools (Pölzl-Stefanec & Geißler, 2022). Meanwhile, previous research has found that, although pre-service teachers were confident in pedagogical knowledge (PK), technological knowledge (TK), and pedagogical content knowledge (PCK), they felt challenged by technological pedagogical knowledge (TPK; Valtonen et al., 2020). Dalal et al. (2021) conducted a semester-long technology course for secondary school teachers and evaluated their TPACK based on the technology-based lesson plans they designed. They found that the teachers improved in all TPACK domains, with the largest growth in technological content knowledge and technological content pedagogical knowledge. The teachers were able to identify the affordances of technology based on content and pedagogical requirements. By combining TPACK with hands-on experiences using the "learning by design" strategy, teachers will be able to integrate technology into their teaching practices effectively (Yeh et al., 2021).

1.2.2. Substitution Augmentation Modification Redefinition (SAMR) technology integration model

Moreover, the Substitution Augmentation Modification Redefinition (SAMR) technology integration model (Puentedura, 2006) can be used to evaluate the extent to which technology is applied in education and scaffold teachers' understanding of technology use (Bicalho et al., 2022; Hamilton et al., 2016; Tunjera & Chigona, 2020). The SAMR model identifies four levels of technology use: (1) *Substitution*: simply using the technology without adjustment; (2) *Augmentation*: improving traditional tasks with technology; (3) *Modification*: redesigning traditional tasks significantly using technology; and (4) *Redefinition*: creating new tasks based on the technology (Hamilton et al., 2016). Utilising the SAMR model, educators can evaluate the state of technology integration and provide targeted support to facilitate further integration. Research has shown that the model can enhance teachers' awareness of technology use and its integration into education (Harmandaoğlu Baz et al., 2018). Additionally, combining the SAMR model with other frameworks, such as TPACK (e.g., Hilton, 2016; Tunjera & Chigona, 2020), offers a comprehensive approach to guide teachers to design instruction that integrates technology effectively.

1.3. TPD for digital competence in Hong Kong

As the current study was conducted in Hong Kong, it is necessary to consider this context specifically. In Hong Kong, teachers' digital competence refers to the ability to adopt technology to facilitate the acquisition of 21st-century skills and cultivate students' ability to be self-directed learners (EDB, 2015). The Hong Kong Education Bureau (EDB, 2018) has further divided digital competence into five series: e-leadership, e-safety, pedagogical, subject-related, and technological. To promote teachers' digital competence and readiness to adopt e-learning in their classes, the EDB has suggested implementing professional development programmes, fostering learning communities, and encouraging reflective practice (EDB, 2015; EDB, 2018). Specifically, it has recommended that professional development equip teachers with essential knowledge of the latest instructional techniques used in e-learning (EDB, 2018). Learning communities allow teachers to share their experiences and provide mutual support to resolve issues (EDB, 2015). Furthermore, they facilitate teachers' adoption of new teaching materials and pedagogies (Law et al., 2011). Actively reflecting on issues can enhance teachers' proficiency in applying new knowledge (Moon, 2006).

Committee on Professional Development of Teachers and Principals (COTAP, 2015) collected relevant data and evidence in Hong Kong to inform TPD strategies and policies and established the "T-dataset^{PD}" based on a territory-wide survey (see https://www.cotap.hk/index.php/en/t-dataset). In their responses, novice teachers indicated that professional development programmes for digital competence "prepared them well to become a teacher holistically" (Policy 21, 2017, p. 15). However, they also raised some issues with the programmes. They said that the programmes were more helpful in the "teaching and learning" domain than the "student development" domain, presumably because they place greater emphasis on teaching than general personal development (Policy 21, 2017). Furthermore, the teachers reported they were not adequately prepared to cultivate creativity and self-direction in their students, respond to societal changes, assess the impact of their changes on social values, or become active in the educational community and volunteer work (Policy 21, 2017). Accordingly, in Hong Kong, there is an urgent need to provide quality TPD on OBL to improve teachers' digital competence, help them integrate technology effectively, and bring about positive student outcomes.

1.4. Study objectives

Considering the increasing importance of teachers' digital competence and the potential of microlearning as a TPD approach, this study focuses on pre-service teachers (PSTs) in Hong Kong who participated in a short TPD course via microlearning. The study aims to explore the effects of microlearning and its ability to create the conditions for professional digital competence in teachers' future practices.

Specifically, the study seeks to:

- Investigate the perceptions of PSTs regarding the effectiveness and relevance of microlearning as a TPD approach to develop digital competence
- Explore how microlearning can affect the integration of technology into teaching practices and the adoption of innovative instructional strategies
- Identify the challenges and opportunities associated with implementing microlearning as a TPD approach for PSTs in the context of education in Hong Kong.

While the current study focused exclusively on PSTs and did not include in-service teachers, we assumed that the participants, who had teaching experience during their internships, would be capable of making connections between their teaching experience and the learning content. This understanding allowed them to provide valuable insights into the requirements for developing professional digital competence through microlearning. Furthermore, considering the similar levels of teaching experience among novice teachers and the PSTs invited to participate, the results of the current study are expected to be generalizable to novice teachers.

2. Methodology

This qualitative case study is firmly grounded within the interpretive paradigm, where each participant is viewed as a unique, standalone case. Qualitative research, noted for its in-depth exploration of "how" and "why" questions (Myers, 2009), lends itself to the descriptive and exploratory nature of this study. The multiple-case study approach allows researchers to gain "a unique example of real people in real situations" (Cohen et al., 2018, p. 289) and facilitates a thorough portrayal of phenomena, subjective experiences, and perceptions. In the context of this study, this approach will provide a picture of teachers' digital competence needs by drawing on

abundant and multi-faceted data from questionnaires, semi-structured interviews, and observations. Additionally, by focusing on the underexplored area of microlearning TPD for English language teachers, we will contribute to theory building in this evolving field (Yin, 2009).

Moreover, this study delves into the ways microlearning can support sustainable e-learning practices among teachers. Because it can deliver bite-sized, focused segments of learning, microlearning encourages the active engagement and self-guided exploration of digital tools, which is critical for effective e-learning. This helps to foster digital competence, TPACK awareness, and SAMR integration among teachers, which are becoming increasingly important in the current digital education landscape. Thus, while qualitative research explains teachers' experiences and needs in the realm of digital competence, it also lays the groundwork for investigating the potential benefits of microlearning in terms of fostering effective and sustainable e-learning practices. This approach is even more pertinent considering that microlearning is a burgeoning field in which the existing theoretical and conceptual frameworks may not provide a comprehensive understanding. The case study method, therefore, serves as a fitting lens to explore, analyze, and contribute to this expanding discourse. This study addresses the following research questions:

- RQ1. To what extent does microlearning influence pre-service teachers' digital competence, TPACK awareness, and SAMR integration?
- RQ2. How does microlearning influence pre-service teachers' digital competence, TPACK awareness, and SAMR integration?

2.1. Participants

The first step of recruitment was to offer one semester long course in Spring 2022, which focused on integrating e-learning resources in primary and secondary schools. Thirty-two of the 36 participants in the course (22 women and 10 men) aged between 20-23 expressed interest in joining this study. The participants were third, fourth, or fifth (final) year pre-service English language teachers studying either primary or secondary education.

All 36 course participants were informed of the nature of the study in writing and completed the pre-course questionnaire (see Appendix A). However, the findings presented below represent the 32 participants who agreed to join the study and provided their informed consent. Among the 32 participants, twelve volunteered to participate in semi-structured interviews (see Appendix B) and observations (see Appendix C). The remaining course participants (n = 4) have the same access to any materials described in this study, but their data were not presented in this study. See Table 1 for participant profiles.

Table 1. Profile of the participants (observations, interviews)

Participant (Pseudonym)	Gender	Age	Year
Jacob	M	23	5
Mona	F	20	3
Anna	F	21	3
Raymond	F	21	4
Alex	M	21	4
Brian	M	21	3
Robert	M	23	5
Sonia	F	23	5
Billy	M	22	4
Samantha	F	22	4
Shane	M	22	5
Anna	F	21	3

2.2. Microlearning course design

As microlearning is a new course format for teachers in Hong Kong, it was important to give the participants (pre-service English teachers) first-hand experience engaging in and developing such lessons. The elective 13-week course that participants in their third, fourth, or fifth year can enroll in as part of their degree plan was designed based on the information gathered in the pre-course questionnaire and included the following features:

- introduction to the rationale and principles of using technology to support English language teaching and learning

- instruction on using technology to enhance English language teaching and learning
- introduction to applications, websites, and related activities useful for developing microlearning lessons
- tips on "getting it right" in the context of the Hong Kong English curriculum.

The microlearning approach to TPD was carried out according to the following procedure:

- introduction to microlearning via short podcasts (3 mins each) and formative assessments using Mentimeter (5 questions per podcast)
- technology instruction via short videos (4–5 mins) developed using Edpuzzle
- applications and websites introduced through a short face-to-face presentation (6 mins), followed by step-by-step instructions and tips developed using Canva (infographics)
- tips for success delivered using animated flashcards made with Quizlet and recorded videos (4–6 mins).

Participants had access to a rich resource repository on Moodle containing short-form content that they could consume at their pace and according to their priorities. Some of the topics and tools were related to SAMR, ways to engage students with technology, classroom management when using technology, creating interactive worksheets, e-book creation, virtual reality, comic strips, and animation. In addition, they could use a discussion forum to reflect on and share their experiences. To ensure that the course remained on-topic and engaging, the content was presented in small chunks and focused on the aforementioned learning outcomes. This structure was intended to make it less monotonous than traditional courses and help the participants retain the information.

2.3. Data collection

This study incorporated three phases of data collection, each designed to address the research questions. In the first phase, participants were asked to complete a qualitative online survey (see Appendix A), which collected their demographic details, perceived digital competence, and perceptions of microlearning as a professional development tool. Subsequently, they underwent personalized training on professional digital competence and engaged in microlearning lessons on integrating technology integration.

During the second phase, twelve participants volunteered for classroom observations; their lessons were video recorded. These observations focused on how and why participants integrated technology into their lessons (i.e., the influence of microlearning on their digital competence and TPACK awareness). To capture the degree of technology integration, an observation protocol grounded in Puentedura's (2006) SAMR framework, was developed (see Appendix B). This was also designed to identify the TPACK-based knowledge required to teach with technology effectively, aligning with Mishra and Koehler's (2006) TPACK model. Following each observation, participants were encouraged to reflect on their teaching using the prompts provided.

The third phase involved two-part individual interviews in English with the same twelve participants. The first part utilized a stimulated recall methodology (participants were shown a video sequence and invited to reflect) (Nguyen et al., 2013), while the second employed a conventional semi-structured interview guide to stimulate discussion about the teachers' digital competence, their perceptions of the microlearning course, and how it influenced their integration of technology. All of the interviews, lasting 35–50 minutes, were audio-recorded and transcribed verbatim.

Throughout the study, the team of four researchers remained in constant communication, devising the procedures and tools (e.g., questionnaire, prompts, and interview guide) collaboratively and ensuring that the data collected were congruent with the research questions.

2.4. Data analysis

The study produced a rich dataset that included multiple perspectives. There were three data sources: the qualitative survey, observations, and semi-structured interviews. The questionnaire data were analysed using descriptive statistics to meaningfully summarize the participants' responses (Jansen, 2010) and provide a general understanding of their personal and professional digital competence, knowledge of how to integrate technology into their lessons, and perceptions of microlearning.

We watched the lesson recordings and read the interview transcripts repeatedly to familiarize ourselves with the data. During the process, we took observational notes and recorded possible themes. We shared these themes using Google Docs; then, we noted and discussed similarities and differences.

In the next stage of the data analysis, the lead researcher conducted a more detailed analysis of each case using a thematic analysis approach (Braun & Clarke, 2006). All of the lesson observations and interviews were analysed in detail. A summary of each case was created using the initial themes, and the summaries were compared. At this stage, the analysis was shared and discussed with the three other researchers, and the themes were finalized.

Finally, extracts were selected to exemplify the final themes and offer insights into the participants' digital competence. The various datasets were cross-checked to ensure the credibility and trustworthiness of the findings (Braun & Clarke, 2006). In addition, the participants were allowed to review the transcripts, themes, and quotes through member checks (Merriam & Tisdell, 2016).

3. Findings

The findings of this study illuminate that microlearning increased the digital competence of the pre-service teachers and helped them recognize the skills they needed to engage in digital pedagogy. By analysing the datasets, we generated five main themes related to professional digital competence. Each theme addressed both RQ1 and RQ2. Participants' interview responses are presented verbatim in the following section.

3.1. Lack of confidence

The results of the pre-course survey showed that the majority of pre-service teachers were uncomfortable using digital tools to engage their students in learning. Over two-thirds (69%; *N = 22*) indicated that they lacked confidence due to their unfamiliarity with digital tools and how they can be used to facilitate English language learning. The remaining participants (31%; *N = 10*) indicated that they were somewhat confident. In other words, the pre-service teachers did not have much faith in their digital competence. They reported in the interviews that they find it relatively easy to use Kahoot! or Mentimeter for formative assessments. However, using applications that use multimodal approaches or digital storytelling felt overwhelming, and many did not know where to start. Jacob, for example, found that using applications for personal use did not transfer to teaching:

If you ask me, I'm confident in using social media, computers… I enjoy checking Facebook and posting tweets. But I don't know how I can integrate a range of technology with my future learners. I think it is not easy to understand how technology can actually support good language learning.

Mona also lacked confidence in her ability to leverage digital resources:

One of the key reasons [I am not confident] is that I need to teach using the textbook provided by the school. Meanwhile, we are required to incorporate technology into the lessons. This means I must discover the "right" tech and create e-activities suitable for my students. I wouldn't know where to begin.

The other participants' answers were similar. Anna stated, "The relationship between personal and professional use is different." Raymond said, "You know, just because we are 'young', we are expected to know how to use it with our students automatically." In the present study, the participants attributed their lack of confidence leveraging technology in their teaching practice to the little previous formal training they had received. Alex noted, "Courses to integrate technology in the classroom are optional in our degree."

3.2. SAMR

In the pre-course survey, the participants indicated they do not know how to create content. Only two (6%) indicated being confident that they could produce digital teaching content, although six (19%) said they could engage in basic content editing and 14 (44%) were confident in their ability to modify and improve existing digital content. However, it was clear from the observations and interviews that the participants could create digital content, so their content creation skills must have developed as they participated in the microlearning course.

At first, a majority of the participants indicated that they found it challenging to create digital resources. A majority of participants indicated that they were unsure which applications to use and how to engage their learners. However, after attending the microlearning course, the majority of pre-service teachers felt increasingly confident that they could use digital tools to create material and engage students in English language learning. For example, Brian explained how he created an e-book using the SAMR framework:

I used the e-book software that was introduced in our training. I moved the reading text and added the built-in text-to-speech features so students could read and listen to the text as it was read. Then, I linked the new vocabulary to Oxford Learner's Dictionaries, and I encouraged everyone to share a review of the text on our Instagram account.

Alex also utilized the SAMR framework to modify an assignment about tourist locations in Hong Kong:

Students read about typical tourist spots in their books, which can be tedious. So, to excite them, I downloaded a map of Hong Kong, used Thinglink [an Augmented Reality application] and created tags that the student could click on, covering the different districts that introduced the spots using videos created by EdPuzzle. Then, they had to select their favourite one and make a digital travel brochure incorporating multimedia and a student-created video.

Other participants discussed incorporating comic strips, interactive worksheets, and flashcards to digitize existing materials. The interviews showed that microlearning provided the teachers with the knowledge and skills they needed to use technology and the SAMR model helped them think about its role in supporting learning.

In the observations, the participants incorporated many digital tools into their lessons to engage their students, using various platforms (e.g., Wordwall, Nearpod, Edpuzzle) to meet their learners' diverse needs. For example, three participants created PowToons to introduce and reinforce aspects of grammar and five used comic strips created with Canva to present new vocabulary. However, further analysis showed that most of the participants only substituted digital teaching materials for physical ones (the first stage of the SAMR model). Robert shared that "identifying one task that fits all of the four definitions of the SAMR model is difficult;" instead, he tried "to think about how [he] can simply modify a task." Sonia also mentioned that incorporating all four components would "be too time-consuming, not only for me but we won't have enough lesson time for the students for the redefinition."

3.3. Classroom management

Before taking the course, 21 (66%) of the participants reported that time management was a challenge when using digital tools in the classroom. Nineteen (59%) felt the same way about managing supportive interactions and behaviours.

We observed that all of the participants integrated digital resources into their lessons but appeared to struggle with classroom management as students worked on their iPads. Only three out of the 12 participants gave clear instructions before the activity and managed to keep their students on-task. Billy explained: "Students were excited, I didn't want to disrupt them by asking them to keep their voices down." Samantha echoed this: "They were happy, and I thought most were working on the activity." Given the difficulties of monitoring the class and the potential for confusion when working with technology, students need to receive clear instructions. In the interviews, the participants realized that incorporating technology in their lessons was challenging – not only because each form of technology is unique but also because of the pedagogical skills required to use them effectively.

They perceived this to be a limitation of microlearning. When asked to elaborate, Jacob mentioned that he had focused on building up his "technical know-how" in order to "design good activities for his students." This sentiment was shared among the participants; technical knowledge took precedence over pedagogy even though, in the microlearning course, these two aspects were given equal weight. This suggests that future courses should focus on digital pedagogy, as participants can learn the required technical skills but still lack the skills to manage their classrooms.

3.4. Personalized training

In the pre-course questionnaire, over two-thirds of the participants (69%; *N = 22*) indicated that it was important for the course to meet their individual needs. Interestingly, 29 (90%) reported that it should focus on specific tools and 24 (76%) said it should be social. Later, the participants mentioned that they all had different levels of digital competence, and microlearning allowed them to select relevant and appropriate content. Shane shared that the "sense of autonomy helped me build on my existing skills without being forced to study what I'm not interested in." Anna added:

The video overviews and step-by-step instructions gave me a really good insight into how I could use them [digital tools] in my teaching. But there was one tool, I think it was Lino, I felt it didn't really do anything, so after the video, I forgot about it.

Similarly, Anna stated:

I liked that I could watch a short video and kind of figure out what the tech was about. And if I didn't like it, I didn't need to do anything else. I think this is a really good way to deepen our knowledge of available technology and decide if it would work for us when we teach.

These comments illustrate that introducing new technology and pedagogy using short, focused segments of learning allows participants to decide what is practical and easy for them to use. The flexibility of microlearning can also make participants more confident in selecting digital tools.

Even though the course was delivered using microlearning and each segment was relatively short, the participants also felt that it provided a form of collective learning because of the multimodal elements (e.g., videos, podcasts, infographics) and built-in discussion forums. Brian noted, "This made me more motivated…I felt we were learning together." Others added that the online forum helped them reflect on ways to modify their teaching practices and support each other. Therefore, this aspect of the course also increased the participants' understanding of how digital tools can facilitate learning in the classroom.

3.5. Hands-on training

Microlearning also gave the participants ample opportunity for hands-on practice, which allowed them to handle digital tools and practice integrating them into their teaching. Mona said, "I consider myself not very good with technology, so I'm very hesitant to use technology in my lesson. So, playing around with so many tools without pressure really helped me to overcome my uncertainty." Likewise, Alex appreciated the "opportunity to experiment with and explore a range of cool tools." Raymond added, "The link to theory became clearer during the practical part as I could experience it first-hand."

Brian said, "I found the prompts provided [helped] me to understand how I can get the best from the technology." When asked to elaborate, he specified that he liked "figuring out which features work best for me." The participatory element of microlearning allowed the participants to expand their practical skills and develop new ideas of how to use technology to impart content knowledge. They found that the microlearning design elements of the course not only taught them how to use technology but also understand why they should do so.

3.6. Summary

In summary, concerning RQ1 ("To what extent does microlearning influence pre-service teachers' digital competence, TPACK awareness, and SAMR integration?"), this study indicates that microlearning impacts all three areas significantly. Initially, many of the participants lacked confidence in leveraging digital tools for teaching due to their unfamiliarity with such resources and the perceived disconnect between personal and professional use. Yet, after undergoing microlearning training, they were more confident and could create digital content using various forms of technology, guided by the SAMR model. The microlearning course also facilitated personalized learning, allowing them to focus on tools relevant to their needs and interests. Its hands-on aspect helped them overcome hesitations and uncertainties. However, there were challenges. For example, some participants struggled with classroom management when integrating digital resources into their lessons, suggesting that future training and courses should focus on digital pedagogy. Furthermore, most participants only substituted digital materials for physical ones, indicating they had not fully maximized the potential of digital technologies as described in the SAMR model. Overall, microlearning has a significant but nuanced influence on pre-service teachers' digital competence, TPACK awareness, and SAMR integration.

Concerning RQ2 ("How does microlearning influence pre-service teachers' digital competence, TPACK awareness, and SAMR integration?"), this research indicates that it does so in the following six ways:

- Microlearning appears to boost pre-service teachers' confidence in utilizing digital tools to facilitate English language learning. Prior to the microlearning course, many of the pre-service teachers expressed discomfort and little confidence in using digital tools. However, as they progressed through the course, their confidence increased, indicating an enhancement in their digital competence.
- The SAMR framework in the microlearning course helped pre-service teachers understand how digital tools can support learning. Although initially most of them only substituted digital teaching materials for physical ones, the model helped them think about how to augment, modify, and even redefine tasks using technology.
- While the pre-service teachers recognized that they struggled with classroom management when integrating digital resources, the microlearning course provided an environment in which they could experiment with the required skills. This highlights the need for future courses to focus on digital pedagogy.
- The microlearning course allowed pre-service teachers to select the content that met their needs, contributing to a sense of autonomy. This personalization helped them build on their existing skills and improve their digital competence.
- Even though the course was composed of short segments, it provided social benefits that made learning a collective experience. The online forums, discussions, and multimodal elements (e.g., videos and podcasts) facilitated peer learning and experience-sharing, enhancing teachers' TPACK and providing examples of how others integrate the different forms of knowledge.
- The course also offered significant hands-on practice, allowing pre-service teachers to explore and familiarize themselves with various digital tools, which likely improved their digital competence and understanding of how to integrate technology into teaching.

4. Discussion and conclusion

The current study has showcased the intricate and challenging process of developing digital competence in pre-service teachers, with a focus on the pivotal role of microlearning. By actively engaging in microlearning tasks, the participants strengthened the digital skills that are for professional growth, facilitating the seamless integration of technology into OBL classrooms. Despite being limited to primary and secondary school teachers in Hong Kong, this qualitative study broadens the understanding of enhancing teachers' digital competence through microlearning, an essential TPD approach.

In our exploration of microlearning, two core elements emerged: (1) concentrated, practical training and (2) a supportive, reflective environment. This approach can be applied to both pre-service and in-service teachers. It enabled the participants to use technological tools effectively; many of the digital practices we saw in the observations emerged directly from the course. One notable example was the use of the e-book tools in software such as Nearpod, Thinglink, and Edpuzzle to convert traditional print resources into interactive and engaging digital learning materials. However, this had an unexpected impact on oral interactions in the classroom (Moorhouse et al., 2021), highlighting the need for an iterative approach informed by microlearning principles to help teachers adapt their teaching practices.

Our analysis also examined how teachers incorporated various tools that were introduced in the microlearning course. They effectively employed student response systems (e.g., Kahoot!, Mentimeter) for formative assessments and online platforms (e.g., Padlet) for brainstorming activities. Their increased confidence in incorporating technology in their teaching indicates the effectiveness of the microlearning approach. However, it also underscores the necessity of going beyond technical skills and focusing on developing teachers' digital pedagogy and ensuring alignment with local contexts (Hubbard, 2018).

The English language teachers' heightened awareness and aptitude in using digital tools after the microlearning course demonstrates its effectiveness for both pre-service and in-service teachers (Kohnke et al., 2023). They were able to devise appropriate teaching materials for the face-to-face classroom, despite occasional frustrations and difficulties concerning classroom management when digital tools were the primary learning resources (An et al., 2021).

The results of this study illustrate the potential of microlearning in cultivating skilled, competent teachers as they demonstrated and expressed digital competence after participating in the course. It allows teachers to direct their own learning and choose the easily digestible learning segments that they find most beneficial (Shamir-Inbal & Blau, 2020). Aligning with principles of informal learning, microlearning encourages learners to decide what,

when, and where they learn, fostering the continuous development of their digital competence. Through the systematic design of TPD that encompasses microlearning, it is possible to cater to the needs of all stakeholders, ensuring that learning is context-specific, collaborative, and relevant (Kennedy, 2016; Opfer & Pedder, 2011; Voogt et al., 2015).

However, this relatively small-scale qualitative case study cannot be generalized to other teachers or contexts. Nevertheless, it provides a starting point for more extensive studies. Accordingly, future research could examine whether there are significant differences related to TPACK and SAMR if the course were taken by in-service teachers in Hong Kong or other contexts. In addition, professional development providers can consider how to develop the most effective activities based on continuous feedback and, thus, implement a cyclical process to increase teachers' competence (e.g., Voogt et al., 2015). Finally, readers will need to choose the ideal way to implement microlearning based on their particular contexts and the technology available.

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Appendix A: Sample questionnaire questions

Q1. What is your gender?
Q2. What is your age?
Q3. How confident are you in using digital tools to engage students in learning?
- Not confident at all
- Slightly confident
- Somewhat confident
- Quite confident
- Very confident

Q4. How confident are you in producing digital content?
- Not confident at all
- Slightly confident
- Somewhat confident
- Quite confident
- Very confident

Q5. How confident are you in engaging in basic content editing?
- Not confident at all
- Slightly confident
- Somewhat confident
- Quite confident
- Very confident

Q6. How confident are you in modifying and improving existing digital content?
- Not confident at all
- Slightly confident
- Somewhat confident
- Quite confident
- Very confident

Q7. What is the most challenging aspect of using digital tools in the classroom? (open)
Q8. What is the most important part of digital competency training? (open)

Appendix B: Sample interview questions

- Can you tell us what tools you prefer to use and why?
- How did you learn to use these tools?
- In your teaching, which digital tools did you use? Why?
- In your teaching, what is the most challenging with using digital tools?
- In your teaching, are there any digital tools you would like to learn how to use? Why?
- Based on your experience participating in microlearning, what are the main differences between traditional training and microlearning?
- Has microlearning helped you to develop your digital competency? What have been the essential components? Why?

Appendix C: Sample observation protocol

- Technology resources (ratio technology/student)
- Digital tools being used
- Skills (listening, speaking, writing, reading)
- Student learning activities
- Interactions (independently, collaboratively [pair/group])
- Teacher roles (e.g., facilitation, modelling, presenting)
- Teacher proficiency
- Student proficiency
- Classroom management
- Other observations