UNIVERSITY OF TURKU

The Effect of Teacher Training Programs on Chemistry Teachers' Readiness to Use ICTs in Teaching

A case study of Vietnamese New In-service Chemistry Teachers

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1 INTRODUCTION

In the current era of Industry 4.0, technology has become an indispensable aspect of our lives, with its influence pervading all areas, including education. The Covid-19 pandemic has served as a catalyst, further accelerating technology adoption in education and leading to a significant transformation in the field. What was once considered an optional addition for schools and teachers has become necessary, with the pandemic mandating a shift to online learning and remote teaching. Technology integration has significantly impacted the teaching and learning landscape, offering new opportunities for creativity and innovation, enabling personalized learning, enhancing communication and collaboration, and improving student preparation for the future.

Before covid, the widespread adoption of technology in education has already increased teachers' demands to integrate technology into their teaching (OECD, 2018). Consequently, the knowledge and skills required to meet the current era's complex and growing demands of educational reforms are significant for teachers. Older generations of teachers may require additional school support to develop their professional competencies alongside their work. On the other hand, new-generation teachers, especially those in their initial teacher education (ITE), must build a foundational understanding of technology in education, develop a digital mindset in teaching, and establish an appropriate attitude toward technology use. This, in turn, has led to the necessity of integrating technology in pre-service teacher training programs and in-service professional development.

In Europe, teacher-specific digital competencies are recognized in competence frameworks as some of the essential competencies teachers are expected to have in about two-thirds of European education systems as of 2019 (Eurydice, 2019). Hatlevik (2017) affirmed that ITE is critical in developing the foundational knowledge and skills that pre-service teachers need to become confident and competent professionals. An effective ITE program can be a guideline for producing new generations of innovative digital teachers. According to Hofer and Grandgenett (2012), training teachers is crucial for preparing them as proficient users of ICT in education. Teacher training institutions (TTIs) are expected to equip new teachers with the necessary skills to incorporate technology into education and to impart ICT competence to students.

Chien et al. (2012) and Kaufman (2015) highlighted a growing trend among TTIs worldwide to revamp their curriculum frameworks to prioritize technology integration in education, driven by increasing societal demands. To meet these new standards and prepare pre-service teachers (PSTs) for the digital age, TTIs must go beyond traditional methods and facilitate training that includes meaningful technology integration activities, learning experiences, and professional development and leadership opportunities (ISTE, 2018). Many institutions have responded to this challenge by introducing new technology courses that range from generic to subject-specific, aimed at enhancing PSTs' technological knowledge and skills (Polly et al., 2010).

Nevertheless, research indicates that current training programs may not be adequate to keep up with the rapidly changing world of technology. Gudmundsdottir and Hatlevik (2018) surveyed 356 new in-service teachers in Norway. These teachers perceived the technology training in their ITE as inadequate, needing more contribution to their personal development plan. Similar results were found by Arstorp (2015) in Denmark, Tondeur et al. (2016) in Belgium, and Usun (2009) in Turkey. The researchers also found a need for more evidence in ITE programs on preparing PSTs to use ICT in the classroom, despite the TTIs highlighting technology outcomes in their frameworks. This poor training quality may be why pre-service and beginning teachers often under-use technology in the classroom (Agyei & Voogt, 2011; Chien et al., 2012). According to Tondeur et al. (2012), only a few pre-service and new in-service teachers can use technology in diverse and flexible ways. As such, it is imperative to investigate the purposeful use of technology in teacher training, especially concerning specific subject teaching.

On a different aspect, Gudmundsdottir & Hatlevik (2018) found that over 80% of teachers had positive beliefs about the usefulness of ICT, indicating a higher chance that they would actively engage in continuous professional development. Despite this, many of them still had a negative attitude toward technology use in teaching, claiming it could be a distraction factor. Poor experiences with ICT in education, such as perceiving it as a distraction, may weaken new in-service teachers' confidence and prevent them from developing higher ICT self-efficacy. Those teachers who perceived ICT as a distraction also had more significant difficulties fulfilling school and curriculum goals connected to ICT use (Langford, Narayan, and von Glahn 2016; Junco, 2012).

The training programs can be more effective by employing scientific methods, measurement tools, and frameworks to guide the development of teachers' digital competence. By understanding the current level of teachers and the specific needs of local educational systems through actual fieldwork, ITE programs can be tailored to address these issues effectively and build courses that prepare PSTs with the necessary technical knowledge and skills for teaching. To this end, it is essential to build a foundation framework for the program and keep it updated to match the current context. Technological Pedagogical Content Knowledge (TPACK) is a widely used framework for assessing PSTs' competencies. In contrast, the Substitution, Augmentation, Modification, and Redefinition (SAMR) model is commonly used as an indicator for self-reflection and professional development building.

This study examines the context of digital use in Vietnamese education, focusing specifically on new in-service Chemistry teachers using the TPACK-SAMR framework. The study will evaluate their digital competence, collect their perspectives on teacher training programs, and assess how the program contributes to their professional development plans. The study's findings are expected to provide valuable insights into the teaching of Chemistry in Vietnam and suggest ways to improve the quality of the teacher training program better to meet the needs of local teaching career requirements.

2 THEORETICAL FRAMEWORK

This study employs two established frameworks, Technological Pedagogical Content Knowledge (TPACK) and Substitution, Augmentation, Modification, Redefinition (SAMR), to comprehensively evaluate teachers' digital skills in teaching. The TPACK framework identifies the essential knowledge teachers need, while the SAMR framework focuses on how teachers apply their digital skills in student interactions. These frameworks complement each other in evaluating teachers' digital skills, and integrating them provides a more comprehensive understanding of teachers' abilities, fulfilling the purpose of this study. This section elaborates further on TPACK and SAMR, highlighting their complementary nature. It also includes a literature review that assesses the effectiveness of educational technology courses for teacher training, encompassing both global and Vietnamese contexts. The review identifies explicitly the critical features of successful courses, later compared with the program under study.

2.1 TPACK model

The Technological Pedagogical Content Knowledge (TPACK) model, proposed by Mishra and Koehler in 2006, provides a framework for measuring teachers' use of technical tools, such as hardware and software applications, to improve student learning. Since its introduction, TPACK has been widely used in research on educational technology (Lee & Tsai, 2009), particularly in evaluating the ICT competencies of PSTs (Joo et al., 2018; Valtonen et al., 2019). The TPACK framework emphasizes the integration of content knowledge, pedagogy, and technology, enabling the analysis and explanation of complex educational phenomena (Chai et al., 2010; Jiawei & Zuhao, 2021). PSTs with strong TPACK competencies are better equipped to use ICT effectively in their classrooms, leading to improved student outcomes (Habibi et al., 2020).

At the first level, the model is composed of three interrelated forms of knowledge: technological knowledge (TK), pedagogical knowledge (PK), and content knowledge (CK). Technological knowledge (TK) is the understanding of technological tools and resources available for teaching and learning. An advanced level of TK allows teachers to use and troubleshoot education hardware and software to evaluate the advantages and limitations of different technologies. Hence, they can use technology to search and organize information, solve problems, and communicate while designing and implementing their teaching ideas. According to Harris, Mishra, & Koehler (2009), TK is a developmental type of knowledge since technology is updated constantly, and teachers need to accelerate their TK through various interactions.

Pedagogical Knowledge (PK), the art and science of teaching, relates to teaching methods, strategies, and techniques for achieving educational goals. It also encompasses understanding learning theories, student motivation, and methods for managing the educational environment (Harris et al., 2009). The art of teaching arises from teachers' personal beliefs, perspectives, and personalities, shaping how they integrate their pedagogical training into their teaching style.

Content Knowledge (CK) refers to the knowledge of the content or subject matter taught. This includes understanding the key concepts, theories, and organizational frameworks within the subject area, as well as the practices and methods used to develop knowledge within the field (Shulman, 1986). For instance, a Chemistry teacher should possess a deep understanding of advanced Chemistry, be able to explain and evaluate the curriculum and have the necessary skills to work in the laboratory and perform science experiments for educational purposes.

The three fundamental knowledge bases of TK, PK, and CK are interdependent and must be integrated to facilitate effective teaching. TPACK recognizes three types of knowledge that arise from the integration of these fundamental knowledge bases: technological content knowledge (TCK), pedagogical content knowledge (PCK), and technological pedagogical knowledge (TPK). The following graph illustrates the interrelationships among this knowledge within the TPACK framework.

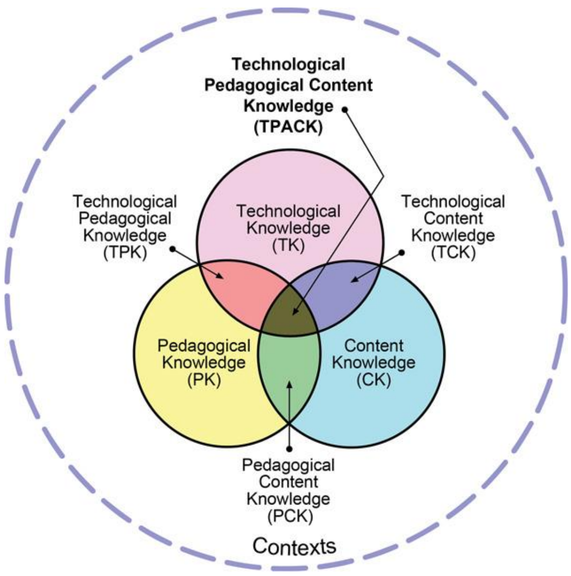

Figure 1. The most common representation of TPACK framework (from http://tpack.org)

Pedagogical Content Knowledge (PCK) was first conceptualized by Shulman (1987), including two sets of skills: representations (communication, explanation, instructional design creations, etc.) and knowing students' learning difficulties to address correcting misconceptions and scaffolding further learning appropriately. Mishra and Koehler (2006) added that PCK also includes teachers' flexibility and creation in adapting teaching strategies to meet the needs of different learners.

Technological Pedagogical Knowledge (TPK), on the other hand, is concerned with using technology to enhance learning activities. It involves understanding how to use specific technologies effectively and creatively to design engaging and compelling learning experiences. TPK is dependent on the creativity of teachers to make effective use of a wide range of technologies.

Finally, Technological Content Knowledge (TCK) is the knowledge of selecting specific technology tools and resources to support teaching and learning. Teachers must understand the advantages and disadvantages of different technologies and how to use them appropriately in designing and implementing teaching strategies for a specific content area.

As in Figure 1, TPACK competence is situated at the center, encapsulating a holistic understanding of utilizing technology for teaching. Notably, it entails more than just proficiency in each of the three primary components individually. Instead, it entails comprehending how to effectively employ technology in teaching concepts, which ultimately enhances student learning experiences. TPACK highlights the interplay between technology, content, and pedagogy, and the purposeful blending of these elements is integral.

TPACK can serve as a valuable guide to educators, prompting them to analyze their approach and the nuanced connections between its various components. Empirical studies, such as those conducted by the Australasian Society for Computers in Learning in Tertiary Education, indicate that the TPACK framework enhances teachers' capacity to employ technology in their learning and professional practices. These findings suggest that TPACK should be incorporated into teacher training programs and form the basis of new professional development opportunities (Maor, 2013). Given its potential impact on educators, training programs, professional growth, and student outcomes, asserting that TPACK is a vital concept in education is an understatement.

The development of TPACK is a continual process that necessitates constant reflection and adaptation. The ability of teachers to engage in independent research and development is pivotal in the evolution of this framework. Nonetheless, teacher training programs are instrumental in laying a robust groundwork for TPACK for educators. A profound comprehension of the TPACK framework is imperative for integrating technology seamlessly into pedagogical practices, and such understanding is often gained through structured training programs (Graham et al., 2009; Hoffer & Grandgenett, 2012). Understanding TPACK and with a clear vision of self-regulation and self-development, teachers can effectively integrate technology and continually augment their knowledge and skills through experience.

2.2 SAMR model

The SAMR model is a framework for integrating technology into teaching and learning that consists of four stages: Substitution, Augmentation, Modification, and Redefinition. While the TPACK framework has a solid theoretical foundation developed over the years, the SAMR model was first introduced by Dr. Ruben Puentedura in a blog post in 2006. Despite its relatively recent origin, it has gained widespread adoption in the educational field, with many schools and districts using it to promote technology in teaching.

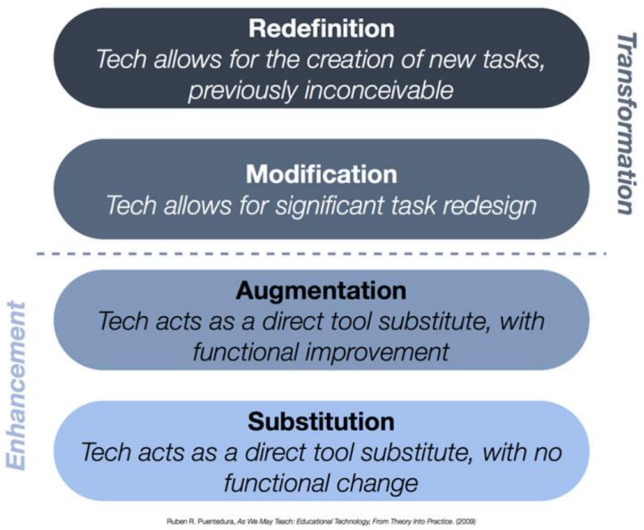

Figure 2. Puentedura's SAMR model (2006) (from http://www.hippasus.com/rrpweblog/)

At the Substitution stage, digital tools are used as direct replacements for traditional tools without any functional change to the learning outcomes. For instance, instead of using the traditional board to present the topic content, teachers can use PowerPoint slides with pre-

prepared information shown to students. However, even with technology, this learning activity's information transfer and purpose remain the same as before.

At the Augmentation stage, technology is used to improve the functional aims of the learning activities beyond what is possible with traditional tools. For example, the traditional exam-taking style can be time-consuming when providing grades and comments to each student. However, with technology, students can conveniently take tests online and receive immediate results. This digital exam-taking saves time and enables students to independently analyze their mistakes and improve their learning trajectory by completing additional tasks and practicing deficient skills (Drugova et al., 2021). Various platforms facilitate the incorporation of such additional functions by teachers. For instance, Google Forms tests allow students to view grade distribution charts and identify their performance on individual questions, enabling grouping discussions to address misunderstandings. Another platform, Quizizz, offers students the opportunity not only to compare their results with the entire class but also to practice their incorrect answers selectively. The gamified nature of Quizizz allows students to replay quizzes multiple times, transforming the assessment into an engaging revision practice. These minor adjustments made by using technologies cannot be achieved in the traditional way.

At the Modification stage, technology integration becomes transformative, requiring a redesign of the lesson around the digital tool. For instance, in a science classroom where students need to learn about light, teachers may show a diagram of how light travels, explain the theory, and provide students with a formula to solve problems. Using technology simulations, students can explore the effect of changing variables on light, follow instructions to interact in a virtual lab and formulate equations by experimenting with the phenomenon. In this case, technology encourages teachers to rethink and redesign the activity (Hamilton, 2016).

Finally, at the Redefinition stage, new tasks that were previously inconceivable without technology are created. For example, instead of teaching students different reading skills using ordinary texts, teachers design a platform where students can find reading material that includes audio, video, and an online dictionary. Students can then interact with the texts while practicing reading and record their reading to receive peer and teacher feedback in discussion forums (Buldiman et al., 2018).

The SAMR model, although widely implemented and praised in training programs and classrooms, has also faced some criticism. Hamilton et al. (2016) critically reviewed the model and identified three main areas for improvement. Firstly, the model needs acknowledgment of the teaching and learning context. Secondly, SAMR focuses on technology products rather than the teaching and learning process. Lastly, the model is perceived as hierarchical due to its commonly associated graphics and emphasis on achieving the highest level of Redefinition (Kirkland, 2014). This perception is reinforced by the alignment of SAMR with Bloom's Taxonomy in Dr. Puentedura's presentation in 2014, in which he situated the enhancement stages (Substitution, Augmentation) to correspond with Bloom's basic levels of learning (Remember, Understand, Apply), and the transformation stages (Modification, Redefinition) to correspond with higher cognitive levels (Analyze, Evaluate, Create), as shown in the figure below.

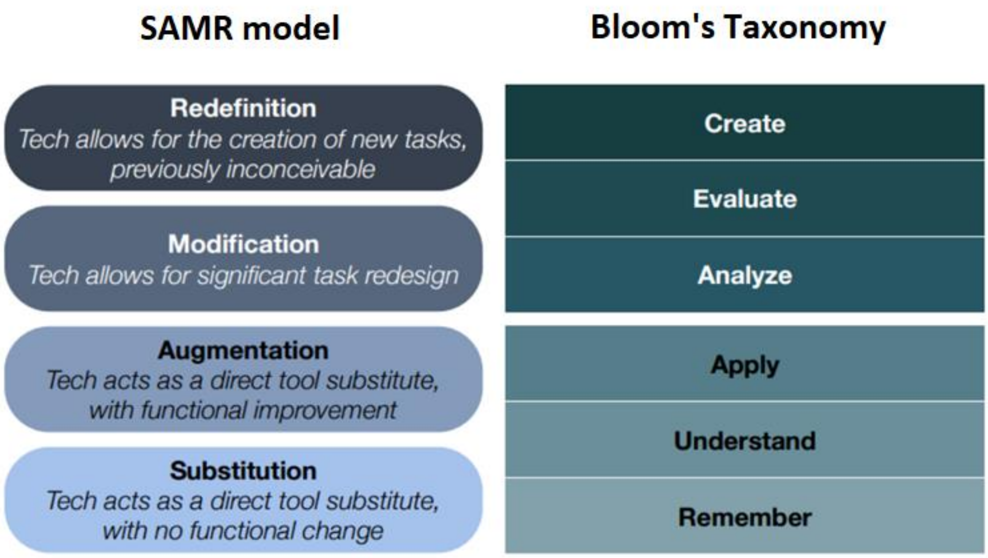

Figure 3. Visual model of the SAMR model and Bloom's Taxonomy
(from a discussion by Ruben Puentedura (2014))

However, researchers have pointed out that the model is used sparingly and hierarchically. Hilton (2016) noted that while teachers strive for higher levels, they also pay attention to lower ones. In fact, the two social studies teachers found that they tended to use technology for substitution and augmentation in content acquisition activities, while modification and redefinition were used for skills practice activities. The SAMR model is not prescriptive in its approach but rather encourages teachers to consider appropriate technology for a specific learning activity or objective (Hilton, 2016; Hamilton et al., 2016; Blundell et al., 2022).

2.3 TPACK-SAMR combination

TPACK and SAMR are widely used frameworks for assessing and developing teachers' technology integration in teaching (Kihoza et al., 2016). Although these frameworks have different origins and approaches, they complement each other in various ways.

Firstly, TPACK and SAMR focus on different aspects of technology integration. TPACK focuses on understanding teachers' competence and how their various component skills interact, while SAMR emphasizes how technology integration impacts student learning. Hilton (2016) noted that TPACK seems more teacher-centered, and SAMR is more student-centered. Tunjera et al. (2020) also argued that TPACK has a behaviorist theoretical foundation, while SAMR has a constructivist approach. Therefore, both frameworks can help teachers develop a more nuanced understanding of technology integration. TPACK can help teachers understand how to select and use digital tools to enhance specific learning objectives. In contrast, SAMR can help them see how different digital tools can support each learning stage, such as knowledge acquisition versus skill practice.

Secondly, TPACK and SAMR can be complementary approaches, each with its own assessment and development goals. TPACK provides a framework for assessing teachers' abilities to match digital tools with teaching methods to transfer content knowledge effectively. It is advantageous during the planning stage, as it delves deeper into the underlying problem of teaching. On the other hand, SAMR lacks theoretical grounding but offers a roadmap for teachers to evaluate the effectiveness of their lessons using different digital tools, enabling them to set clear goals for improving their technology integration practices. SAMR reflects how teachers demonstrate their skills to students, while TPACK focuses more on the quality of the teacher's skills. For instance, Hilton (2016) notes that when teachers reflect on their teaching activities throughout the year, they use SAMR as a reflective tool for each lesson, while TPACK reflects on their overall skills.

Additionally, Geer et al. (2017) highlight that teachers can enhance their TPACK by utilizing the SAMR model, which allows for a step-by-step advancement. TPACK helps teachers better understand how to use digital tools by contextualizing the knowledge required for technology integration. Simultaneously, Kihoza et al. (2016) indicate that the SAMR model provides a means to evaluate distinct stages of incorporating technology for improvement and innovation, presenting a unique chance to assess integration from the viewpoints of educators and learners.

Although the TPACK and SAMR models are widely used for assessing teachers' digital competence, they have limitations when used in isolation. Tunjera et al. (2020) note that both models fail to provide practical guidance on integrating all knowledge domains to transform teaching activities. Therefore, it is crucial to consider the contextual and flexible nature of these models, emphasizing pedagogical intentionality (Bicalho et al., 2022). Ultimately, using any framework should help teachers make more intentional and effective use of technology in their teaching (Hilton, 2016).

One potential way to use TPACK and SAMR together is to assess a teacher's TPACK skills first and then use SAMR as a roadmap for improvement. This approach could help teachers identify which digital tools to become more familiar with to achieve their pedagogical goals. Although there is limited research on combining these two models, this study aims to use both models to assess teachers' digital skills. While the study cannot provide a combined framework and will only use separate instruments for both models to assess separately, the data collected can provide a more comprehensive picture to analyze and discuss.

2.4 TPACK-SAMR and the teacher training curriculum

2.4.1 Current Findings on Pre-Service Teachers' Technology Competencies

Blundell et al. (2022) conducted a scoping review to investigate the application of the SAMR model in teaching with technology by analyzing 230 publications up until 2021. The review identified 123 types of teacher actions, with most teachers using technology to substitute and augment traditional teaching methods, as evidenced by only eight types of modification action (6.50%) and ten types of redefinition action (8.13%). The most commonly used digital tools were in the substitution and augmentation stages, including presenting content with various digital devices and software, creating activities using hardware and software-based tools, sharing materials using digital platforms, and communicating through various electronic means. While some teachers have transformed their teaching methods and implemented new approaches to teaching and learning, the general trend is towards making minor improvements to existing teaching methods. Chen (2008) and Herold (2015) have found that teachers face challenges in understanding how to effectively implement technology in classroom practices, particularly when it comes to constructivist teaching strategies. Therefore, most teachers require additional training to develop their digital mindset and think innovatively about technology use in the classroom.

Multiple studies have indicated insufficient TPACK among pre-service and new in-service teachers. Al-Abdullatif (2019) found that Saudi pre-service teachers exhibit low confidence in various TPACK integration practices. Similarly, Koh and Divaharan (2011) discovered that pre-service teachers need more TPACK understanding and help to grasp the interplay between CK, PK, and TK. Research focusing on specific components of TPACK has yielded mixed findings. Chai et al. (2013) and Wang et al. (2020) found that teachers possess limited technology-related knowledge across TK, TPK, TCK, and overall TPACK. Furthermore, pre-service teachers often receive technology skills in isolation from teaching methods and subject matter (Tondeur et al., 2017; Voogt & Mckenney, 2017). Certain studies have indicated that pre-service teachers show the most development in TK and TPK during their teacher training, while TCK receives less emphasis (Koh & Divaharan, 2011; Swan & Hofer, 2011). Valtonen et al. conducted a series of studies from 2019 to 2022, assessing pre-service teachers' progress during their initial three years of teacher training. They found that skills related to PK gained the most, while TCK remained the lowest during the three years. The authors propose that PSTs' TCK and TPACK can be enhanced through increased focus on subject-specific pedagogical modeling, evaluating products, and collaborating with peers.

These findings indicate that Initial Teacher Education (ITE) needs improvement. According to Kay (2006) and Niess (2012), ITE provides distinct technology courses that mainly concentrate on educating PSTs about various technologies (such as word processors, presentation software, and the internet) and their advantages and limitations. Although this approach offers benefits such as boosting the self-confidence of PSTs, fostering a holistic comprehension of technology's role in instruction, and building a solid groundwork of technical abilities, it has not led to integrating digital technologies into their teaching practices. Furthermore, Mouza et al. (2014) argue that the current ITE curriculum lacks the integration of technology courses, pedagogy courses, and subject content courses, causing PSTs to feel uncertain about integrating technology into their teaching practices. Additionally, other researchers, such as Angeli and Valanides (2005), Graham et al. (2009), and Niess (2011), have found that PSTs often fail to apply theoretical knowledge to their teaching practices or collaborate effectively with their peers, despite having sufficient knowledge. As a result, many researchers have designed and implemented various types of TPACK courses, focusing on guiding PSTs to blend technological knowledge (TK), pedagogical knowledge (PK), and content knowledge (CK) in their teaching practices. The following section will summarize the results of developing practical educational technology courses for PSTs.

2.4.2 Features of Effective Educational Technology Courses

The implementation of the SAMR model in instructional design courses needs a more apparent recommendation from researchers. However, to better understand the context and to demonstrate relative change resulting from technology-infused practices, a baseline may prove helpful for teacher reflection and professional development (Blundell et al., 2022). In contrast, multiple studies have aimed to enhance the TPACK competence of PSTs through diverse approaches. The literature suggests that particular features of an educational course, such as mentoring and peer coaching, work sample analysis, authentic experience, observation, rehearsal and field experience, and reflection, can facilitate the development of PSTs' TPACK skills.

Teacher educators (TEs) are pivotal in fostering and supporting technology learning among PSTs while recognizing the importance of peer collaboration in the learning process. According to Baran et al. (2019), the most successful approaches for fostering the development of PSTs' TPACK involve learning from role models (trainers), understanding technology value, and discussing experiences and challenges of integrating technology. Collaboration and peer coaching enable PSTs to acquire skills with their peers' support and identify their own weaknesses, as reported by Jang (2010) and Tokmak, Incikabi, & Ozgelen (2013).

Work sample analysis is another practical approach that involves critiquing or reviewing practitioner-created materials or enacted lessons that involve technology-integrated lessons. This assignment presents a demanding task for PSTs as it requires them to deeply contemplate integrating content, pedagogy, and technology to develop effective instruction. It entails merging knowledge from their educational technology, subject, and pedagogy courses. This activity promotes the cognitive skills of PSTs in combining their knowledge, thus enhancing their TPACK thinking (Mouza et al.,2014).

Instructors within education faculties should employ more than just technology in their instructional environments for presentation purposes. They should also provide PSTs with practical, hands-on experiences with technology. It is crucial to offer authentic learning opportunities with technology, as these experiences effectively foster PSTs' preparedness to utilize technology (Banas & York, 2014; Gill & Dalgarno, 2017; Tondeur et al., 2012). Longitudinal studies have also highlighted the critical role of learning experiences with technology in developing PSTs' TPACK, as noted by Gill & Dalgarno (2017) and Wang et al. (2018).

Observation is another indispensable feature of a teacher training program. PSTs, with opportunities to observe compelling examples of technology integration in practice, develop clearer ideas on incorporating technology into their lessons (Polly et al., 2010). Additionally, engaging in rehearsal activities with peers and gaining field experience with actual students are crucial components of effective teacher training. According to Koehler and Mishra (2005), teachers must experience the learning process to understand better how to support their future students. Therefore, rehearsal plays a vital role in preparing PSTs for actual classroom experiences, enabling them to enhance their understanding from both a teacher's and a learner's perspectives. It is worth noting that increasing teaching experience has been found to correspond with an improvement in PSTs' Technological Pedagogical Content Knowledge (TPACK) (Haciomeroglu et al., 2009).

Lastly, reflection is a vital technique for supporting the development of learners' knowledge (Westberg & Hilliard, 2001). Similarly, in developing TPACK, pre-service teachers (PSTs) must engage in reflective practices alongside learning theories, designing instructional strategies, and implementing them (Koh & Divaharan, 2011). Reflecting on technology-infused practice can effectively facilitate the growth of technological knowledge and technology integration into teaching.

In conclusion, TPACK courses that incorporate the features mentioned above have been effective in improving pre-service teachers' TPACK skills in various subject areas, including science in general and chemistry. Several studies have reported significant improvements in the TPACK competencies of pre-service teachers who participated in such courses (Durdu & Dag, 2017; Mouza et al., 2014; Aktaş & Özmen, 2022). These findings suggest the importance of incorporating these features in teacher training programs to enhance the effectiveness of technology integration in teaching and learning.

2.4.3 Technology in Vietnamese Education System

Vietnam has prioritized education as a key area for development, with the Ministry of Education and Training (MOET) emphasizing integrating information and communication technology (ICT) in teacher training since 2014. Although there have been changes in the curriculum and improvements in teacher institutes, progress in this area has been limited due to the lack of investment in educational research. Most of the research in this field is small-scale and conducted by Vietnamese researchers pursuing advanced degrees overseas. Existing research indicates that the current pre-service teachers (PST) curriculum does not provide sufficient ICT knowledge for effective use in teaching (Tang, 2022). However, the COVID-19 pandemic has brought increased attention to the importance of ICT in education, with many schools adopting blended teaching methods. As a result, significant changes have occurred in how people perceive and utilize technology in education. A study by Pham et al. (2021) explored the challenges and opportunities of online learning during the COVID-19 pandemic in Vietnam. The study found that while online learning presented many challenges, it also provided opportunities for teachers to experiment with new teaching methods and for students to develop digital literacy skills. The study suggested that online learning should be further developed in Vietnam to improve access to education for all students.

Recent studies have examined the extent to which technology-related knowledge is integrated into teacher training programs in Vietnam. For example, Tang (2022) found that while the curriculum for Mathematics teaching at Ho Chi Minh University of Education provides a sufficient level of TPACK in two technology courses, these courses only contribute five credits out of 135 credits. The study suggests that increasing the amount of technology-related courses in the program could better equip teachers with the necessary TPACK skills. Additionally, since there is no introduction to the TPACK framework in the current program, students lack a clear understanding of combining pedagogy, content, and technology in teaching. The study recommends rebuilding the program according to the TPACK framework to provide students with a more comprehensive view of technology integration.

Other studies have focused on the TPACK skills of PSTs and in-service teachers in specific subject areas, such as Language Teaching and Mathematics. Nguyen (2021) found that high school English teachers showed a high level of TK and PCK but had only average levels of other TPACK skills. Similarly, Thai et al. (2022) analyzed the "T" part of TPACK and found that PST's technology-related skills are at an average level with a lack of experience using technology in the classroom. They believe that increased communication and learning experiences could increase PST's belief in the advantages of ICT, thereby increasing their ICT competence, which aligns with Nguyen's findings. In research on language teachers, Pham et al. (2019) and Vo et al. (2020) found that PSTs mostly use only PowerPoint in their classes, indicating a level of technology use at the substitution stage in the SAMR model. This could be due to low confidence, poor knowledge of ICT use in education (Pham et al., 2019), and constraints related to school facilities and the curriculum (Le & Song, 2018).

Although the TPACK model is widely recognized as a valuable framework for integrating technology into teaching and has been extensively researched worldwide, there is still a lack of awareness and knowledge of this model among Vietnamese teachers. In addition, the SAMR model is even less well-known in Vietnam, and there is a dearth of research on teacher training in the country. To address this gap, this study aims to assess both TPACK and SAMR features of a teacher training program from the perspectives of newly graduated chemistry teachers with practical classroom experience. The study will focus on graduates from Hanoi National University of Education, Vietnam's most significant teacher training institution. The research will employ surveys to assess the TPACK skills of the new teachers, and in-depth interviews will investigate the use of technology in Chemistry teaching based on the stages in the SAMR model. The findings of this study will contribute to the development of effective teacher training programs in Vietnam that incorporate technology integration and ultimately improve the quality of education in the country.

The research questions of this study are:

RQ1. What are new in-service Chemistry teachers' levels of knowledge and current usage of technology in teaching under a TPACK-SAMR lens?

RQ2. How do new in-service Chemistry teachers perceive their teacher preparation program for purposeful technology use in Chemistry teaching?

RQ3. How do new in-service Chemistry teachers perceive their digital readiness for the future use of technology integration?

3 METHODOLOGY

3.1 Research Design

Creswell (2012) has highlighted that utilizing a mixed-methods approach can be most effective in research studies that collect quantitative and qualitative data to understand a research question or question comprehensively. In the present study, a self-reported survey was used to collect quantitative data on the seven component skills of TPACK. This method has been proven quick and reliable in accessing insight into the teachers' TPACK. Using numbers to display the component skills makes it clear and easy to follow, compare, and reflect. However, the research questions of this study did not require a detailed analysis of the teachers' TPACK aspects. Instead, the survey was processed to provide a foundational understanding for further development of an in-depth interview with each participant to gain a more comprehensive understanding of their opinions and perspectives on the training program.

According to Merriam (2009), qualitative research is valuable for comprehending "how people interpret their experiences, how they construct their worlds, and what meaning they attribute to their experiences." Thematic, semi-structured interviews are an effective qualitative research method that balances structure and flexibility, enabling interviewees to bring new insights to the research topic (Galletta & Cross, 2013, p.24). In this study, questions focused on the prominent themes of TPACK and SAMR implementation were prepared, with follow-up questions asked during the interview to elicit clarification and new perspectives. This approach allowed for a nuanced and in-depth understanding of the teacher's perspectives on the training program and its effectiveness in improving their digital readiness.

3.2 Participants

The sample for this study consisted of seven Chemistry teachers (four males, three females) who graduated from the Chemistry department of Hanoi National University of Education (HNUE) in 2021 or 2022. All participants currently work as Chemistry teachers at secondary or high schools in Vietnam. Participants were recruited through an invitation posted in an official Facebook group of students from the Chemistry Department at HNUE. The inclusion criteria for the study were that participants had to be newly graduated from the Chemistry Department of HNUE in 2021 or 2022, which was specified in the digital invitation. Table 1 provides a summary of the background characteristics of the participating Chemistry teachers.

Table 1. Background Characteristics of the Participants

Participant	Graduation year	Teaching experiences		Grade	No. of sessions/week
		Secondary	Highschool		
T1	2021	X		6	16
T2	2021	X		6,8,9	20
T3	2022	X		7,8	14 - 18
T4	2022		X	11	6 - 10
T5	2021		X	12	4
T6	2022	X		6,7,8	18
T7	2022	X		6,7,8	12

Note: Participant names have been replaced with T1 to T7 to maintain confidentiality

3.3 Instrument and Data Collection

The data collection process consists of three phases. The first phase involves gathering comprehensive information about the study program by collecting data from the program's website and consulting with teacher educators to establish a general understanding. The second phase is to survey the participants, assessing their confidence level in digital skills, considering the TPACK framework. Finally, in the third phase, individual interviews were conducted with the participants to gain in-depth insights into their TPACK survey responses. The interviews include detailed examples and explanations, which would be evaluated using the SAMR framework. The combined analysis of survey results, detailed examples, and SAMR evaluation would address Research Question 1. The interviews are also designed to provide answers for Research Questions 2 and 3.

RQ1. What are new in-service Chemistry teachers' levels of knowledge and current usage of technology in teaching under a TPACK-SAMR lens?

RQ2. How do new in-service Chemistry teachers perceive their teacher preparation program for purposeful technology use in Chemistry teaching?

RQ3. How do new in-service Chemistry teachers perceive their digital readiness for the future use of technology integration?

First, the researcher gathered information about the training program from the department's website to gain insight into the technology-related teaching included in the program. The website provided only basic information such as course names, number of credits, learning outcomes, and requirements. The researcher actively sought to obtain more detailed information about course syllabi and content from the department but encountered difficulties and was unable to acquire the desired information. Nevertheless, the collected information was analyzed and interpreted to establish an initial foundational understanding of the program, which was used to inform the design of the research instrument and guide the actual data collection with participants. The results of this analysis will be presented in the "Data Analysis" section.

The second phase employs a two-part survey instrument for data collection. Part 1 involves a self-evaluation of participants' Technological Pedagogical Content Knowledge (TPACK) skills. The TPACK.xs self-reported survey, developed by Schmid et al. (2020), is used for this purpose. Although many other authors have yet to validate the scale, it has undergone careful testing by the authors with a sample of 117 participants. The results of this study demonstrate the high reliability of the TPACK.xs survey, with Cronbach's alpha coefficients ranging from .77 to .91 and McDonald's omega coefficients ranging from 0.79 to 0.92. Notably, the TPACK.xs survey represents a more recent and practical TPACK assessment tool compared to other commonly cited instruments, such as Schmidt et al.'s (2009), Chai, Koh, and Tsai's (2011), and Valtonen et al.'s (2017) scales. Furthermore, the TPACK.xs survey comprises 28 items, with four items per each of its seven subscales, rendering it more manageable for participants to complete and better connected to the actual teaching context. In addition, the items are general, allowing for easy adaptation to specific subjects, in this case, Chemistry.

For Part 2, participants were asked to reflect on the frequency of technology use during different teaching stages, including Assessment, Planning and Designing, Practical Teaching, and Management. The categorization and description of these stages were developed based on the Vietnamese standards for Chemistry teachers' self-report surveys (Thai & Trinh, 2016). To quantify the frequency of technology use, a five-point scale is used, with the following options: never (0%-20%), rarely (20-40%), sometimes (40-60%), often (60-80%), and usually to always (80-100%).

The third phase of this study entails conducting 1-on-1 interviews with each participant to gather qualitative data in addition to the quantitative survey results obtained in Phase 2. The interviews provide an opportunity to deepen our understanding of the research questions by exploring participants' views, experiences, and perceptions of their teacher training program and their plans for using technology and digital tools. Appendix 9 comprises the interview protocol and questions, formulated utilizing the outcomes of Phase 1 and 2.

Data collection began with a digital invitation sent to all students from the Chemistry Department at HNUE through a Facebook group, with the survey link provided in a Google Form format that included the consent form as stated in the appendices. Subsequently, interviews were scheduled based on participants' availability and conducted individually via Zoom, with each interview lasting between 45 and 60 minutes and involving a set of interview questions, with the possibility of clarifying questions as necessary.

The interviews were recorded for analysis, and comprehensive notes were carefully documented during the interview sessions. Qualitative data analysis followed the three-phase process outlined by Elo et al. (2008), including preparation, organizing, and reporting. All analyses and notes were securely saved on a personal laptop protected by a password to ensure confidentiality.

3.4 Data analysis

The process of data analysis comprises four sequential steps. Step 1 entails an in-depth analysis of the teacher training program to establish a comprehensive background understanding of the curriculum and the incorporation of technology content. In Step 2, quantitative data from the online survey were presented, highlighting significant results, such as notable peaks and variations. Next, the interview responses were carefully examined and categorized in step 3, explicitly addressing reflection examples of educational technology implementation based on the SAMR stages. Additionally, this step involves identifying patterns and discerning diverse experiences and unique recollections. Finally, in Step 4, the outcomes derived from the preceding steps were consolidated into individual reports and group reports, with particular attention given to emphasizing meaningful insights and findings.

3.4.1 Analysis of the Teacher Training Program

Step 1 - This section analyzes the curriculum of the teacher training program in the Chemistry Department at Hanoi National University of Education. It examines the expected learning outcomes, the percentage of various components in the TPACK framework, and how technology content explicitly appears in the curriculum.

Learning outcomes

The teacher training program has established a set of learning outcomes that align with the Vietnamese standards for teachers. The university's website presents these outcomes, which can be summarized into four categories:

- **Virtues**: love for nature and country; trust in students; honesty; responsibility; self-awareness; engagement in life-long learning; and devotion to a career in education.
- **General competencies**: independence; adaptability; good communication and cooperation; leadership; problem-solving; creativity; critical thinking; and a deep understanding of the local culture and society.
- **Educational competencies**: the ability to design and implement activities using appropriate methods and techniques; manage the classroom effectively; cooperate with other educational stakeholders inside and outside the school; provide guidance and advice to students, foster their abilities; have a capacity for social activity and be professionally proficient.
- **Chemistry education competencies**: the ability to work in a laboratory and perform chemistry experiments; have a strong knowledge of the content; apply advanced chemistry to explain, analyze, and evaluate the primary chemistry curriculum; demonstrate research competency in Chemistry and Chemistry Education; as well as foreign language competency, and technology competency.

Specifically, the technology competency is comprised of three component skills: the ability to use and manage standard ICT tools, access and organize technology resources, and integrate ICT effectively in teaching and learning. The following section will analyze the curriculum to determine how well it aligns with the TPACK components and whether the courses explicitly demonstrate a match with the learning outcomes of technology competency.

Program curriculum with TPACK

Up until 2018, the curriculum contained 135 credits. Courses' names and number of credits are published on the university's website. Table 2 shows the percentage of each component skill in TPACK framework:

Table 2. Program structure and TPACK

Type of studies	Courses	Credits	Percentage (%)	TPACK
General studies	Language and Political courses	20	14.81	
Subject-related general studies	Fundamental Physics and Mathematics	12	8.89	
Subject content studies	Fundamental and Advance Chemistry Practical experiments in laboratory	63	46.67	CK
Pedagogy studies	Basics of educational skills	14	10.37	PK
	Pedagogical methods in teaching Chemistry Teacher practices/Internship	20	14.81	PCK
Undergraduate thesis	Elective topics	6	4.44	CK/PCK

The curriculum predominantly emphasizes content knowledge (CK), accounting for 46.67% of the program. Following CK, pedagogical content knowledge (PCK) constitutes 14.81%, and pedagogical knowledge (PK) makes up 10.37%. Notably, none of the courses explicitly incorporate technology content, making it difficult to ascertain whether technology integration is intentionally addressed within the curriculum. This ambiguity arises from the absence of detailed teaching topics in the general and pedagogy courses. For deeper insights into intentional technology training within the program, it will be necessary to interview the participants. Presently, although the learning outcomes expect effective utilization of ICT in teaching, the courses do not align with these expectations.

The curriculum is updated every five years, and since 2019, there have been some minor changes to the program. For example, new technology courses were introduced to the curriculum containing General Computer Skills (2 credits) and Basics of Computer Science (2 credits). However, since the participants in this research graduated in 2021 and 2022, they studied with the curriculum from 2018 and earlier. Therefore, these two new courses will be excluded from this research. The Appendices provides additional information related to the program analysis. Appendix 1 offers comprehensive details regarding the program courses, while Appendix 2 compares the 2014-2018 curriculum with the 2019 curriculum.

3.4.2 Participants' Data Analysis

Step 2 - Quantitative survey data was exported from Google Forms results into an Excel spreadsheet. The data were coded numerically, with survey responses for the first part assessing TPACK skills being coded as follows: positive - strongly agree (5), agree (4); neutral - neutral

(3); negative - disagree (2), strongly disagree (1). Survey responses for the second part assessing the frequency of technology use in different stages of teaching were coded as follows: positive - usually to always (5), often (4); neutral - sometimes (3); negative - rarely (2), never (1). The data was then analyzed using Excel formulas to calculate each subskill's mean and standard deviation.

Step 3 - The individual interview transcripts and notes were analyzed using a deductive approach following the steps described by Elo et al. (2008) in three main stages: preparation, organizing, and reporting. In the preparation stage, video recordings of participants were transcribed, cleaned, and rechecked multiple times to fix spelling and grammar and ensure a clear and easy-to-follow presentation. In this stage, the researcher familiarized themselves with the data.

During the organizing stage, the researcher developed categorization matrices based on the design idea of the interview questions and the literature which constructed the instrument used in the survey part (since a major part of the interview is to develop further an understanding of the answers in the survey). Data were arranged in different categories for easier grouping and finding sub-themes. An example of the matrices used is as follows:

Table 3. An example of categories matrices

	Assessment	**Planning and Designing**	**Practical teaching**	**Management**
T1				
T2				
…				

In the data, it is essential to note that participants often provided information that could be classified into multiple categories in response to a single interview question. For example, when asked about their use of technology in direct classroom teaching, T6 stated:

> *"Ví dụ với bài kiểm tra thì em hay thích dạy thôi không thích kiểm tra trên lớp. Em sẽ nhắn cô chủ nhiệm và gửi link Google Form đúng giờ để chuyển tiếp cho học sinh vào làm."*
>
> "I don't like giving tests as much as teaching stuff. So usually, I'll message the homeroom teacher when it's time for the test and send her the Google form link. Then she'll get the students to take the test online."

This response reveals T6's approach to assessing students and highlights their tendency to communicate with students through their homeroom teacher. Therefore, the researcher needs to exercise caution while categorizing participant responses.

Since this study does not test hypotheses or directly compare results to previous studies, the categorization matrices are unrestricted. Data in different categories are coded according to the principles of inductive content analysis, as illustrated below:

Open coding	Notes and headings are written in the text while reading it
↓	
Coding sheets	Collection of all the headings
↓	
Grouping	Find similar points and rearrange the headings
↓	
Categorization	Compare between data and classify them
↓	
Abstraction	Formulate general descriptions

Below is an example of how the data was categorized into sub-themes.

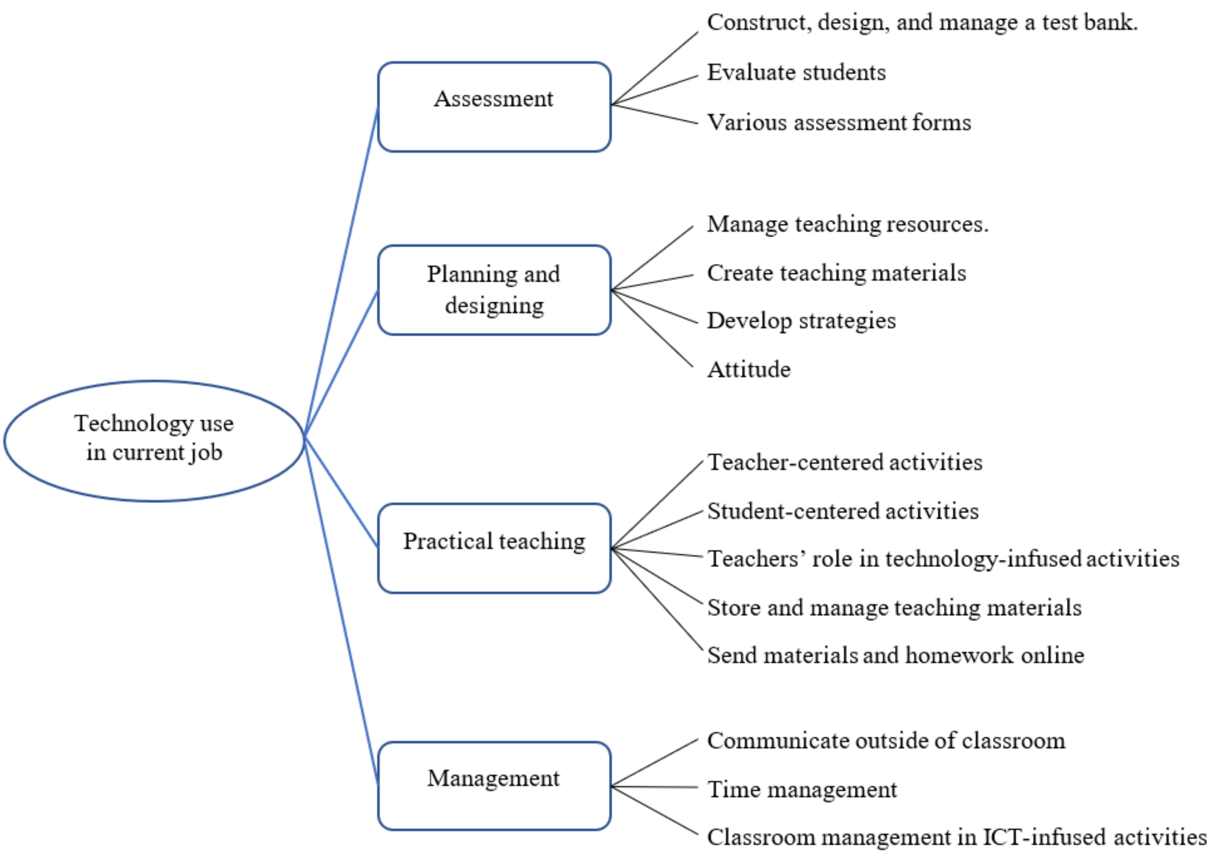

Figure 4. Examples of the sub-themes coding

Note. More detailed information is provided within each sub-theme in the full coding scheme.

Furthermore, the data also needs to be coded based on the SAMR model. The researcher followed a deductive approach and used existing literature such as Puentedura (2006, 2014), Hamilton (2016), Blundell et al. (2022) to develop a SAMR coding scheme (as detailed in Appendix 9). Each stage of the model is defined and includes examples to categorize teaching activities. For instance:

Table 4. Example of SAMR coding scheme - Substitution stage

Stage	Definition	Example	
		Traditional way (without Tech)	**Transformative way (with Tech)**
Substitution	Tech acts as a direct tool substitute, with no functional change Save time and space	Exam on paper	Online assessment tools: Google form, Kahoot, etc. (Students do the tests with digital tools and receive grades/comment immediately)
		Teach with black board and chalk	Use PowerPoint slides to show images, clips, content text.
		Print out/ write down the homework	Send online files to students (doc, pdf, etc.)
		Having students write on paper to prepare for upcoming lesson or use paper poster for presentation	Students type and hand in their homework online or use PowerPoint/ other digital forms to present their work.

To ensure data reliability, the researcher performed coding three times at intervals of two to three weeks. The similarity check between the coding iterations yielded a score of over 90%. In cases where there were ambiguous codes, they were discussed with the supervisor to reach a consensus. Consequently, the coding results can be considered reliable.

Step 4 – During the last step of the data analysis process, extra care was taken to sort the results into different categories, enhancing their clarity and organization. This categorization allows for a more systematic and structured representation of the findings. Additionally, specific interview materials that hold particular relevance and provide valuable insights were highlighted and grouped into their respective categories. These examples serve as concrete illustrations of the data, making the analysis more comprehensive and understandable.

Furthermore, the results obtained from the participants' TPACK confidence levels, frequency of technology usage, and the SAMR analysis were connected and examined collectively. Identifying patterns and relationships among these variables makes it possible to uncover common themes, trends, or tendencies within the data. Connecting various aspects of the analysis enhances the overall understanding of how participants' confidence, technology usage, and adoption of the SAMR model are intertwined.

Finally, to ensure a comprehensive analysis, the results were critically reflected upon in the context of the current literature review. Critical remarks and insights can be derived by integrating the findings with relevant scholarly works. This synthesis enables a deeper understanding of the implications and significance of the data, allowing for informed conclusions and the identification of potential areas for further research.

4 FINDINGS

4.1 Chemistry Teachers' Perception on Their Technology Use

RQ1: What are new in-service Chemistry teachers' levels of knowledge and current usage of technology in teaching under a TPACK-SAMR lens?

Findings revealed that despite their limited teaching experience (1-2 years), participants were confident in their skills, as evidenced by their TPACK self-reported survey scores. The mean score for each TPACK component skill was approximately 4 out of 5 on the Likert scale, and the overall TPACK score was 3.75. During interviews, the participants reported high confidence in their knowledge and the positive impact of integrating technology into their teaching practices. Technology was utilized in almost all teaching stages, with the highest frequency of use in planning and designing for material search and information updating and the lowest frequency in management. The overall technology usage rate was reported to be high (60-80%). On the other hand, the examples shared by participants showed only evidence of substitution and augmentation use of technology.

4.1.1 TPACK Skills

The self-reported survey results indicated that teachers scored high (averaging near 4 - agree) in all component skills. Specifically, teachers rated themselves highest in content knowledge (CK) and technology knowledge (TK), with an average score of 4.11. However, despite the high score, TK showed the most significant variability in self-evaluations. While four teachers reported high confidence in their TK with a score of 4.75 (strongly agree), one teacher (T5) rated herself 2.50 (disagree), indicating a lack of confidence in handling technology-related issues in her work.

It is worth noting that TK and CK received the highest scores, while their combination as technological content knowledge (TCK) was rated the lowest among all skills, with a score of 3.07. This result suggests that teachers were uncertain about the technology used in teaching Chemistry Science and how to select technology to enhance teaching topics. However, the teacher's pedagogical skills, including pedagogical knowledge (PK), pedagogical content knowledge (PCK), technological pedagogical knowledge (TPK), and technological pedagogical content knowledge (TPACK), all showed consistently high scores ranging from 3.71 to 3.86.

Table 5. Descriptive statistics of TPACK.xs subscale

Categories	T1	T2	T3	T4	T5	T6	T7	M	SD
PK	3.50	3.75	3.75	4.25	3.25	4.50	3.75	3.82	0.39
CK	3.75	3.75	4.25	5.00	3.50	4.00	4.50	**4.11**	0.48
TK	3.25	4.75	4.75	4.75	2.50	4.75	4.00	**4.11**	**0.84**
PCK	4.00	3.50	3.25	4.50	3.50	4.00	4.25	3.86	0.42
TPK	3.50	4.00	3.75	3.25	2.75	4.50	4.25	3.71	0.56
TCK	3.00	3.00	3.00	3.75	2.00	3.50	3.25	**3.07**	0.51
TPACK	3.75	3.50	4.00	3.75	3.00	4.25	4.00	3.75	0.38

Note. Scale: 1 (strongly disagree) to 5 (strongly agree)

In summary, participants in the survey are confident in their teaching skills, especially their basic skills (TK, CK, and PK). However, they are less confident in rating their TCK.

4.1.2 SAMR inTeaching Practices

Technology in Assessment

The participants in the study reported using technology in assessment, specifically, school systems or Google Classroom, to manage and store student progress. They all responded positively to technology in assessment, citing its ease in managing grades and the ability to conduct tests outside of school, which increases teaching time. Additionally, the participants noted that technology-based assessments could enhance student engagement. However, younger students were prohibited from using digital devices in the classroom or at home, limiting their access to interactive revision games like Kahoot or Quizizz. Despite this, some participants (T2, T6) identified an alternative tool in Plicker, a similar game to Kahoot that uses QR code cards instead of digital devices for student responses. T6 explained:

> *"Em dùng để kiểm tra miệng thì sẽ rất nhanh mà kiểm tra được cả lớp mỗi buổi. Thì em sẽ đánh giá được cả quá trình của học sinh chứ không phải thỉnh thoảng mới gọi bạn đó lên bảng."*
>
> "When I use it (Plicker), I can test the whole class quickly before every new lesson. This way, I can check on the progress of all students, not just at certain checkpoints."

Based on the participants' descriptions, they did not utilize additional technological features during exams. Their use of technology in assessments was in the Substitution stage, involving using technology to save time and enhance student engagement through the integration of fun effects and easily accessible video content for test questions.

Technology in Planning and Designing

All participants except for T5 reported using technology daily in planning and designing activities. T5 expressed a negative attitude toward technology-infused activities, citing a lack of time for Chemistry because her students are in Social Science majors. T5 instead focused on the fundamental knowledge of the subject without utilizing digital games and simulations. Conversely, the other participants reported using technology extensively in their planning, primarily to research and enhance their understanding of the subject matter and stay current with field developments. They enjoyed teaching with technology, perceiving it as reducing stress and making lessons more engaging for students.

When planning their lessons, all participants expressed consideration of the content, the time allocated for each topic, and the abilities and preferences of their students. For example, T7 was confident in identifying the methods and techniques she used in her teaching examples, emphasizing her consideration of suitable teaching methods for different topics and using technology in developing teaching activities.

> *"Đương nhiên là phải phù hợp với kiến thức của chương trình, phù hợp với thời lượng dạy, lứa tuổi học sinh và sở thích học sinh trong lớp. Nghĩa là khi mình chọn một nội dung hoạt động nào đấy thì phải đảm bảo tất cả học sinh đều có thể theo dõi và tham gia được. Ví dụ mình không thể đưa một hoạt động đòi hỏi kĩ năng và độ nhanh nhạy CNTT của học sinh lớp 8 cho lớp 6 làm được." (T7)*
>
> "Of course, the technology we use must be appropriate for what we are teaching, how long we have to teach it, and also for the age and interests of the students. We need to choose activities that everyone can do and participate. I mean, we can't give grade 8 level stuff to grade 6 students, that wouldn't make sense." (T7)

Even T5, who did not use technology much, showed confidence in her pedagogical choices in teaching, stating that she first determines the appropriate pedagogical method before selecting the appropriate activities and tools.

> *"Tất nhiên là khi mà soạn ra một giáo án thì đầu tiên là mình phải xác định được cái phương pháp dạy học của mình là gì trước đã. Rồi sau đấy thì mình mới chọn những cái trò chơi cho phù hợp với từng cái phương pháp đó, chứ em nghĩ là không phải trò chơi nào cũng sẽ phù hợp với các phương pháp." (T5)*
>
> "For sure, when I plan the lesson, the first thing I do is figure out which pedagogical method I will use. Once I know that, I can choose the right activities and tools. You

cannot just throw any game or tool together with any method and expect it to work." (T5)

The participants' considerations generally reflected their PCK. At the same time, some also mentioned TPACK in light of the teaching context, such as the characteristics of their students and the facilities available at their schools.

However, when asked to explain the connection between pedagogical methods, types of technology chosen, and teaching content, most participants were confused and unable to name the methods they employed. T4 explained:

> *"Khi đi học thì em chỉ học để hiểu bản chất phương pháp và kĩ thuật dạy học là gì chứ em không nhớ tên một cách máy móc. Thì em cố gắng truyền tải một cách tốt nhất hướng đến dạy học theo năng lực học sinh, Ví dụ như kĩ thuật đảo ngược hay chia nhóm. Em vẫn áp dụng nhưng em thường không gọi tên."*
>
> "When I was in teacher training, I wanted to understand different teaching methods and techniques to use them effectively. I did not focus on memorizing the names of each technique. Nowadays, I am constantly working on improving my skills to help my students learn better. For example, some techniques like group work and flipped classrooms… I used them but didn't usually label them with their formal names."

For designing teaching materials, they primarily relied on PowerPoint slides, stating they could easily access relevant materials already created and published online for free. Given that the current curriculum did not necessitate such materials, they did not perceive it as essential to produce novel simulations or experiment videos. However, they expressed a willingness to prepare additional digital materials if necessary for the new curriculum.

In this study, the participants indicated integrating technology into their teaching planning and design daily, as it facilitates content comprehension and allows for staying current with educational developments. Additionally, technology was reported to make teaching less stressful and more enjoyable for students. During the lesson planning phase, the participants considered various factors such as content, time, and student preferences and abilities. While some participants exhibited confidence in selecting appropriate teaching methods and incorporating technology into instructional activities, most displayed hesitancy regarding the pedagogical approaches utilized, suggesting a deficit in TPACK competence. Overall, technology was predominantly utilized for substitution purposes during the planning and design stage.

Technology in Practical Teaching and Management

The participants shared similar views regarding integrating technology into a practical science subject like Chemistry. They agreed that technology is most useful in three scenarios:

- visualizing abstract concepts (such as quantum chemistry)
- demonstrating experiments that posed safety risks or logistical challenges
- illustrating how theories apply to real-world situations

As mentioned earlier, they mainly utilized PowerPoint slides with videos and online teaching materials to teach students during the initial stage of acquiring new knowledge. During the practice phase, they mainly employed traditional methods, presenting problems as examples and explaining how to find solutions.

They developed revision activities for specific appropriate topics requiring students to collaborate on technology-driven projects like digital mind maps, PowerPoint presentations, or making videos. However, depending on the time available, such activities should only be introduced after completing theoretical topics. Before engaging in technology-driven projects, students must first gain an understanding of the application of the theory. In summary, technology directly enhanced teaching practices, primarily in the substitution and augmentation states.

Table 6. Examples of teaching and management practices

Participant	Example	SAMR stage
T1	*"Ví dụ như trong một tiết ôn tập em có thể sử dụng trang web mind map ấy ạ thì để cho học sinh tóm tắt kiến thức. … Em còn thiết kế một cái trang web em muốn cho học sinh sử dụng nhưng em thấy chưa được thành công lắm. Trang web đấy để học sinh có thể lên đọc bài, chơi game và thực hiện các nhiệm vụ."* "When I review topics with my students, I use an online mind map to help summarize the main ideas. I even made a website with learning stuff, games, and tasks for students to try, but it did not work as well as I had hoped."	Substitution Augmentation
T3	*"Hầu như ngày nào em cũng sử dụng máy chiếu để giảng dạy, trình chiếu cho học sinh và ngoài ra để mở rộng cho học sinh, em sẽ lấy những cái video mà em đã tìm kiếm trước đó em liên hệ em lại bật ra thôi."* "I pretty much use the projector every day to present my teaching material. And I also show my students videos I have searched for earlier (in the planning stage)."	Substitution
T5	*"Chẳng hạn như là lớp 11 thì nó sẽ có những cái bài về phân bón hóa học thì cũng sẽ chia nhóm ra và gọi là gợi ý cho học sinh xem là trong cái phần đó thì các bạn nên trình bày những cái điểm chính là gì và có thể lựa chọn những hình thức nào. Thì giữa cái sơ đồ tư duy và trình bày thuyết trình theo kiểu PowerPoint thì gần như là cả lớp*	Substitution

Participant	Example	SAMR stage
	đều lựa chọn thuyết trình PowerPoint. Trong đó các bạn tìm kiếm thông tin, show ra các video liên quan cũng như là trình bày mọi thứ trên PowerPoint, thì đó là cái bài tập mà em giao cho học sinh về nhà." "For a lesson on fertilizer in Grade 11, I asked the students to make a mindmap or PowerPoint presentation to show what they learned. They had to do this as homework and then come to class the next day to present. Most of them went with a PowerPoint and included information and videos they found online."	
T6	*"Cách đây khoảng hai, ba tuần em dạy bài Oxi không khí sự cháy cho học sinh lớp 8 thì có một phần là bảo vệ môi trường. Em cũng cho học sinh về nhà quay lại một số hành động, biểu hiện bảo vệ môi trường không khí hoặc là hành động sai dẫn đến ô nhiễm. Học sinh được tự do lên ý tưởng và trình bày nội dung mình chuẩn bị."* "A few weeks back, I taught grade 8 students about "Oxygen - The Atmosphere and Combustion". As part of their homework, I asked them to create a video showcasing ways to protect the air or actions that contribute to pollution. They had complete freedom to create whatever they wanted and then present it to the class the next day."	Augmentation
T7	*"Lớp 8 – bài thực hành điều chế khí Oxi. Đầu giờ em cho học sinh khởi động chơi Quizizz: 4 nhóm, mỗi nhóm được phát ipad của trường có kết nối sẵn wifi chỉ cần đăng nhập tham gia trò chơi. Sau đó thì có 1 hoạt động nhỏ qua phần mềm…em lại quên mất tên rồi nhưng em cho xem video để các bạn đề xuất câu hỏi/nội dung liên quan."* "In a grade 8 practical lesson where we were supposed to make oxygen gas in the laboratory, I switched the lab experiments with some in-class teaching. First, I gave the students iPads and had them play Quizizz in groups of four. Then, we did a quick activity using software, I cannot remember the name right now, but it's like a virtual lab where students watch videos and come up with questions about what they see in the lab."	Augmentation

To facilitate practical teaching, most participants relied on online platforms like Google Drive, Clouds, and Google Classroom to manage and share teaching materials. However, not all utilized these platforms to distribute homework or learning materials to their students. For instance, T6 mentioned not giving homework, while T1 and T3 stated that their students could not use digital devices at home.

All participants agreed that homeroom teachers are primarily responsible for this task when communicating and supporting students outside the classroom. Therefore, they usually contacted their students through the homeroom teachers. However, T2 mentioned that he directly communicated with his students during projects to guide and monitor them in online meetings outside of class. The following table presents a summary of the findings in the section: SAMR in teaching practices (formatted based on Bicalho et al., 2022).

Table 7. SAMR results summary

	Substitution	Augmentation
Tendency	Teaching practices that can be developed without ICTs. Keeping learning results despite the insertion of new technologies.	Functional and fun teaching practices with the use of ICTs. Enriching learning experiences without bringing significant changes to learning outcomes.
Teaching intention	Decrease student and teacher effort. Save teaching time. Increase communication, interaction, productivity, and students' interest.	Expand the reach of teaching materials, classes, content, tasks, etc. Integrate and interconnect contexts, resources, information and people.
Assessment	Manage grades with digital software (Google Classroom, Excel, schools' private systems) Use online tests (e.g. Google Forms). Conduct interactive revision tests (e.g. Kahoot, Plicker).	
Planning and designing	Update and find teaching materials with technology. Create digital materials (e.g. videos, worksheets). Using Microsoft Office for lesson planning	Create educational games on platforms like Quizizz or Virtual Labs. Develop virtual learning environments (websites, forums, etc.).
Practical Teaching	Present lessons with PowerPoint or other software. Upload materials and homework for student access. Encourage digital collaboration (e.g. Padlet, MindMap).	Guide students in creating digital projects (e.g. PowerPoint presentations, videos, 3D Periodic Table).
Management	Communicate through social media or homeroom teachers to support students outside the classroom.	
Teacher's reflection	Acknowledging the teacher's role as a coach or facilitator in student-centered activities and considering other ways to enhance this role. Expressing delight in student engagement and responsiveness observed during technology-infused activities and identifying strategies to build on this success. Reflecting on the effectiveness of the instruction provided during technology-infused activities, including any areas for improvement, and considering ways to manage the classroom more effectively. Identifying and addressing potential disadvantageous factors that may impact the success of technology-infused activities, such as limited school facilities, regulations, or students' digital knowledge. Evaluating the transfer of content to students during technology-infused activities and identifying areas for improvement to ensure that all students are gaining knowledge effectively.	

4.1.3 Frequency of Technology Use in Each Stage of Teaching

In the preceding sections, the utilization of technology in teaching was explicated with emphasis on Substitution and Augmentation. The outcomes of the frequency survey revealed that technology employment was reported lowest used in classroom management, which refers to utilizing technology for time management, classroom administration, and communicating with students beyond the classroom setting. Most participants frequently used technology in planning and designing (with a frequency of use exceeding 80%). On the other hand, the utilization of technology in Assessment and Teaching Practices exhibited variability among participants. Descriptive statistics regarding the frequency of technology usage are presented in the table below.

Table 8. Descriptive statistics of Frequency of Technology Use

Frequency of Technology Use	T1	T2	T3	T4	T5	T6	T7	M	SD
Assessment	4	3	4	3	2	4	4	3.43	0.73
Planning and Designing	5	5	5	5	4	5	4	4.71	0.45
Teaching Practices	4	4	5	3	2	5	3	3.71	1.03
Management	2	3	2	1	1	3	3	2.14	0.83
Average	3.75	3.75	4.00	3.00	2.25	4.25	3.50	3.50	0.63

Note. Scale: 1 (never – 0%) to 5 (always 80% - 100%)

4.2 Chemistry Teachers' Perception of the Teacher Training Program

RQ2: How do they perceive their teacher preparation program for purposeful technology use in Chemistry teaching?

The findings indicated that the program did not provide specific courses on technology in an educational setting. Instead, technology knowledge was covered in general and pedagogical courses. Although the range of topics taught was broad, ranging from primary Microsoft Office to complex software in Chemistry education, the teaching only briefly introduced these topics. Moreover, teacher educators (TEs) primarily demonstrated technology without integrating it into lessons, and ethical issues must be adequately addressed. In all other courses, technology was used as a direct tool, such as PowerPoint slides, email, or Google Classroom, to distribute materials. Most participating teachers did not find the program effective in preparing them for their job regarding educational technology use. They suggested that the program should offer more practical courses and more coaching on the purposeful use of technology, specifically in Chemistry teaching.

4.2.1 Educational Technology Content in the Program

In response to the question of which courses specifically taught educational technology (Edtech) and what the participants learned, it was revealed that there were no dedicated courses on this subject matter. However, educational technology was integrated into almost every pedagogical course that was undertaken, including Pedagogical methods in teaching Chemistry, Teaching practices at teacher training schools, General pedagogical training, and Assessment and Evaluation in Education. According to T5,

> *"Có ứng dụng công nghệ thông tin trong dạy học thì chắc là có các cái môn phương pháp. Các môn phương pháp phương pháp 1 hay phương pháp 2. Nói chung là khá ít."*
> "Thinking of Technology, then Pedagogical courses? There was no particular course that was dedicated to Edtech. I can say there was not much technology teaching in the program."

This sentiment was echoed by T6, who said,

> *"Thực ra không có môn riêng nào mà tất cả các môn phương pháp em đều thấy có 1 phần về ứng dụng CNTT."*
> "I don't think there was any specific course on Edtech. It was just a part of the general Pedagogical courses."

Participants then listed several examples of topics covered in these courses, including basic Microsoft Office skills, image and video editing, special Edtech applications, and software such as ChemDraw, Crocodile, Padlet, e-assessment tools, simulations, and virtual labs. T2 stated,

> *"Em nhớ là em được học về ChemDraw, em cũng dùng khi dạy cấp 3 và thấy rất tiện để vẽ công thức hữu cơ."*
> "I learned how to use ChemDraw, which is useful for creating organic chemical structures to teach higher grades."

T1 added,

> *"Bọn em kiểu được các được thầy cô giới thiệu sử dụng thôi chứ không hẳn là được học bài bản. Ví dụ như các trang web như là Padlet… các cái trang web để bọn em phục vụ dạy học như là kiểm tra thì dùng Azota."*
> "TEs introduced us to useful e-assessment tools like Azota or interactive sites such as Padlet for teaching. Even though they only briefly introduced without clear instruction."

Furthermore, four participants mentioned the course Applied Informatics in Chemistry, in which they learned how to use Excel to draw graphs and analyze experimental results. They noted that this course benefited advanced higher-education chemistry studies but may be less relevant for secondary and high school teaching.

In summary, the study found no dedicated courses on Edtech, but purposeful technology was integrated into almost every pedagogical course. Participants listed examples of topics covered in these courses, such as Microsoft Office skills, special Edtech applications and software, e-assessment tools, and simulations. The course Applied Informatics in Chemistry was also mentioned as particularly useful for advanced chemistry studies.

4.2.2 Technology-infused Experiences in Pedagogical Courses

The participants' experiences with technology courses were varied, but all reported that the topics were only briefly introduced and needed more practical application. Others expressed a lack of technology-based learning activities in the program. Not all participants can mention specific instances of technology incorporated into their learning. T7 said,

> *"Đợt em học em thấy phần kiến thức chỉ mang tính chất là giới thiệu thôi...Em thấy giới thiệu rất nhiều nhưng về mặt thực hành sinh viên chưa được tiếp cận nhiều. Chẳng hạn như ChemDraw chỉ có bạn nào đam mê hoặc làm luận văn hữu cơ chẳng hạn thì sẽ dùng nhiều. Thực tế bây giờ đi dạy em thấy nhiều người vẫn gõ file Word chứ đâu dùng đúng phần mềm gõ công thức hóa học đâu."*
>
> "TEs mostly introduced those topics very briefly, but PSTs did not have chances to practice. For instance, we learned how to use ChemDraw, but only those pursuing further studies in Organic Chemistry used the software. Many teachers still type normally in Word (Microsoft Word) without the correct add-in function for chemical formula typing."

According to T4,

> *"Khi sử dụng thực tế em thấy mình phải tự tra cứu và mày mò nhiều...Ví dụ như PowerPoint có rất nhiều hiệu ứng đẹp thì thầy cô chỉ dạy cơ bản thôi."*
>
> "They only taught the basic skills, but it wasn't comprehensive… It's only enough for you to learn on your own."

When asked, T2 and T5 could not recall any learning activity with technology in the program. T5 said,

> *"Gần như là không có nếu có chắc là chỉ có một hai tiết học trong cái bộ môn thực hành dạy học Hóa học rồi còn những cái môn khác thì em vẫn cảm thấy nó nặng về lý thuyết*

nhiều quá, những cái phần mềm dạy học Hóa học gần như là không giới thiệu. Nó chỉ tập trung vào cái việc là chữa soạn giáo án hoặc là soạn PowerPoint các thứ thôi, chữa về cái cách gọi là trình bày thôi hoặc là về lý thuyết. Em không thấy sử dụng quá nhiều công nghệ thông tin hoặc là dạy sinh viên cách sử dụng công nghệ thông tin ở trong dạy học."

"Almost no... No, I can only recall 1 or 2 sessions in the course Teaching practices at teacher training schools. Other courses were too theoretical-based. TEs only focused on fixing PSTs' understanding of theories or PowerPoint presentations. I did not see them using much technology in classrooms or teach PSTs to use technologies in teaching."

T5 then remembered a specific instance when one TE sent an application download link via email before class. The TE introduced the application using PowerPoint slides and demonstrated how to use it in class while PSTs watched and followed along. This activity is an example of the Substitution stage in the SAMR model, as the technology was used as a direct substitute for traditional teaching methods.

Another participant (T1) described a different learning activity, where the TE created a website for PSTs to access instructions, tasks, and deadlines. PSTs worked in groups to upload their products on the website and receive feedback. This activity was conducted during the pandemic when the students were studying online. T1's description lacked specific details about the website's functions, so it was unclear whether the activity belonged in the Substitution or Augmentation stage. Nonetheless, the website facilitated PSTs' collaboration and TE's lesson organization.

Interestingly, four other participants referred to a particular activity in which TE assigned each group to research and present different applications each week, such as Camtasia or Canva, for editing videos and images. After following guiding questions, PSTs presented their findings in front of the classroom. Although this activity appears engaging, it belongs in the Substitution stage of the SAMR model, as the technology was mainly used to replace traditional teaching methods. However, in some sessions, PSTs were asked to perform short teaching activities using the assigned software, which indicated an Augmentation stage.

4.2.3 Technology-infused Experiences in Other Courses

The information provided shows that the use of technology by TEs in the classroom was quite limited. The most commonly used technology mentioned is PowerPoint slides, which were used instead of writing on the board. Additionally, some TEs used technology for classroom management tasks such as online storing learning materials, sending homework, and online tests. Google Classroom was mentioned as a tool some TEs used for these management tasks.

One participant (T7) mentioned using another online system during the pandemic, which had high interaction with students. However, this system was only available during the pandemic, and most TEs have returned to traditional teaching methods, with only some switching to Google Classroom for management tasks.

> *"À đợt dịch là trường có hệ thống giao học liệu và bài tập online ấy. Dùng cái đấy em thấy rất tiện. Em thấy sinh viên sau này còn thích học online hơn là quay lại đi học trực tiếp...Xong cũng có một trang điện tử để khi đăng nhập vào sẽ hiện lên tất cả các môn mình học kì này và trong mỗi môn sẽ có file bài tập, nhiệm vụ, tài liệu hoặc thậm chí bài thi chấm điểm trực tiếp. Lúc đi học lại rồi nhiều thầy cô vẫn dùng Google Classroom để đưa tài liệu lên cho bọn em tải xuống đọc. Bây giờ em đang học cao học ở trường thì em lại không thấy có những cái online như vậy." (T7)*
>
> "During the pandemic, the university has an online system to help with management. I find it really useful. Some students even like online studying more than in-person studying. Students could see their ongoing courses on that online site when they signed in. Each course folder includes learning materials, homework, and online tests. After the pandemic, many teachers still use Google Classroom to upload materials. However, I am studying for a master's degree now, and I don't see anything like this in the master's program." (T7)

Overall, the use of technology by TEs in the classroom was somewhat limited, although there were some examples of using technology for management tasks. It may be worth exploring ways to incorporate technology more fully into teaching and learning practices, especially given the potential benefits that technology can offer in terms of convenience, engagement, collaboration, and access to learning materials.

4.2.4 Ethical Issues in Technology-infused Classroom

During the study, T7 showed a lack of understanding of the term "cracked version" and did not seem to pay attention to technology ethical issues. In contrast, all other participants admitted having at least some cracked software on their laptops. They shared the same attitude toward using cracked software, which was to go for it when a paid license was unavailable or necessary. T4 even expressed a sense of reward for successfully cracking software that was not available for free. While they understood the importance of copyright and licensing, they preferred to use software for free.

When asked about their experiences in the training program, their responses varied. T1 and T7 did not recall anything related to digital ethical standards, while T2, T3, and T4 remembered that the TEs had advised them to use authentic software. However, T3 offered a fascinating insight, mentioning that some TEs suggested that if students did not need to use the software professionally and regularly, they could use the cracked version instead. T5 and T6 even reported that some TEs had provided them with links to download the necessary cracked versions for the courses.

In Vietnam, digital ethical standards are often overlooked in teacher training programs, and there seems to be a general attitude among teachers that using cracked versions of software is acceptable as long as paid license versions are not readily available or necessary.

4.2.5 Perceptions of Program Effectiveness

According to the participants, their teacher training program was ineffective in providing them with adequate technological knowledge for teaching. They believed the program only covered basic skills in Microsoft Office and photo/video editing, which they were already proficient in before entering university. While introducing other educational technologies, the focus was more on technical usage than practical application in planning and teaching in the classroom. As a result, they admitted that they did not use much of what they had learned from the program in their current jobs.

The participants felt that the program introduced too many technologies and applications, making exploring and becoming proficient in any of them difficult. Consequently, they only used familiar applications. For example, T6 mentioned that he found the program interesting but had yet to find a way to apply the knowledge in his teaching. As a chemistry teacher, he only wanted to learn how to draw chemical formulas using ChemDraw, design attractive and effective PowerPoint presentations with effects and games, and know some simulations and virtual labs functioning. He believed that it was unnecessary to overload teachers with so much technological knowledge. From all the things TEs taught, the only thing he applied in his current job was what he learned about designing PowerPoint presentations for teaching purposes.

Moreover, they found it okay to use simple technologies for the current curriculum they were teaching. T1, T2, and T3 stated that the subject matter they taught was very simple, and they did not need to design materials since everything was readily available on the Internet.

> *"Mình không tìm được trong sách mà mình cần muốn để cho học sinh xem thì mình mới cần phải thiết kế các cái thí nghiệm ảo đấy. Em thấy là hầu hết khi em soạn bài cần tìm những cái video liên quan đến thí nghiệm mà em muốn cho học sinh xem thì đều có trên mạng hết rồi. Em cũng thấy không hay sử dụng cái phần thiết kế thí nghiệm ảo lắm. Nó cũng chưa đến đoạn cần phải dùng những cái mà kiểu nó quá là chuyên môn." (T1)*
>
> "Most of the experiments I wanted to show my students can easily be found online. I don't really need to design the simulation or use the virtual lab in my class. It's not up to that advanced part in the curriculum." (T1)

Despite some reservations, it is noteworthy that most participants expressed satisfaction with the program. For example, T1 stated that the program covered the basics of technological knowledge and that the teacher educators were constantly updating it. Similarly, T3 believed that the program was effective, even though he could only apply some of the learned skills in his current job due to differing circumstances. The participants also acknowledged the challenges associated with designing a curriculum that caters to a wide range of PSTs with varying competency levels and personal orientations.

4.2.6 Recommendations for Future Improvement

The participants were asked what changes they would like to see in the program. T1 and T6 wanted to stay the same, believing adding more learning could be stressful and overwhelming for student teachers. On the other hand, others expressed their desire to increase the practical training in the program, with a particular focus on purposeful technology in teaching.

T7 emphasized the need for more practice and a systematic checkpoint testing of practical skills. At the same time, T2, T4, and T5 specifically mentioned that they want more advanced training in video editing, graphic design, and PowerPoint presentations. T2 stated:

> *"Em nghĩ là nên xây dựng một môn CNTT riêng phải ba tín. Thứ nhất là đi theo xu hướng về chỉnh sửa thiết kế video hình ảnh, thiết kế đồ họa…Em nghĩ cũng phải có môn riêng về thiết kế PowerPoint chuyên sâu. Còn bây giờ chỉ đang học mấy cái cơ bản hiệu ứng, không có gì đặc sắc. Bởi vì theo xu hướng thì phải trẻ hóa một chút, video hình ảnh hiệu ứng rồi âm nhạc có thể không liên quan đến bài học nhưng tạo cảm hứng học hơn."*

"We should have a technology course for at least three credits to add more advanced learning on editing videos, images, and graphic design. We should also have an advanced course on designing PowerPoint. Currently, the TEs are only teaching basic effects that we already know. However, the design should be trendy, with catchy effects, videos, and music to capture students' attention. These elements may not directly relate to the content but will increase students' engagement and excitement."

T5 also emphasized the need to start pedagogical training from the first year of the program, saying,

"Bây giờ bình thường mình đang học phương pháp tập trung vào năm ba, bốn thì mình cũng có thể dạy bắt đầu từ năm nhất. Có nghĩa là chia nhỏ với chương trình ra năm nào mình cũng sẽ nhắc lại cái phần đó thì khi mình nhắc đi nhắc lại nhiều thì sinh viên sẽ ghi nhớ hơn là mình chỉ dạy tập trung các môn vào hai năm cuối."

"Instead of focusing on the last two years, we can start (learning technology and pedagogy) from the first year and repeat it every year. I guess student teachers will learn better that way."

In addition, T3 expressed a need for a specific course focused on technologies in chemistry teaching. T3 stated,

"Em nghĩ là nếu như có thêm hẳn một môn học về các phần mềm ngoài cái phần Word mà học môn chung ra. Nếu như mà có cả cái học phần về chuyên ngành có thể áp dụng được ấy...Em muốn là có môn học thiên về phương pháp nhiều hơn ấy. Chẳng hạn 15 tuần học thì mỗi một hoặc hai tuần học về một cái ứng dụng nào đấy."

"I want a specific course about technologies that can be used in chemistry teaching. For example, in a 15 weeks course, we learn about one application every 1-2 weeks. I want to learn more about how I can apply technology in actual teaching."

Overall, the feedback provided by the participants shows that there is a need for improvements in the program, particularly in terms of increasing practical training and advanced technology courses. It is also recommended to start pedagogical training from the program's first year to better prepare student teachers for their future careers. T3's suggestion of a specific course focused on technologies that can be used in chemistry teaching is also a valuable recommendation.

4.3 Chemistry Teachers' Readiness for Future Use of Technology Integration

RQ3: How do new in-service Chemistry teachers perceive their digital readiness for the future use of technology integration

The study results revealed that most teachers were motivated to improve their technology integration skills. Some teachers proactively sought opportunities to update their knowledge, often through social media groups or online news sources, when they needed more knowledge in certain areas. Conversely, some indicated that they tended to make changes in response to curriculum requirements, suggesting extrinsic motivation as the primary driver. Regardless of motivation, most teachers did not have concrete goals or plans for self-reflection and further learning. Furthermore, the teachers' lack of confidence in sharing their experiences with others resulted from a perceived need to achieve a higher level of expertise before doing so, ultimately leading to feelings of isolation in their professional development journey.

4.3.1 Motivation for Professional Development

All participants shared a common concern for the engagement level of their students in the classroom. They all agreed that incorporating technology into their lessons effectively captures students' attention and increases the excitement. They observed that students, considered "digital natives," are drawn to exciting technologies and react positively to them, resulting in better outcomes. According to T3, motivating students is to make learning fun and avoid scaring them with complex subjects such as chemistry. T3 explained that he must continuously improve himself to attract students:

> *"Ví dụ như hôm nay mình lên lớp mà nó biết hết là mình sẽ làm cái gì xong rồi ngày nào cũng như ngày nào thì nó sẽ không còn thú vị nữa. Có thể hôm nay mình cho nó chơi trò A ba buổi liên tiếp thì đến buổi thứ tư nó nghĩ là thầy lại định cho chơi tiếp nhưng mình lại đổi sang trò B. Thì chúng nó không đoán được chúng nó sẽ mong chờ. Mình phải luôn luôn đổi mới, vừa nâng cao kĩ năng của mình vừa cho học sinh thấy thú vị và có động lực học."*
>
> " If you use the same trick every day, the kids will catch on and get bored of your class. However, if you let them play with game A for three days in a row and then switch it up to game B on the fourth day, they won't know what to expect and will be super excited for the next lesson. As a teacher, you gotta keep updating yourself and coming up with cool stuff to make your lessons interesting and keep your students motivated to learn."

T3 also emphasized upgrading his technology knowledge to make his job more manageable. He admitted that he was a "lazy teacher" who wanted to use technology to save time and enhance his teaching:

> *"Mình làm sao mình đỡ mệt. Thì dùng slide như thế mình đỡ phải viết…Thứ nhất là công nghệ ngày càng thay đổi. Những cái ra sau thường sẽ tốt hơn trước nên mình nên biết nhiều để cái vốn của mình phong phú lên. Và mình áp dụng được sẽ thuận tiện hơn cho mình."*
>
> "Do what makes you less tired. Like, using slides helps you avoid writing in class. Technology is always evolving, and the new stuff is usually better. Teachers must keep learning and stay up-to-date with the latest tech to reduce their workload and stuff."

T4 and T7 shared the same view, affirming their desire to enhance their skills and knowledge to be more effective in guiding their students and keeping them informed. They believed staying current with technological advancements is crucial for achieving these goals.

All the teachers interviewed emphasized the importance of professional development in enhancing their teaching practice. They acknowledged the role of technology in capturing their students' attention and motivating them to learn. The teachers also recognized the need to continually update their skills and knowledge to improve their effectiveness in the classroom and better serve their students.

4.3.2 Goals and Plans

The study findings indicated that, despite the participants' motivation to improve their educational technology knowledge, most lacked a clear plan or target for developing their skills. While some participants (such as T5 and T6) did not have any specific targets at the time of the study, others (including T1, T2, and T3) had a general idea of wanting to learn more, particularly in areas such as PowerPoint and educational game designing. T2, for example, emphasized the need to be more creative in utilizing digital tools and felt that he still needed to utilize his potential fully. Moreover, T4 and T7 expressed their desire to learn and share their learning journey and tips with their students to enhance their learning experience. However, the participants had yet to develop a concrete learning plan to achieve their targets. Most participants viewed learning as an ongoing process through their work rather than through separate, designated learning activities. They believed that adapting themselves to work and making changes to meet work requirements was sufficient for improving their competence.

4.3.3 Learning and Sharing Practices

During the interview, participants were probed on their approaches to updating and sharing their technology knowledge. T5 conveyed contentment with her current skill set and had no plans to learn more until the curriculum changed next year. However, the rest of the participants indicated they actively seek solutions to technology-related challenges via Google, YouTube, and social media. Four participants acknowledged Facebook groups as their primary source for updates on new technology trends and experiences in teaching. T3 mentioned that search engines would recommend additional digital tools or websites whenever he searched for something. Regarding sharing their knowledge, all participants disclosed that they only shared their insights with close acquaintances or when asked for assistance. They felt inadequate to share their knowledge proactively and preferred to learn from others. T4, in contrast, showed a willingness to help colleagues without prompting.

In the words of T7,

> *"Khi nào người ta cần và muốn sự giúp đỡ từ em vào những hoạt động mà em biết và có thể giải thích chuyên sâu thì em mới tự tin giới thiệu. Còn cái gì em mới sử dụng thấy hay em cũng chưa dám đưa lên khi chưa hiểu quá sâu."*
>
> "If someone asks me for help on a familiar topic, I'm happy to assist confidently. However, if I'm starting to use a new tool or technique, I won't share it with others until I have a solid understanding."

T3 also shared,

> *"Em thấy em chưa học được gì nhiều, toàn học cái người ta đã chia sẻ rồi. Em chia sẻ lại người ta cười mất. Người ta đã biết từ bao giờ rồi."*
>
> "I don't feel like I've learned much. Most of what I know came from others sharing their knowledge in the groups. I'm afraid to share my own thoughts because I feel like everyone else probably knows it already, and they might even laugh at me for being late to the party."

Despite their different attitudes towards sharing, all participants recognized the importance of updating their technology knowledge and actively sought out new information in their job.

4.4 Results Summary

This study aimed to investigate three areas related to new in-service Chemistry teachers: their current use and knowledge of technology in teaching, their perceptions of their teacher preparation program, and their digital readiness for future technology integration.

The findings revealed that the participating teachers had high confidence in their TPACK skills and reported frequent use of technology during the planning and designing stages. However, their use of technology was limited to substitution and augmentation stages as per the SAMR model.

Concerning their perception of their teacher preparation program, participants felt a lack of specific courses on educational technology and technology integration needed to be emphasized more in all the courses they took. While they were introduced to various types of technology, they felt the introduction needed to be more effective and necessary for their actual work. Thus, they suggested that the program focus on vital technology and provide more coaching time for practical application.

Finally, while most participants expressed high motivation to enhance their technology integration skills, they lacked concrete goals or plans for self-reflection and further learning. Moreover, they viewed studying further as unnecessary and considered updating their skills to fulfill their job requirements as their professional development goal.

5 DISCUSSION

5.1 Teachers' High Confidence

The findings of this study reveal that, despite their limited teaching experience, the participating teachers demonstrated a noteworthy level of confidence in their Technological Pedagogical Content Knowledge (TPACK) skills, as indicated by their self-reported survey scores. However, these results diverge from previous studies conducted by Chai et al. (2013) and Wang et al. (2020), which reported lower levels of technology-related proficiency among pre-service teachers.

It is crucial to acknowledge the potential influence of this study's small sample size, comprising only seven teachers. The participants mentioned a tendency to share their experiences primarily when they considered themselves experts in the field, suggesting a potential bias in the results. It is plausible that only those who were already confident in their skills agreed to participate. Furthermore, it is worth noting that self-efficacy refers to an individual's belief in their capability to achieve desired outcomes (Burns et al., 2016), and it closely relates to personal goal setting. In this case, the participating teachers expressed contentment with their current digital skills, perceiving that the existing curriculum does not demand more advanced competencies. This low goal setting in job requirements may help explain their heightened confidence in their abilities. Additionally, self-reported measures were employed, which may be influenced by personality traits rather than accurately reflecting abilities (Burns et al., 2016). Considering the small sample size and the fact that individuals were invited to participate in individual interviews with an unfamiliar researcher, it is reasonable to assume that individuals with higher confidence levels were more likely to volunteer for the study.

Indeed, a necessary inquiry emerges: Could this observed low goal setting be attributed to the program? This hypothesis is supported by the participating teachers' reported high dependence on the curriculum and a noticeable absence of proactive self-development, with their primary focus being on meeting job requirements. Consequently, investigating this phenomenon in greater depth presents an intriguing avenue for future research endeavors.

5.2 Teachers' Actual Technology Integration Skills

5.2.1 Challenges in Integrating Fundamental Knowledge (TK, CK & PK)

The survey conducted revealed that the teachers displayed high levels of confidence in their subject content knowledge (CK), pedagogical knowledge (PK), and technological knowledge (TK) skills, as reflected in their survey scores. However, during the interviews, the teachers struggled to explain how they effectively integrated technology, pedagogy, and content into their teaching practices. This result suggests that although the teachers possessed solid individual skills, they faced challenges when integrating them effectively.

This finding aligns with previous research conducted by Koh and Divaharan (2011), who reported that pre-service teachers often lacked sufficient Technological Pedagogical Content Knowledge (TPACK) and struggled to comprehend the relationship between CK, PK, and TK. Similarly, Tondeur et al. (2017) and Voogt and McKenney (2017) observed that PSTs often obtained technology skills separately from their knowledge of teaching methods and subject matter.

In this study, the participants reported a similar scenario during their initial teacher education (ITE) program, which primarily focused on the technical aspects of different technologies without fully integrating them into educational practices. The teachers underwent separate courses in pedagogy, content, and technology, which may have hindered their ability to recognize the interconnections between these skills and apply them effectively in their teaching practices.

Therefore, ITE programs must consider the curriculum as a whole and establish meaningful interrelationships between subject content, pedagogy, and technology courses. One approach that could be adopted is to sequence the courses in a specific manner:

1. Technology courses should concentrate on teaching new and innovative educational technologies.
2. Subject content courses should require pre-service teachers (PSTs) to design lessons utilizing newly acquired technology to teach specific topics.
3. PSTs should present their lesson plans in pedagogy courses and receive constructive feedback, facilitating discussions on the optimal combination of technology choices to enhance instruction.

This recommended sequence is based on the research conducted by Mouza et al. (2014), who also integrated technology, pedagogy, and subject content courses in their program, significantly improving PSTs' TPACK abilities. By adopting such an approach, ITE programs can better equip future teachers with the necessary skills and understanding to integrate technology effectively into their instructional practices.

5.2.2 Explanation for Complex Knowledge (TCK, TPK, PCK, TPACK) Scores

The Chemistry teachers who participated in this study reported that their Technological Content Knowledge (TCK) was lower than their other self-reported knowledge, which is consistent with the findings of previous studies on pre-service teachers conducted by researchers such as Koh and Divaharan (2011), Swan and Hofer (2011), and Valtonen et al. (2019). During the interview, participants stated that their ITE program only briefly introduced some specific Chemistry Edtech tools, such as ChemDraw and Crocodile. Although these tools were commonly used in designing Chemistry teaching materials, the teachers did not have sufficient opportunities to practice using them in actual lesson plans.

Moreover, they found it unnecessary to use these technologies since they can easily find relevant teaching materials online. To address this issue, the institute should focus more on improving PSTs' TCK by conducting a needs analysis and thoroughly understanding which technology is vital for the actual job of Chemistry teachers in the Vietnamese context. The program should focus only on teaching those Chemistry education technologies with more practical exercises for PSTs to understand how these technologies can enhance the teaching content.

Besides lower TCK, the teachers expressed high confidence in their TPK, PCK, and TPACK skills, which they attribute to compelling features of their ITE program, such as mentoring and peer coaching, authentic experience, observation, rehearsal, and field experience. The fact that four of them shared the same experience of working in groups and engaging in peer discussions about the practices of different technologies suggests that peer collaboration in the classroom is the most valuable for their learning. While the teachers were comfortable sharing with their peers, they hesitated in actively sharing new findings with colleagues or in public forums, fearing judgment for not being experts. This attitude could hinder their long-term professional development. One possible reason for this hesitation could be the hierarchical nature of the workplace, which may make junior teachers reluctant to share their thoughts and ideas openly. While this aspect cannot be changed, teacher educators (TEs) in the program can play a role in encouraging more collaboration and sharing activities to foster confidence and enhance collaborative learning traits among the teachers. By nurturing a culture that embraces open sharing and constructive feedback, the ITE program can facilitate the long-term development of teachers and equip them with the skills necessary for their careers.

The teachers also noted minimal time for hands-on practice with technology during the program. Although observation, rehearsal, and field experience are crucial aspects of ITE, these activities focused primarily on enhancing their PCK skills rather than on practicing new technology. They recalled some sessions where they designed lesson plans, presented in class, and discussed with peers to improve their planning, but these discussions mainly focused on pedagogy rather than technology. Therefore, TEs should have in-depth knowledge of important and frequently used technologies and connect them with topics and teaching activities instead of introducing the technology separately.

In addition, the teachers reported that work sample analysis and reflection were absent from their ITE experience. To address this, TEs should leave room for pre-service teachers to bring new ideas and technologies to the classroom (Jang, 2010), fostering collaborative learning and active sharing among PSTs, as mentioned earlier. Additionally, it is vital for ITE programs to continually update their curriculum based on input from in-service teachers regarding the most common and applicable technologies in the field. A valuable suggestion for teacher training institutions is establishing a network of program graduates and maintaining regular communication to gather feedback on their experiences and needs. By leveraging the insights and expertise of these graduates, ITE programs can stay current and relevant, ensuring that they provide PSTs with the necessary knowledge and skills to meet the demands of the teaching profession. This ongoing collaboration and program refinement process contribute to the continuous improvement of teacher education and the integration of effective technology practices.

Overall, it is recommended that ITE programs include work sample analysis and reflection, as these aspects have shown promising results in previous studies (Mouza et al., 2014; Koh & Divaharan, 2011), and technology should be integrated into the entire training, as suggested by Tondeur et al. (2013).

5.2.3 Limited Use of Substitution and Augmentation in Teaching Practices

Although the teachers reported having adequate TPACK skills for their job, in-depth interviews revealed that they mainly used technology as a substitute for traditional teaching methods and sometimes as a means of augmenting teaching and learning. They did not demonstrate an intention to modify or redefine learning with technology. These findings are consistent with the analytic SAMR research review conducted by Blundell et al. (2022), as well as the studies conducted by Pham et al. (2019) and Vo et al. (2020) on language teachers in Vietnam. While Le and Song (2018) attributed these results to school facilities and curriculum constraints, this may not be the most significant factor in this case. Participants described their school facilities as adequate for teaching, with a projector, TV, and speaker. While some schools lacked internet connectivity, this did not pose a significant problem. The only minor issue was that some schools did not permit students to use personal digital devices such as mobile phones and laptops in the classroom, making it difficult to distribute online collaborative activities. Nonetheless, the participants' extensive use of technology in their teaching suggested comfort with the tools, and schools' infrastructural deficiencies did not present substantial obstacles.

The most critical factor was that the teachers needed sufficient knowledge of integrating technology into their teaching. The limited TCK could explain why they only thought of technology pedagogically when using it and as a tool to achieve predetermined teaching goals. The interviews further revealed unfamiliarity with technology integration frameworks in teaching and their inability to link their choices with theoretical support. When asked about their decisions on activities, the participants expressed a lack of reflection and consideration, doing what they thought appropriate without introspection. The findings imply that these teachers primarily rely on instinctive approaches and require more guidance to reach their full potential in using technology for teaching.

When analyzing the examples of learning activities in their ITE, it became evident that TEs only used technology in the substitution and augmentation stages. This behavior of TEs could influence why these teachers view technology integration as less advanced. As TEs serve as role models for PSTs in their future utilization of technology (Baran et al., 2019), their approach can shape the perceptions and practices of PSTs. One effective approach to addressing this issue is to utilize the SAMR model as an instructional design to guide PSTs' reflection activities. In this method, PSTs first must create multiple plans for teaching a particular topic, using technology in each stage of the SAMR model and without technology. Afterward, they can choose the plan that they believe is most appropriate for the specific context of their teaching, such as public or private schools, student levels, and curriculum, while also considering their teaching styles and skills. TEs can utilize a teaching design that involves collecting the lesson plans created by the PSTs and using analysis tools to categorize them into various themes. TEs can send the categorized results to PSTs before class, where they can discuss the collected ideas. This teaching approach has the potential to bring the PSTs' TPACK skills to the forefront, foster their creativity, and improve their understanding of SAMR and its role in enhancing their use of technology in teaching.

5.3 Lack of Clear Goals and Plans for Developing Digital Skills

The study revealed that teachers lack clear goals or plans for developing their digital skills. Instead, they tend to address problems as they arise, relying on their existing knowledge without a systematic approach to skill development. This reactive approach does not lead to genuine skill improvement, as they may or may not use the solutions again in the future, often sticking to familiar technology tools.

Despite having few teaching sessions per week and some teachers admitting to not spending much time on lesson preparation, they still feel job pressure, which hinders their dedication to enhancing their skills. Other school-related tasks and additional teaching commitments after school further multiply their workload, leaving them with little time or motivation to transform their teaching practices. Some teachers even expressed a lack of interest in skill development after the first year, as they feel content with following the curriculum and relying on basic or traditional teaching methods. The absence of clear goals can be attributed to a lack of specific frameworks or foundational knowledge on technology integration in teaching. Teachers make planning and teaching decisions based on intuition rather than a well-defined strategy. Providing pre-service teachers (PSTs) with a solid foundation in technology integration theories, such as the SAMR framework, is essential to guide them toward more advanced technology usage. PSTs should also be supported in developing clear orientation plans, with explicit baseline and checkpoints, to facilitate their professional development. Implementing utility value practices, reflecting on theories, translating them into teaching ideas, and guiding PSTs in developing personal planning skills can be effective.

Despite lacking clear goals or personal plans, teachers are motivated to enhance their technology-related skills. It is crucial for the workplace environment and schools to nurture and support this motivation. Traditional one-time teacher training workshops and conferences have a limited impact on teachers' practices. Instead, a continuous and sustained training approach is necessary to ensure teachers' ongoing development and improve their teaching practices (Carlson & Gadio, 2002; Enochsson & Rizza, 2009; Sardone & Devlin-Scherer, 2008).

5.4 Suggestions for the Teacher Training Program

Based on the interviews, it is evident that the teacher preparation program has inadequately equipped participants with the essential technology skills required for their teaching practices. The program exhibits various shortcomings, necessitating recommendations for improvement.

Firstly, the program lacks a clear link between subject content understanding, teaching pedagogy, and technology skills. Although the program integrates several essential features of a successful ITE, such as pedagogy skills, it places little emphasis on technology. Additionally, PSTs lack preparation in critical skills and self-reflection. Secondly, TEs primarily utilize technology as a substitute for traditional teaching methods. Although some pedagogy courses encourage hands-on experience in the classroom and augment the use of technology, these opportunities could have been more frequent. Thirdly, teaching basic technical skills and software content is unnecessary and time-consuming for all participants, as they had already acquired these skills during their secondary or high school education. Finally, despite introducing various fascinating technologies, only some of them are beneficial in their actual job. Based on these insights and participants' feedback, recommendations for teacher training institutions in Vietnam are necessary.

To bridge the gap between content knowledge (CK), pedagogical knowledge (PK), and technological knowledge (TK), a comprehensive redesign of the program is necessary, grounded in a robust framework (Tang, 2022). Integrating more technology into the current program or adding a few more educational technology courses alone will not improve the quality of teacher preparation. Instead, integrating technology into the ITE should be integral to the educational process, such as planning, implementing, and evaluating learning using technology. PSTs should learn the theoretical foundations of the framework to evaluate their progress better and develop their skills (Tang, 2022). Two recommended frameworks for the program are Technological Pedagogical Content Knowledge (TPACK) and the Substitution Augmentation Modification Redefinition (SAMR) model. TPACK provides a deep understanding of the combination of pedagogy and content knowledge with technology. In contrast, the SAMR model provides a roadmap with checkpoints of technology performance in the classroom.

To serve as effective role models for prospective science teachers (PSTs), technology educators (TEs) must demonstrate proficiency in utilizing technology. TES must create an authentic learning environment that allows PSTs to practice and refine their technical skills. Given the varying technical proficiency levels among PSTs, organizing technology courses based on proficiency levels enables PSTs to select courses that cater to their specific needs. The technology chosen for the program should also be relevant to their future use in actual teaching jobs, cutting down the time spent on unnecessary content and increasing practical time for PSTs. Additionally, the program should emphasize the importance of ethical awareness, providing instruction on the responsible use of legal products, respecting authenticity, and serving as exemplary models for future students. Implementing these recommendations is crucial to enhancing teacher preparation programs in Vietnam and equipping PSTs with the necessary skills to integrate technology into their teaching practices seamlessly.

On the contrary, it is essential to consider the unacknowledged benefits that participating teachers have derived from the program. The focal point of educational technology implementation is not centered around mastering intricate skills but rather the purposeful utilization of fundamental concepts. Since the participating teachers already possessed basic technology skills before enrolling in the program, they may perceive a need for novel knowledge acquisition. However, it is imperative to recognize that they have effectively employed these foundational technology skills within their pedagogical practices, albeit without conscious awareness. Undoubtedly, this integration contributes to the development of their teaching competencies. Hence, the program and teacher educators should endeavor to explicitly incorporate technology content, enabling pre-service teachers to comprehend the technological aspects they will be exposed to comprehensively.

5.5 Limitation

The present study has several limitations that warrant acknowledgment. Firstly, the sample size was small, consisting of only seven teachers who were conveniently selected through an invitation posted on a Facebook group. Consequently, the generalizability of the findings may be restricted, as a randomly sampled group would have better represented the population. The convenience sampling method may have introduced bias, as teachers with greater confidence in their technology-related skills might have been more inclined to participate.

Secondly, using self-reported measures, such as surveys and interviews, introduces the potential for bias and inaccuracies due to participants' social desirability or memory recall. While the

TPACK survey is commonly employed in research, some statements may need to be more easily understood. For instance, participant T5, who rated herself low in various technology-related skills, explained during the interview that her ratings were based on the extent of technology use in her job rather than a lack of confidence in her skills. Additionally, participants' unfamiliarity with self-reporting and reflective practices poses a challenge in assessing their abilities. The absence of clear guidance or a comparative scale also makes it difficult to differentiate between proficiency levels. While identifying Levels 1 and 2 is relatively straightforward, distinguishing between Levels 3, 4, and 5 becomes more complex. The interviews generated from the participants' perspectives can also result in bias. Evaluating participants' lesson plans or observing their classroom practices would provide additional valuable data. However, such assessments would require more time and resources.

Despite these limitations, the combination of self-reported measures and interviews was a reliable means of assessing teachers' technology competencies. It yielded valuable insights into the implementation of the teacher training program.

5.6 Future Studies

This study offers valuable insights into the teacher training program at HNUE and sheds light on the current digital skills of chemistry teachers in their teaching practices. In light of the findings and existing research, it may be unnecessary to measure TPACK and SAMR further. However, future research can significantly contribute by establishing specific standards for technology integration in chemistry teaching within the Vietnamese educational context, including determining the minimum requirements stipulated by the current curriculum and identifying the recommended level of technology integration necessary for effective chemistry instruction.

Furthermore, it is crucial to clarify the significance of technology within the secondary and high school curriculum and to assess teachers' perceptions of the need and motivation to enhance their digital skills. A comprehensive understanding of the underlying reasons for skill enhancement is pivotal for fostering motivation and enabling teachers to establish clear and specific developmental goals.

Moreover, future research endeavors should develop viable solutions to enhance the quality of technology integration and training in teacher education programs. A promising avenue involves exploring TCK practices and development to effectively connect technological knowledge (TK) and content knowledge (CK) in order to enhance Technological Pedagogical Content Knowledge (TPACK). Another direction worth exploring is the design of integrated courses that purposefully integrate technology with specific pedagogical methods tailored to teaching specific content areas. The potential effectiveness of implementing these courses on a broader scale across various teacher training institutions could be assessed using pre-and post-tests.

Additionally, studies that concentrate on designing a logical sequence of courses within the program, promoting continuous practices, and integrating knowledge are recommended. Future research should adopt a holistic approach to technology integration, moving beyond isolated course interventions. Such an approach recognizes technology as an ongoing process in teaching and learning, with the TPACK framework interwoven throughout teacher preparation courses.

In summary, future research should strive to establish specific standards for technology integration in chemistry teaching, clarify the significance of technology within the curriculum, explore more effective approaches to enhance TPACK, design integrated courses that purposefully combine technology and pedagogy, and adopt a holistic perspective on technology integration within teacher preparation programs.

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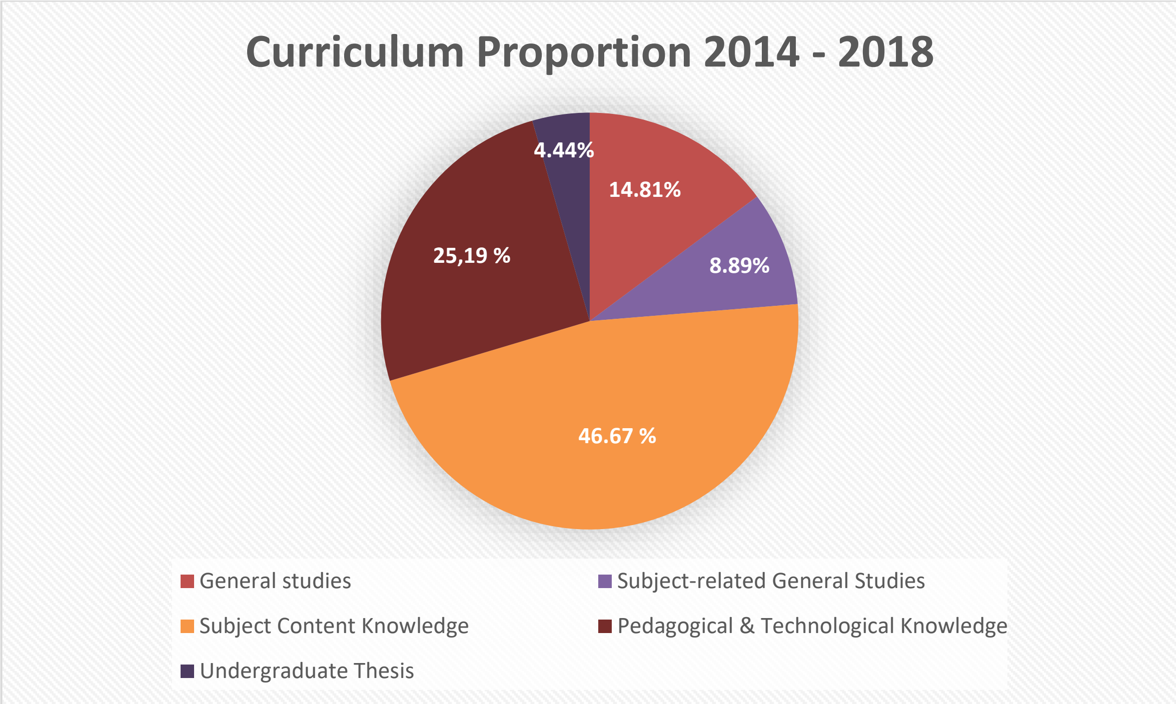
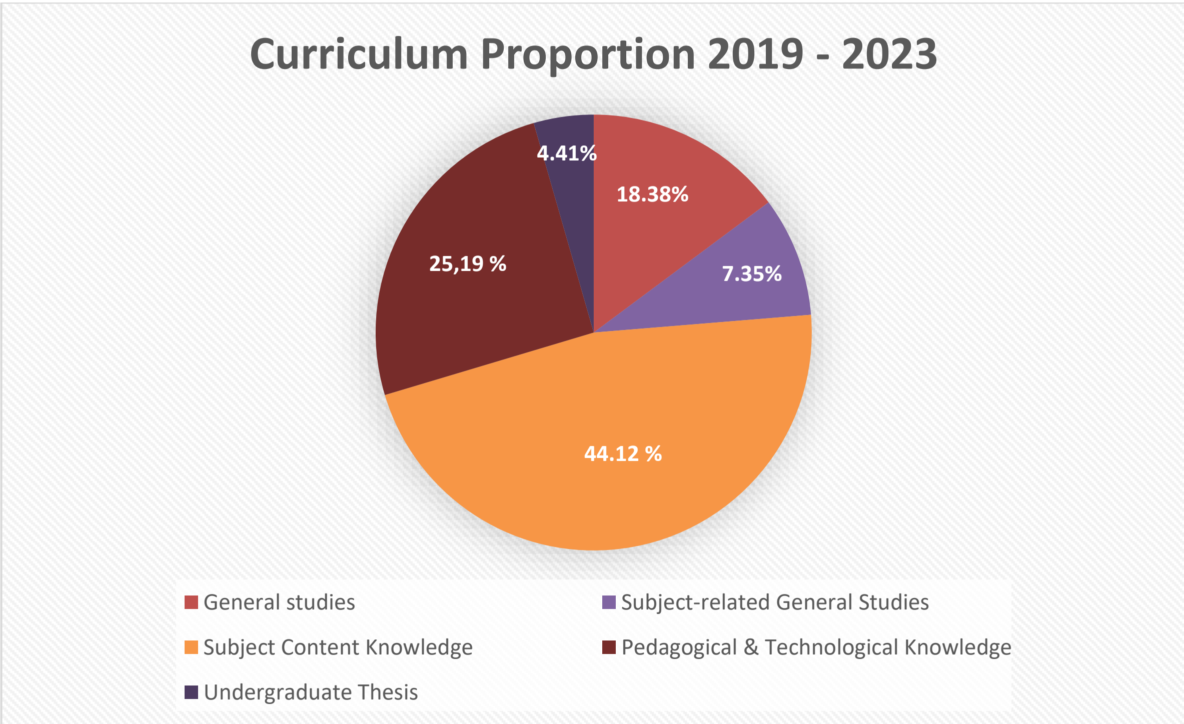
APPENDICES

Appendix 1 – Teacher Training Courses Chemistry Department, HNUE

Couse	Credits	Course	Credits
General studies (Languages and Political courses – 20/135 credits) 14.81%			
English 1	4	Fundamental of Marxism-Leninism 1	2
English 2	3	Fundamental of Marxism-Leninism 2	3
English 3	3	Revolutionary Strategy of the Vietnamese Communist Party	3
Ho Chi Minh Ideology	2		
Subject-related general studies (12/135 credits) 8.89%			
Fundamental Physics 1	2	Advanced Mathematics 1	4
Fundamental Physics 2	3	Advanced Mathematics 2	2
Practical Fundamental Physics	1		
Subject Content Knowledge: (63/135 credits) 46.67%			
Accelerated Chemistry A1	3	Applied Informatics in Chemistry	2
Accelerated Chemistry 2	2	Specialized English	3
Inorganic Chemistry - Metals	3	Inorganic Chemistry – Non-metals	2
Crystals and Coordination Compounds	2	Molecular Symmetry & Group Theory	1
Fundamental Organic Chemistry - Hydrocarbons	3	Practical Accelerated & Inorganic Chemistry	2
Thermodynamics	2	Kinetic Chemistry & Colloids	3
Electrochemistry	2	Hydrocarbon Derivatives	2
Heterocyclic Compounds & Polymers	2	Environmental Chemistry	3
Quantitative Chemical Analysis	2	Qualitative Chemical Analysis	3
Practical Physical Chemistry	1	Chemical Engineering	2
Practical Organic Chemistry	2	Agricultural Chemistry	2
Water Treatment Technology	2	Fundamentals of Organic Chemistry	2
Quantum Chemistry	2	Practical Analytical Chemistry	2
Field Visit	1	Physicochemical Analysis	3
Practical Environmental Chemistry	1	Fundamentals of Inorganic Chemistry	2
Pedagogical and Technological Knowledge (34/135 credits) 25.19%			
General Pedagogical Training	3	Educational Psychology	4
Theories of Education	3	Educational Skills Practice	2
Communication Skills in Educational Environment	2	Pedagogical Methods in Teaching Chemistry 1	3
Pedagogical Methods in Teaching Chemistry 2	2	Assessment and Evaluation in Education	3
Teaching Practices at Teacher Training Schools	3	Methods in Teaching Chemistry at Secondary and High schools	3
Internship 1	3	Internship 2	3
Undergraduate Thesis: 6/135 credits 4.44%			

Appendix 2 – Graphs of Curriculum Proportion





Note. New courses General Computer Skills (2 credits) + Basics of Computer Science (2 credits)

Appendix 3 – Invitation Post

Appendix 4 – Consent form (English)

PARTICIPANT INFORMATION SHEET AND PRIVACY NOTICE

TITLE OF THE MASTER'S THESIS: The Effect of Teacher Training Programs on Chemistry Teachers' Readiness to Use ICTs in Teaching: A case study of Vietnamese New In-service Chemistry Teachers

Invitation

I would like to invite you to take part in my research project. Before you decide whether to take part, it is important that you understand why the research is being done, what it will involve for you, what information I will ask from you, and what I will do with that information.

I will in the course of this project be collecting personal information. Under General Data Protection Regulation 2016, we are required to provide a justification (what is called a "legal basis") in order to collect such information. The legal basis for this project is your informed consent to participate and consent to processing your personal data.

You can find out more about our approach to dealing with your personal information at https://utuguides.fi/researchdata/datasecurity.

Please take time to read this document carefully. Feel free to ask me any questions you may have and to talk to others about it if you wish. You will have at least 5 days to decide if you want to take part.

What is the purpose of the research?

My research aims to study the specific aspects of the teacher training program, such as learning activities, inquiries, and educators' behavior, that influence new in-service Chemistry teachers' preparedness and intention to use ICTs in teaching. My research will provide valuable insights into how to improve teacher training programs to better prepare Chemistry teachers to use ICTs in their instruction.

Who is undertaking the research?

Trang Nguyen

Email: trang.t.nguyen@utu.fi

Univerisity of Turku, Department of Education,

Assistentinkatu 5,

20500 Turku

Finland

Who has oversight of the research?

The researchers act as the "Data Controller" for personal data collected through the research projects & is subject to the General Data Protection Regulation 2016. I also follow the data protection guidelines of the Finnish Social Science Data Archive, available at: https://www.fsd.tuni.fi/en/services/data-management-guidelines/informing-research-participants/.

Why have I been invited to take part?

You have received this invitation because you are a Chemistry teacher who graduated from Hanoi National University of Education in 2020 and 2021 and now are working at a school in Hanoi. I am hoping to recruit 10 participants for this study.

Do I have to take part?

No. It is up to you to decide whether or not you want to take part in this study. Please take your time to decide; I will wait for at least 3 days before asking for your decision. You can decide not to take part or to withdraw from the study any time. If you wish to have your data withdrawn please contact one of the researchers with your participant number and your data will then not be used. If you do decide to take part, you will be asked to sign a consent form (verbal confirmation in video recording).

What are the benefits for me in taking part?

You can benefit from the discussion and reflect on your own use of ICT in teaching. If you are interested, I can share short reports on the project results with you.

Are there any risks for me if I take part?

The research is unlikely to cause any risk or harm.

What will you do with my information?

Your personal data / information will be treated confidentially at all times; that is, it will not be shared with anyone outside the research team or any third parties specified in the consent form unless it has been fully anonymised. The exception to this is where you tell me something that indicates that you or someone else is at risk of harm. In this instance, I may need to share this information with a relevant authority; however, I would inform you of this before doing so. During the project, all data / information will be kept securely in line with the university's data protection policies. I will process your personal information for a range of purposes associated with the project primary of which are:

To use your information along with information gathered from other participants in the research project to seek new knowledge and understanding that can be derived from the information I have gathered.

To summarise this information in written form for the purposes of dissemination (through a master's thesis). Any information disseminated / published will be at a summary level and will be anonymised and there will be no way of identifying your individual personal information within the published results.

If you wish to receive a summary of the research findings or to be given access to any of the publications arising from the research, please contact me.

How long will you keep my data for?

Until the project is finished, your personal data will be stored, and once the project is completed, the video records will be eliminated, while the transcription will be preserved for a period of 2 years.

How can I find out what information you hold about me?

You have certain rights in respect of the personal information the University holds about you. For more information about Individual Rights under GDPR and how you exercise them please visit https://utuguides.fi/researchdata/datasecurity.

What happens next?

Please keep this information sheet. If you do decide to take part, please contact the researcher using the details below.

Thank you for taking the time to read this information.

If you decide you want to take part in my project, and I hope you do, or if you have any further questions then please contact me via email trang.t.nguyen@utu.fi

If you have any concerns about the project at this point or at any later date you may contact me or you may contact my Supervisor, Koen Veermans, koevee@utu.fi.

INFORMED CONSENT FORM

Title of Project: The Effect of Teacher Training Programs on Chemistry Teachers' Readiness to Use ICTs in Teaching: A case study of Vietnamese New In-service Chemistry Teachers

Participant identification number for this study:

Name of Researcher(s): Thi Thuy Trang Nguyen

I, the undersigned, confirm that:

1. I have read and understood the information about the project, as provided in the Information Sheet dated ________________ or it has been read to me.
2. I have been able to ask questions about the project and my participation and my questions have been answered to my satisfaction.
3. I understand that taking part in this study involves an interview lasting about 30-40 minutes where audio/video record will be taken which will be transcribed as text later. Recording and transcribed data will be kept on a password protected device and be destroyed after the assessment work will have been finished, latest in July 2023.
4. I understand that taking part in the study has no potential risk or harm. During the interview I am free not to answer questions.
5. I understand I can withdraw from the study at any time without giving reasons and that I will not be penalised for withdrawing nor will I be questioned on why I have withdrawn.
6. I understand that the information I provide will only be used for a Master’s thesis.
7. I agree that my information can be quoted in the research study with pseudonyms, meaning the processing my personal data in a way that the data can no longer be connected to me without additional information. Any of my additional information will be carefully stored, separate from the personal data.
8. The procedures regarding confidentiality have been clearly explained (e.g. use of names, pseudonyms, anonymisation of data, etc.) to me.
9. I understand that personal information collected about me that can identify me, such as my name, or where I live, will not be shared beyond the study team.
10. Separate terms of consent for interviews of data collection have been explained and provided to me.
11. I consent to the audio/ video recording.
12. I understand that other researchers will have access to this data only if they agree to preserve the confidentiality of the data and if they agree to the terms I have specified in this form.
13. I voluntarily agree to participate in the project.
14. I know who to contact if I have any concerns about this research

Name of participant	Signature	Date
Name of researcher	Signature	Date

Appendix 5 – Consent form (Vietnamese)

THÔNG TIN VỀ VẤN ĐỀ BẢO MẬT DÀNH CHO NGƯỜI THAM GIA

ĐỀ TÀI DỰ ÁN:
The Effect of Teacher Training Programs on Chemistry Teachers' Readiness to Use ICTs in Teaching: A case study of Vietnamese New In-service Chemistry Teachers

"Đánh giá hiệu quả của chương trình đào tạo trong việc chuẩn bị hành trang CNTT cho giáo viên Hóa học ở Việt Nam"

Lời mời

Tôi muốn mời bạn tham gia vào dự án nghiên cứu của mình với đề tài về CNTT trong đào tạo giáo viên dạy học Hóa học. Trước khi chính thức tham gia, tôi muốn bạn đọc kĩ tờ thông tin này để hiểu rõ các vấn đề xoay quanh dự án bao gồm: nguyên nhân tiến hành dự án, những gì sẽ ảnh hưởng đến người tham gia, thông tin bạn cung cấp sẽ được sử dụng như thế nào.

Trong quá trình phỏng vấn, tôi sẽ thu thập thông tin cá nhân của người tham gia. Thông tin này sẽ được sử dụng vào quá trình phân tích, đánh giá dữ liệu và hoàn toàn được bảo mật. Theo điều luật về Bảo vệ thông tin cá nhân 2016, tôi sẽ gửi bạn một văn bản Giấy chấp thuận để xác nhận sự đồng ý tham gia và cung cấp thông tin cá nhân cho dự án.

Bạn có thể tìm hiểu thêm về quá trình xử lý thông tin của người tham gia dự án trong link sau: https://utuguides.fi/researchdata/datasecurity.

Xin vui lòng nghiên cứu kĩ văn bản này. Bạn hoàn toàn có thể hỏi tôi bất cứ điều gì bạn còn thắc mắc, hoặc trao đổi thêm với mọi người nếu bạn muốn.

Mục đích của dự án là gì?

Đây là một dự án nằm trong chương trình Thạc sĩ của trường Đại học Turku, Phần Lan. Dự án này nhằm nghiên cứu các khía cạnh của chương trình đào tạo giáo viên chuyên ngành Hóa học ở ĐHSPHN có ảnh hưởng tích cực đến sự sẵn sàng và chủ động của giáo viên mới tốt nghiệp khi sử dụng ICT trong dạy học. Từ đó đưa ra những gợi ý cho việc xây dựng một chương trình hiệu quả hơn cho các khóa đào tạo sau này.

Ai là người tiến hành dự án?

Trang Nguyễn
Email: trang.t.nguyen@utu.fi
Univerisity of Turku, Department of Education,
Assistentinkatu 5,
20500 Turku
Finland

Ai sẽ giám sát dự án này?

Người nghiên cứu chính (Trang Nguyễn) sẽ là người thu thập, dự trữ và xử lý thông tin theo đúng Luật bảo vệ thông tin cá nhân 2016 và hướng dẫn của Hội Dữ Liệu Khoa học xã hội Phần Lan.
https://www.fsd.tuni.fi/en/services/data-management-guidelines/informing-research-participants/.

Tại sao bạn lại được mời tham gia?

Bạn là đối tượng phù hợp cho nghiên cứu này nếu bạn là giáo viên Hóa học tốt nghiệp Khoa Hóa học, ĐHSP Hà Nội trong năm 2021 hoặc 2022 và hiện đang làm việc ở một trường học tại Hà Nội.

Bạn có bắt buộc phải tham gia không?

Không. Bạn có toàn quyền quyết định có tham gia dự án này hay không. Vui lòng cân nhắc kĩ lưỡng và liên hệ lại với tôi về quyết định của bạn. Nếu bạn đồng ý tham gia, bạn cần xác nhận lại một lần nữa trong phần ghi hình buổi phỏng vấn.

Bạn có lợi ích gì khi tham gia dự án?

Thông qua quá trình trao đổi và cùng đánh giá, tôi tin rằng bạn sẽ tìm thấy những thông tin có ích cho việc phát triển nghề nghiệp của bản thân. Nếu bạn yêu cầu, tôi sẽ gửi lại báo cáo phân tích của dự án với bạn (bằng tiếng Anh).

Bạn có thể bị ảnh hưởng tiêu cực từ dự án không?

Dự án này và nội dung buổi phỏng vấn sẽ không tạo ra bất cứ sự tiêu cực hay nguy hiểm nào cho người tham gia.

Tôi sẽ làm gì với thông tin cá nhân của bạn?

Thông tin cá nhân và các thông tin khác mà bạn cung cấp sẽ luôn được bảo mật. Thông tin sẽ không được chia sẻ với bất kì ai hay bên thứ ba nào trừ khi đã được ẩn danh. Tuy nhiên, nếu bạn đưa ra thông tin nào đó trong buổi phỏng vấn có liên quan đến pháp luật và sự an toàn của một ai đó (bao gồm chính bạn), tôi sẽ phải báo lại với cơ quan chức năng. Dù vậy, tôi cũng sẽ xin ý kiến đồng ý của bạn trong mọi tình huống trước khi quyết định. Trong suốt quá trình tiến hành dự án, sự lưu trữ và xử lý thông tin sẽ được tiến hành tuân theo các quy định về bảo mật thông tin của Đại học Turku. Về cơ bản, tôi có thể sẽ xử lý thông tin cá nhân của bạn như sau:

- Phân tích cùng với thông tin của những người tham gia khác để tổng hợp, trả lời câu hỏi nghiên cứu đặt ra.
- Trích dẫn lại lời nói của bạn trong Luận văn dưới dạng ẩn danh với mục đích nghiên cứu. Người đọc Luận văn sẽ không thể xác nhận được cá nhân tham gia phỏng vấn là ai thông qua các trích dẫn đó.

Nếu bạn muốn được xem lại các trích dẫn và tóm tắt kết quả dự án, vui lòng liên hệ lại với tôi qua email.

Dữ liệu phỏng vấn sẽ được lưu trữ đến bao giờ?

Toàn bộ dữ liệu bao gồm phần ghi hình phỏng vấn và bản ghi chép sẽ lưu trữ trong quá trình dự án. Khi dự án kết thúc, Luận văn được thông qua (muộn nhất là tháng 08/2023), toàn bộ file ghi hình sẽ bị hủy vĩnh viễn. File ghi chép lại nội dung phỏng vấn sẽ được lưu trữ thêm 2 năm trong trường hợp cần xem xét lại nội dung nghiên cứu.

Làm sao để chắc chắn tôi sẽ giữ những thông tin gì về người tham gia?

Bạn có quyền được nắm rõ tình hình thông tin cá nhân của bạn sẽ được sử dụng như thế nào. Vui lòng truy cập link sau để biết thêm chi tiết: https://utuguides.fi/researchdata/datasecurity.

Vui lòng giữ lại phiếu thông tin này và nếu bạn quyết định tham gia hãy liên hệ với người tiến hành dự án qua email: trang.t.nguyen@utu.fi.

Cám ơn bạn đã dành thời gian đọc tờ thông tin này!

GIẤY CHẤP THUẬN

Đề tài dự án: "Đánh giá hiệu quả của chương trình đào tạo trong việc chuẩn bị hành trang CNTT cho giáo viên Hóa học ở Việt Nam"
Số thứ tự người tham gia:
Người thực hiện đề tài: Nguyễn Thị Thùy Trang

Tôi cam kết:
1. Tôi đã đọc và hiểu các thông tin liên quan đến dự án trong tờ thông tin ngày ……………….. hoặc các thông tin đã được đọc rõ ràng cho tôi.
2. Tôi đã được giải đáp toàn bộ các thắc mắc của mình liên quan đến dự án này và việc tham gia dự án.
3. Tôi hoàn toàn nhận thức được việc tham gia dự án sẽ bao gồm một buổi phỏng vấn dài 30-40 phút được ghi hình lại và sẽ được chuyển thành văn bản ghi chép sau đó. Các dữ liệu ghi hình và văn bản ghi chép sẽ được lưu trữ trong quá trình diễn ra dự án. Bản ghi hình sẽ được xóa bỏ muộn nhất vào tháng 08/2023 và bản ghi chép sẽ được xóa trong 2 năm sau đó.
4. Tôi hiểu rằng việc tham gia dự án sẽ không gây ra bất cứ nguy hiểm hay vấn đề tiêu cực nào. Trong quá trình phỏng vấn, tôi có thể từ chối trả lời câu hỏi.
5. Tôi hiểu rằng tôi có thể rút khỏi dự án bất cứ lúc nào mà không cần phải đưa ra lý do, và tôi sẽ không phải nhận bất cứ hình phạt hay thắc mắc gì về việc đó.
6. Tôi hiểu rằng các thông tin tôi cung cấp sẽ chỉ được sử dụng trong phạm vi luận văn thạc sĩ này.
7. Tôi đồng ý với việc các lời nói của mình khi phỏng vấn có thể sẽ được trích dẫn lại trong luận văn dưới dạng ẩn danh, có nghĩa là toàn bộ các thông tin cá nhân liên quan đến phần trích dẫn đó phải được lưu trữ riêng biệt và bảo mật để không ai có thể suy đoán được nhân danh của người đưa ra trích dẫn.
8. Tôi đã được nghe giải thích kĩ lưỡng về toàn bộ quá trình bảo mật và xử lý thông tin cá nhân.
9. Tôi hiểu rằng các thông tin cá nhân của tôi bao gồm tên tuổi, địa chỉ, nghề nghiệp, vv. sẽ được giữ kín trong phạm vi dự án này và không thể được chia sẻ cho bất cứ ai bên ngoài dự án.
10. Tôi đã được giải thích về những hình thức đồng thuận khác cần biết khi đồng ý tham gia phỏng vấn thu thập dữ liệu.
11. Tôi đồng ý với việc ghi hình buổi phỏng vấn.
12. Tôi đồng ý cho phép các nhà nghiên cứu khác truy cập vào những dữ liệu này khi họ tuân thủ quy tắc bảo mật và ẩn danh thông tin.
13. Tôi tình nguyện tham gia vào dự án này.
14. Tôi biết cần liên hệ với ai khi có thắc mắc về dự án.

Người tham gia	Chữ ký	Ngày
Người thực hiện đề tài	Chữ ký	Ngày

Appendix 6 – Self-reported survey (English)

Part 1: Teaching skills

No.	Item	1 *Strongly disagree*	2 *Disagree*	3 *Neutral*	4 *Agree*	5 *Strongly agree*
Please rate the following statements regarding your pedagogical knowledge.						
1	I can adapt my teaching based upon what students currently understand or do not understand.					
2	I can adapt my teaching style to different learners.					
3	I can use a wide range of teaching approaches in a classroom setting.					
4	I can assess student learning in multiple ways.					
Please rate the following statements regarding your Chemistry knowledge in teaching.						
5	I have sufficient subject knowledge.					
6	I can use a subject-specific way of thinking in updating my knowledge.					
7	I know the basic theories and concepts.					
8	I know the history and development of important theories.					
Please rate the following statements regarding digital technologies (computers, tablets, mobile phones, Internet, etc.).						
9	I keep up with important new technologies.					
10	I frequently play around with the technology.					
11	I know about a lot of different technologies.					
12	I have the technical skills I need to use common technology in teaching (projector, computer, smartboard,…)					
Please rate the following statements with regard to teaching in which you do not use any special technologies or media.						
13	I know how to select effective teaching approaches to guide student thinking and learning in Chemistry subject.					
14	I know how to develop appropriate tasks to promote students complex thinking of Chemistry subject.					
15	I know how to develop exercises with which students can consolidate their Chemistry knowledge.					
16	I know how to evaluate students' performance in Chemistry learning.					
Please rate the following statements regarding teaching with technologies.						
17	I can choose technologies that enhance the teaching approaches for a lesson.					

No.	Item	1 *Strongly disagree*	2 *Disagree*	3 *Neutral*	4 *Agree*	5 *Strongly agree*
18	I can choose technologies that enhance students' learning for a lesson.					
19	I can adapt the use of different technologies to different teaching activities.					
20	I am thinking critically about how to use technology in my classroom.					
21	I know how technological developments have changed the field of Chemistry specifically and Science in general.					
22	I can explain which technologies have been used in research in my field.					
23	I know which new technologies are currently being developed in the field of Chemistry.					
24	I know how to use technologies to participate in scientific discourse in my field.					
25	I can use strategies that combine content, technologies, and teaching approaches in my classroom.					
26	I can choose technologies that enhance the content for a lesson.					
27	I can select technologies to use in my classroom that enhance what I teach, how I teach, and what students learn.					
28	I can teach lessons that appropriately combine my teaching subject, technologies, and teaching approaches.					

Part 2: Frequency of Technology Use in Teaching

Technology Use in	Always 80-100%	Usually 50-80%	Sometimes 30-50%	Rarely < 30%	Never 0%
Assessment: - Utilize software to construct, design, and manage a test bank. - Employ ICT to gain insight into students' learning and performance. - Utilize ICT for student assessment purposes.					
Planning and designing: - Utilize ICT to enhance subject matter comprehension, as well as to locate and organize teaching resources. - Employ ICT to create or edit teaching materials, such as worksheets, PowerPoint presentations, simulations, and so on. - Develop an ICT-infused curriculum and implement teaching strategies that integrate ICTs.					
Practical teaching: - Incorporate ICTs into instructional contexts and apply appropriate teaching strategies that are student-centered.					
Classroom management: - Utilize ICTs for instructional management, including time management and classroom environment control. - Use ICT to communicate, reach out, and provide support to students outside of the classroom.					

Appendix 7 - Self-reported survey (Vietnamese)

Phần 1: Đánh giá năng lực nghề nghiệp

STT	Tiêu chí	1 *Rất không đồng ý*	2 *Không đồng ý*	3 *Bình thường*	4 *Đồng ý*	5 *Rất đồng ý*
Hãy tự đánh giá các khẳng định dưới đây về năng lực nghiệp vụ sư phạm của bạn.						
1	Tôi có thể diều chỉnh cách dạy để phù hợp với trình độ hiện tại của HS (HS đã hiểu gì và chưa hiểu gì).					
2	Tôi có thể điều chỉnh phong cách dạy của mình để phù hợp với các đối tượng HS khác nhau.					
3	Tôi có thể sử dụng linh hoạt nhiều cách tiếp cận nội dung dạy học trong phạm vi lớp học.					
4	Tôi có thể đánh giá quá trình học của HS bằng nhiều hình thức đa dạng.					
Hãy tự đánh giá các khẳng định dưới đây về năng lực chuyên môn Hóa học của bạn.						
5	Tôi có kiến thức chuyên môn đầy đủ cho việc dạy học môn Hóa học phổ thông.					
6	Tôi có thể sử dụng tư duy Hóa học trong việc nâng cao năng lực chuyên môn.					
7	Tôi nắm được các lý thuyết và chuyên đề cơ bản của môn học.					
8	Tôi biết lịch sử và quá trình phát triển của các thuyết quan trọng.					
Hãy tự đánh giá các khẳng định dưới đây về năng lực CNTT của bạn.						
9	Tôi cập nhật các CNTT mới quan trọng trong ngành.					
10	Tôi thường xuyên tự tìm tòi khám phá CNTT.					
11	Tôi biết rất nhiều các công nghệ khác nhau.					
12	Tôi có đầy đủ kĩ năng và năng lực sử dụng các công cụ CNTT cơ bản trong dạy học (máy chiếu, máy tính, bảng thông minh,…)					
Hãy tự đánh giá các khẳng định dưới đây về các tiết học mà bạn hoàn toàn KHÔNG sử dụng CNTT hay công nghệ hỗ trợ nào khác.						
13	Tôi biết cách lựa chọn các phương pháp dạy học phù hợp để hướng dẫn HS tư duy Hóa học và hoàn thành nội dung kiến thức cần học.					
14	Tôi biết cách xây dựng các nhiệm vụ học phù hợp để khuyến khích HS tư duy sâu trong môn học.					
15	Tôi biết cách xây dựng các hoạt động luyện tập giúp HS hiểu và nắm vững kiến thức.					
16	Tôi biết cách đánh giá năng lực của HS.					

STT	Tiêu chí	1 *Rất không đồng ý*	2 *Không đồng ý*	3 *Bình thường*	4 *Đồng ý*	5 *Rất đồng ý*
Hãy tự đánh giá các khẳng định dưới đây về các tiết học có sử dụng CNTT.						
17	Tôi có thể lựa chọn các hình thức CNTT giúp nâng cao hiệu quả của phương pháp dạy học.					
18	Tôi có thể lựa chọn các hình thức CNTT giúp nâng cao hiệu quả tiếp thu của HS trong tiết học.					
19	Tôi có thể điều chỉnh để sử dụng nhiều hình thức CNTT trong các hoạt động dạy học khác nhau.					
20	Tôi suy nghĩ và đánh giá về các cách sử dụng CNTT trong tiết học của mình.					
21	Tôi có hiểu biết các đổi mới CNTT trong lĩnh vực Hóa học và Khoa học.					
22	Tôi có thể giải thích được về các CNTT sử dụng trong việc nghiên cứu Hóa học.					
23	Tôi biết về các CNTT mới đang được sử dụng và phát triển trong lĩnh vực nghiên cứu Hóa học.					
24	Tôi biết cách sử dụng CNTT để tham gia vào các buổi đàm thoại chuyên môn Hóa học.					
25	Tôi có thể sử dụng các chiến lược dạy học có sự kết hợp phù hợp của phương pháp, CNTT và nội dung cần truyền tải.					
26	Tôi có chọn hình thức CNTT để nâng cao hiệu quả truyền đạt kiến thức trong tiết dạy.					
27	Tôi có thể chọn hình thức CNTT phù hợp để hỗ trợ nội dung dạy học, cách dạy học và cách HS tiếp nhận kiến thức.					
28	Tôi có thể tiến hành các tiết học có sự kết hợp hợp lý của phương pháp, kĩ thuật dạy học, loại hình CNTT và nội dung học.					

Phần 2: Tần suất sử dụng ICT trong công việc

Sử dụng ICT trong	Rất thường xuyên 80-100%	Thường xuyên 50-80%	Thỉnh thoảng 30-50%	Hiếm khi < 30%	Không bao giờ 0%
Kiểm tra đánh giá: - Sử dụng các phần mềm hỗ trợ xây dựng, thiết kế, quản lí ngân hàng đề kiểm tra. - Sử dụng ICT để phân tích đối tượng HS. - Ứng dụng ICT để sử dụng đa dạng các hình thức kiểm tra đánh giá.					
Thiết kế bài dạy: - Sử dụng mạng internet tìm kiếm, khai thác và quản lí thông tin phục vụ cho việc dạy học Hóa học. - Sử dụng các phần mềm thiết kế, hiệu chỉnh các tư liệu dạy học hóa học như văn bản, bài trình chiếu, tranh, ảnh, phim, mô phỏng… - Lên kế hoạch dạy học có sự kết hợp ICT vào chương trình và sử dụng các phương pháp dạy học với ICT hợp lí.					
Tiến hành bài dạy: - Sử dụng ICT trong lớp học, kết hợp với các phương pháp dạy học tích cực và phương pháp dạy học đặc thù của Hóa học theo định hướng phát triển năng lực người học.					
Quản lý lớp học: - Sử dụng công cụ ICT để quản lí thời gian, tổ chức lớp. - Sử dụng các công cụ ICT để liên lạc, theo dõi, quản lí và hỗ trợ HS ngoài lớp học.					

Appendix 8 – Interview protocol (English)

Time of Interview:

Date:

Name of Interviewer:

Names of Interviewees:

Introduction to the Interview:

The purpose of this study is to investigate how the teacher training program at the Chemistry Department, HNUE, has equipped new in-service teachers with technology competence for their teaching careers. The goal of this research is to gain insights into teachers' perspectives on their actual needs in the field and to provide recommendations for improving the training program.

To better understand this topic and answer the proposed research questions, I have collected survey data via a Google Form and am now conducting interviews with new in-service teachers who graduated from the program in 2021 and 2022. This interview is a crucial part of this research study, and I appreciate your willingness to participate.

Please note that all participants' personal information will be anonymized in the findings report, including this interview. All data collected will be stored on a password-protected computer and used solely by the researcher. The interview will take approximately 40-60 minutes.

Before we proceed, please take a moment to re-read the signed consent form and ask any questions you may have.

Lastly, I will turn on and test the recording device to ensure that all responses are accurately captured. Thank you for your cooperation in this research study.

1. Tell me a little about yourself and your teaching experience so far (ie. Graduation year, current workplace, teaching grades, how many classes/lessons per week, school's facilities, students technology exposure level…)
2. What does the use of technology in the classroom mean and look like to you?
3. Teaching experiences with Technology:

- How are you using technology in your current work? (In planning and designing, practical teaching, assessment, management)
- Can you describe some occasions in which you teach using technology?
- What do you consider when choosing that specific technology in the occasions?
- How do you organize student-centered technology-infused learning activities? (Including description and how often)

4. Can you describe your experience with technology and/or digital resources within your preservice preparation program at the university?
    - What did you learn about technology in education?
    - How do you feel about the effectiveness of the teaching?
    - Can you describe some experiences of learning with technology in detail?
5. To what extent has technology and/or digital resources been used within your **pedagogy courses** at the university and by your professors/instructors?
6. To what extent has technology and/or digital resources been used within **other courses** at the university and by your professors/instructors?
7. How would the ethical aspect be delivered in the program? (cracked software, license, authorization)
8. If possible, what would you like to change in the program?
9. How do you often update and share your technology-related knowledge?
10. In the near future, what would be your goals for integrating technology in your work? Do you have a plan for achieving your goals?

Appendix 9 – Interview protocol (Vietnamese)

Thời gian:

Ngày:

Người phỏng vấn:

Người tham gia phỏng vấn:

Giới thiệu về buổi phỏng vấn: Mục đích của buổi phỏng vấn này là để thu dữ liệu cho đề tài tốt nghiệp thạc sĩ của người phỏng vấn, chủ đề nghiên cứu về hiệu quả đào tạo CNTT trong dạy học của chương trình đào tạo tại Khoa Hóa học, ĐHSPHN. Qua nghiên cứu này, chị muốn tổng hợp và cung cấp cái nhìn của các GV đã tốt nghiệp và đang công tác về những yêu cầu, mong muốn sử dụng CNTT của họ trong công việc, từ đó đưa ra các gợi ý đổi mới chương trình đào tạo cho phù hợp hơn với thực tiễn.

Chị đã tổng hợp dữ liệu từ khảo sát trên Google Form và bây giờ là giai đoạn phỏng vấn các bạn GV mới tốt nghiệp năm 2021, 2022 để tìm hiểu kĩ hơn về cái nhìn của các bạn đối với việc sử dụng CNTT trong dạy học. Toàn bộ thông tin cá nhân của người tham gia sẽ được ẩn danh, mã hóa trong bản ghi chép của tất cả các dữ liệu, bao gồm cả buổi phỏng vấn này. Toàn bộ dữ liệu được lưu trong máy tính cá nhân, và sẽ chỉ được những người trực tiếp liên quan đến nghiên cứu tham gia xử lý. Buổi phỏng vấn dự kiến sẽ kéo dài khoảng 40-60 phút.

[Mời người tham gia đọc lại Giấy chấp thuận và đưa ra câu hỏi nếu có]

[Thông báo về việc ghi âm và bắt đầu ghi âm]

[Bắt đầu phỏng vấn]

1. Em hãy giới thiệu qua một chút về bản thân và kinh nghiệm làm việc của mình nhé (VD: năm tốt nghiệp, chỗ làm hiện tại, khối lớp công tác, số tiết/tuần, cơ sở vật chất của nhà trường, mức độ tiếp cận CNTT của HS…)
2. Đối với bản thân em, em hiểu CNTT trong dạy học là gì và CNTT thường được sử dụng như thế nào trong dạy học?
3. Kinh nghiệm sử dụng CNTT trong dạy học:
    - Em đang sử dụng CNTT như thế nào trong công việc hiện tại? (Trong việc soạn giáo án, tiến hành giảng dạy, kiểm tra đánh giá, quản lý và tổ chức lớp học)
    - Em có thể mô tả lại chi tiết một vài hoạt động dạy học với CNTT mà em đã từng tiến hành được không?
    - Em có cân nhắc gì không khi lựa chọn hình thức CNTT đó trong hoạt động vừa rồi?
    - Em có tổ chức các hoạt động tập trung vào người học không? (mô tả và mức độ thường xuyên)

4. Em có thể mô tả lại trải nghiệm của bản thân với CNTT trong chương trình đào tạo giáo viên ở HNUE được không?
    - Em đã được học những nội dung gì?
    - Em cảm thấy/ đánh giá như thế nào về mức độ hiệu quả của chương trình?
    - Em có thể mô tả lại một vài hoạt động học có sử dụng CNTT trong chương trình được không?
5. Với các môn học dạy về CNTT như kể trên, các giảng viên sử dụng CNTT trong giảng dạy như thế nào?
6. Với các môn học khác trong chương trình, các giảng viên sử dụng CNTT trong giảng dạy không như thế nào?
7. Em có được dạy về các lưu ý đạo đức máy tính như vấn đề bản quyền, phần mềm lậu,… không?
8. Nếu được, em muốn thay đổi điều gì trong chương trình?
9. Em thường xuyên cập nhật và chia sẻ những kiến thức liên quan như thế nào?
10. Trong tương lai gần sắp tới, em có đặt ra mục tiêu phát triển gì bản thân không và có kế hoạch cụ thể gì để thực hiện những mục tiêu đó không?

Appendix 10 – SAMR coding scheme

Stage	Definition	Example	
		Simple way	**Transformative way**
Substitution	Tech acts as a direct tool substitute, with no functional change Save time and space	Exam on paper	Online assessment tools: Google form, Kahoot, etc. (Students do the tests with digital tools and receive grades/comment immediately)
		Teach with black board and chalk	Use PowerPoint slides to show images, clips, content text.
		Print out/ write down the homework	Send online files to students (doc, pdf, etc.)
		Having students write on paper to prepare for upcoming lesson or use paper poster for presentation	Students type and hand in their homework online or use PowerPoint/ other digital forms to present their work.
Augmentation	Tech acts as a direct tool substitute, with functional improvement	Assessment only for providing grades and simple comments	Using online assessment tools with additional functions: Quizizz (allow students to receive hint, choose types of hint for each question, provide summary and practice wrong answers again, etc.).
		Presentation with text, image and video	Presentation with virtual lab, simulations, visualizing abstract concepts, etc.
		Simple homework files (doc, pdf, etc.)	Interactive combination of tasks on self-designed websites, online games that allow additional functions, etc.
		Simple presentation with PowerPoint, slides, images or videos from the Internet.	More complex tasks required students to research independently, self-made videos, design digital products…
Modification	Tech allows for significant task redesign.	Teachers show a diagram of how light travels, explain the theory, and give students a formula to solve problems.	Using technology simulations, students can explore the effect of changing variables, follow instructions to interact in a virtual lab, and formulate the equation by experimenting with the phenomenon.
Redefinition	Tech allows for the creation of new tasks, previously inconceivable.	Teaching students different reading skills using normal text.	Teacher designs a platform with reading material that includes audio, video, and an online dictionary. They can interact with the text while practicing reading and record their reading to receive peer and teacher feedback in discussion forums.