# ICT Integration in Developing Competence for Pre-Service Mathematics Teachers

## A Case Study from Six Universities in Vietnam

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**Abstract—**Competence structure that pre-service teachers need to develop to become a future teacher has been defined since the 1930s. For pre-service mathematics teachers, their competence has its own characteristics. ICT integration in developing competence for pre-service mathematics teachers has been been proved to be effective in many previous studies. In Vietnam, the Ministry of Education and Training (MOET) has recommended the use of ICT to enhance teaching-learning activities in schools and universities, therefore, there have been many studies on ICT intergration at different educational levels. However, there are only a few studies on the use ICT integration in developing competence for pre-service mathematics teachers. This paper presents results from a research on the feasibility of ICT integration in developing competence of Vietnamese pre-service mathematics teachers. The research was conducted by surveying on a randomly selected of 297 pre-service mathematics teachers and 40 mathematics lecturers in six universities which provide mathematics training programs. Results show that despite of the availability of technologies, ICT integration in training pre-service teachers is still limited. In addition, ICT integration in teaching activities of mathematics teachers is not really effective because the levels of their ICT skills are very different. Pre-service mathematics teachers have the ability to use ICT equipment, and good accessibility to learning systems, but their use of the learning management systems (LMS) is limited. This study can be a reference for future studies to test the effective of ICT integration in training pre-service teachers when designing activities to develop feasibly and effectively their competence.

**Keywords—**ICT integration, pre-service teachers, teaching competence, mathematics

# 1 Introduction

With the advances of technology development in the context of the Industry 4.0, many industries have to change to adapt with new and smart technologies, connections and designs. Education is not an exception. The form of smart education, which appeared recently, has gained a lot of attention. To develop smart education, it is required to train qualified teachers with appropriate competence to the teaching requirements in the context of the Industry 4.0 [1].

Since the 1960s, researches on developing teaching competence for teachers were confirmed based on solid theories and practical experience. Many studies in this period had identified the competence structure and essential teaching skills that pre-service teachers need to develop to become a future teacher. From 1970s, studies in Soviet Union and Eastern Europe countries focused on studying the scientific labor organization - the process of teaching and learning. These studies have introduced a system of teaching and education competence that described in order; organization and content of pratical activites; pedagogical practice for pre-service teachers; and processes to build up and develop teaching competence for pre-service teachers [2] [3] [4].

Teaching competence of pre-service mathematics teachers has its own characteristics. Previous studies have provided evidences of pre-service mathematics teachers' competence, and also provided recommendations for changes of training models for future teachers, with the purpose of improving teaching and learning mathematics of future generations. Previous studies also indicated that: a teacher with good mathematics qualification is just a "need" condition for effective mathematics teaching, while there are other factors such as good communication skills, passion for mathematics, good understanding of students and of mathematics teaching theories [5] [6].

With the fast development of Information and Communications Technologies (ICT), its applications can be applied to make students' learning become more independent, flexible, proactive, and interactive. Therefore, the ICT's advantages are changing perspectives of what learners need to learn, how to leanr, and how to teach. The use of ICT integration for training in pedagogical schools has been proved to be effective in many studies [7] [8] [9] [10] [11] [12]. However, its effectiveness is not always obvious because it depends on other factors such as teacher competence, infrastructure, number and quality of ICT integration activities [13] [14].

In Vietnam, The Ministry of Education and Training (MOET) has recommened the use of ICT to enhance teaching-learning activities in schools and institutions. Therefore, there are many studies about ICT integration in different educational levels. However, there are only a few studies about ICI integration in developing competence of pre-service mathematics teachers in Vietnam [15] [16] [17]. In addition, the number of Vietnamese universities which having training programs for

pre-service mathematics teachers is large (31 universities, including 6 pedagogical and 25 multidisciplinary ones), and they are located at different geographical areas with various economic and social developments (Table 1). Therefore, the applications of ICT in training pre-service mathematics teachers is also at different levels, and its effectiveness and its feasibility in developing pre-service teachers are still a matter of little attention.

To help narrow the research gap, this study presents findings of a research conducted during the 2017-2019 period, about the feasibility of ICT integration in developing competence of pre-service mathematics teachers in pedagogical universities in Vietnam. Our scientific question is: "How to make ICT integration in developing competence of pre-service mathematics teachers feasible and effective in the current context of the Vietnamese pedagogical universities?"

Literature review is summaried in section 2, while our methods are presented in section 3. Results are shown in section 4, then discussed in section 5.

## 2 Literature Review

### 2.1 Integration of ICT in training pre-service teachers

ICT are one of the major factors in the context of the current Industry 4.0. ICT are being integrated in many fields, including industry, business, engineering, agriculture, medicine, and education. ICT integration in education is very important today because educational systems around the world are under increased pressure to use the new ICT to teach students' knowledge and skills they need in the 21st century [18] [19].

In the context of the Industry 4.0, the application of ICT in training pre- and in-service teachers has many opportunities and challenges. Previous researches have shown that teachers' ability to establish a relationship between content, pedagogy, and technology depends largely on how they are taught to integrate technology in teaching [20] [21] [22]. According to Li, Qian, & Han [23], TPACK model (Technology, Pedagogy, and Content Knowledge) which based on the basic requirements related to technology, pedagogy and subject knowledge, is likely to be applied effectively in training teachers in the future.

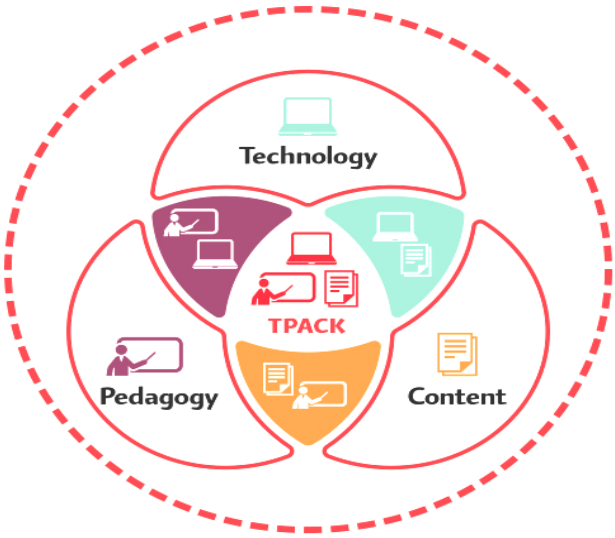


**Fig. 1.** TPACK Model (Source: http://tpack.org)

Many authors have been studied ICT integration in training pre-service teachers all over the world, such as in Australia [7, 8], in France [9], in Turkey [10], in South Africa [11], and in Canada [12]. The integration of ICT in training pre-service teachers has been studied in Asian countries [24] [25], and also in most of countries in South East Asia [26] [18] [27]. Results from these studies concluded that after integrating ICT into the training program, pre-service teachers did progress over time, and upon evaluation. In addition, ICT integration can be applied to all of the subjects, from physic and chemistry [9] to science [11] and languages [13], for different teaching levels [8] [10] [12]. There are several approaches to integrate ICT in training pre-service teachers, using E-learning [28] [29], M-learning [30] [31] [32], online learning [33], and other technologies (video, camera, TV/radio, animation/simulation, and sound system, for example) [34] [35].

However, it is not obvious that ICT integration will always bring positive outcomes because there are several obstacles that prevent the use of ICT in pre-service teacher training programs. These obstacles can be classified into two categories: the internal and external obstacles. The internal obstacles can be listed as resistance to change, teachers' negative attitudes, lack of self-confidence, and lack of awareness about advance of ICT [14]. As reported in [8], using technology was proved to be useful in improving students' learning in Australia, but they did not use it in their lessons yet, thus displaying a mismatch between what the teachers believed and their actual practices. The main reason to explain for this is that pre-service teachers were not required to apply ICT in their classrooms by the mentor teachers who did not use ICT in their teaching. The external obstacles are related to lack to time, inadequate technical support, technological difficulties, and incomplete resources as identified in several studies [13] [36] [37].

All of the above analysis can be seen that the application of ICT in pre-service teachers training has been actively implemented with a variety of content and application forms. However, the effectiveness of this application will be influenced by personal factors, learning environments, and sometimes culture. Therefore, in the design of plans to exploit ICT in teaching, the problems of the participation of teachers, students, and the learning environment should be paid proper attention to ensure learning outcomes.

### 2.2 ICT integration in developing teaching competence of pre-service mathematics teachers

One of the important applications of ICT integration in training pre-service teachers is to develop their teaching competence. Teachers' competence is defined as the "knowledge, skills and attitudes that are necessary in order to be able to perform the teaching profession in an effective and efficient manner" [38] [39]. ICT integration in mathematics has been studied the most among other subjects. Similarly, findings indicated that the level of ICT integration for pre-service mathematics teachers is very different between developing countries and developed ones, or even between different areas within a country. In Ghana, mathematics teachers do not integrate ICT in their mathematics instruction due to various barriers such as lack of knowledge about ways to integrate ICT, and lack of ICT training [40]. [41] found that it is crucial to improve Indonesia secondary mathematics teachers's on knowledge of ICT and the use of ICT in teaching as they have a largely inadequate knowledge of both aspects. In contrast, [42] found that Turkey pre-service teachers are committed to using ICT in their teaching and they are mostly confident and mostly believe in the value of ICT in developing mathematics teaching competence. However, most of the studies have agreed and concluded that ICT intergration is effective in improving competence of pre- and in-service mathematics teachers, as well as in improving students' performance and achievement. A study conducted in Indonesia has found that pedagogic competence of pre-service mathematics teachers has improved considerably after using e-learning in their classroom training [43]. Similar conclusion about the effective of blended e-learning in training pre-service mathematics teachers in Nigeria can be found in [44]. Another study in Nigeria secondary schools has discovered that the use of ICT tools was useful in enhancing mathematics teaching and learning activities of both teachers and students [45]. The efficacy of using M-learning (e.g. iPads and mobile devices) to enhance Australian pre-service primary mathematics teachers' professional development was highlighted in [46].

In general, most of the studies has concluded that applying ICT helps to improve teaching competence for pre-service and in-service teachers, but the levels of success greatly varies between one country and another because of the differences in the quality of pre- and in-service teachers, lack of knowledge about ways to integrate ICT, lack of training opportunities for ICT trainings, and lack of access to facilities.

### 2.3 Overview of apply ICT in developing teaching competence of pre-service mathematics teachers in Vietnam

Vietnam, a middle-income country in Southeast Asia with more than 90 million people, is one of the countries with many development opportunities thanks to the development of ICT. Recent economic and social developments have not only improved the quality of life, but also made investment in education is more concerned. A national statement was given in 2001 on ICT integration in education in Vietnam, with a general plan for the 2002-2005 period. The goal was to increase the use of ICT in teaching activities from 5% to 10% of the total time for each subject [47]

According to the MOET, the new Vietnamese mathematics education program will contribute to the formation and development of personalities of students. During the implementation of the program, it is important to apply mathematics to real life situations, and to create the connections between mathematics ideas and between mathematics and other subjects, especially STEM subjects [48] [49] [50]. Originating from the above requirement, pre-service mathematics teachers' competence needed to be formed and developed when they are still in university. This requires pedagogical universities to find solutions to develop pre-service teachers' competence using ICT integration.

Studies about ICT integration in teaching mathematics and training pre-service mathematics teachers in Vietnam firstly appeared in the late 1990s and early 2000s. At the beginning, they focused on ICT applications in teaching mathematics at high schools and training pre-service mathematics teachers. A number of previous studies have affirmed: In the era of information explosion, higher education in the world has many development opportunities, but also great challenges especially the ones related to solving relationships between the scales of schools and training effectiveness; between training and researching; between demands and resources. Facing that pressure, professional educators in Vietnam must think about how to integrate ICT effectively to meet the requirements of modern education [51] [52].

Several Vietnamese authors studied different approaches for ICT integration in teaching mathematics, such as using multimedia in methods of teaching mathematics at universities [15], or training pre-service teachers competence using ICT supports. However, these studies were not enough to meet the demands of the society, the fluctuation of content, textbooks, and the explosive development of ICT. Therefore, training competence of pre-service teachers by ICT integration is increasingly concerned.

## 3 Methods

This study uses quantitative methods to find answers to our scientific question, because it will produce descriptive statistical results which can be used to better illustrate ICT integration for training pre-service mathematics teachers in Vietnam.

This study collected data from two surveys, one for pre-service mathematics teachers and one for mathematics lecturers to estimate the feasibility of ICT

integration in developing competence for pre-service mathematics teachers. We analysed data in the following directions:

- Accessibility of ICT equipment in teaching activities of pre-service mathematics teachers and mathematics lecturers.
- The level of ICT integration in developing competence of pre-service mathematics teachers.
- The level of using mathematics websites of pre-service mathematics teachers and mathematics lecturers.

In Vietnam, there are totally 31 university having mathematics training programs, including 6 pedagogical universities and 25 multidisciplinary universities. These universities are located in a large geographical area. Therefore, it is not possible to conduct a simple random sampling of the entire study object. Due to limitations of time and resources, universities were selected by cluster sampling method. 31 universities are classified according to its geographical area (10 in the North, 13 in the Central, and 8 in the South). Based on density distribution of these universities, we selected randomly two universities in the North, three universities in the Central, and one university in the South for our surveys.

**Table 1.** Vietnamese universities providing mathematics training programs, classified by region. Selected universities for this study are in red. (Source: MOET)

| North | Central | South |
|---|---|---|
| Hung Vuong University | Ha Tinh University | An Giang University |
| Thai Nguyen University | Hong Duc University | Can Tho University |
| Tan Trao University | Quang Binh University | Dong Thap University |
| Hanoi Education University | Hue University | Kien Gian University |
| Hai Phong University | Vinh University | Tien Giang University |
| Hoa Lu University | Khanh Hoa University | Dong Nai University |
| Hanoi National University of Education | Pham Van Dong University | Sai Gon University |
| Hanoi National University of Education II | Phu Yen University | Ho Chi Minh City Pedagogical University |
| Hanoi Metropolitan University | Quang Nam University | |
| Tay Bac University | Quy Nhon University | |
| | Da Nang University | |
| | Da Lat Univeristy | |
| | Tay Nguyen University | |

In Vietnam, training programs for pre-service mathematics teachers at pedagogical universities are normally four years, and the last year is focused on developing teaching competence. Mathematics lecturers who directly participate in training programs of the 4th-year pre-service mathematics teachers belong to the department of theory and mathematics teaching methods. Thereofer, we selected 4th-year pre-service mathematics teachers and mathematics lecturers in six pedagogical universities in Vietnam for our study.

Our surveys were distributed to 100% of 4th-year pre-service mathematics teachers and lecturers of the department of theory and mathematics teaching methods in six selected universities. For students, we use a simple random sampling method. At each university, we randomly selected 50% of 4th-year students for our surveys. We proceeded to enter the list of 4th-year students into a spreadsheet like Excel for each field (the total number of 4th-year mathematics students was 594), using Excel's RAND function to generate random numbers among the entered numbers. Next, we sorted the list in ascending order of randomly selected numbers and selected 297 samples (the first 50% of the sorted list). At the end of the surveys, we received totally 40 reponses from mathematics lectures and 297 reponses from pre-service mathematics teachers (response rate of 82.5%) from Thai Nguyen, Hanoi, Tay Nguyen, Dong Thap, Hong Duc, and Vinh universities.

**Table 2.** Numbers of pre-service mathematics teachers and mathematics lecturers from six selected pedagogical universities participated to our surveys.

| University | Geographical area | No. of pre-service teachers | No. of lecturers |
|---|---|---|---|
| Thai Nguyen University | North | 54 | 7 |
| Hanoi University | North | 41 | 7 |
| Tay Nguyen University | Central | 53 | 6 |
| Vinh University | Central | 54 | 7 |
| Hong Duc University | Central | 49 | 6 |
| Dong Thap University | South | 46 | 7 |
| Total | | 297 | 40 |

In our surveys, mathematics lecturers were asked to answer to questions related to the accessibility to ICT facilities in their universities, the level of using ICT equipment, websites can be used in teaching activities, their ICT skills in teaching. Pre-service mathematics teachers were asked to indicate the level of using ICT equipment and LMS systems in their studying activities.

Mean values and standard deviations were used to analyze data to highlight the most important variables. Although this analyzing method is simple, but it is effective to answer to our research questions.

# 4 Result

## 4.1 Accessibility of mathematics lecturers to ICT equipment for teaching is limited

Our survey results showed that most of ICT equipment are not available or limited access (M = 1.88, SD = 0.71). More specifically, except for audio devices (mp3, mp4, and iPod) and digital cameras, the use of other technology devices are average or above average. Computers are more accessible than other technological devices, having highest average mean value and lowest standard deviations (Table 3).

**Table 3.** Accessibility of mathematics lecturers to ICT equipment (1 = no use, 2 = limited use, and 3 = freely use).

| Accessibility to ICT equipment | Mean | Std. Deviation |
|---|---|---|
| Access to the school's computers | 2.34 | 0.55 |
| Access to the school's lecture management system | 2.21 | 0.86 |
| Access to the school's audio equipment | 1.34 | 0.67 |
| Ability to use cameras | 1.24 | 0.58 |
| Ability to use projectors | 2.00 | 0.54 |
| Free Internet access | 2.03 | 0.94 |
| Ability to use smart board | 1.97 | 0.82 |
| N = 40 | 1.88 | 0.71 |

The use of ICT equipment in teaching of mathematics lecturers is low (M = 2.96, SD = 1.02). Along with TVs and mobile phones, the use of all ICT equipment has the highest standard deviation. This suggests that mathematics lecturers have different opinions about the feasibility of these tools, whereby some lecturers use these tools while others do not (Table 4). Lecturers have more access to LMS systems and computers than other ICT equipment such as audio devices, projectors and cameras.

**Table 4.** The level of use of ICT equipment of mathematics lecturers (1 = never, 2 = rarely, 3 = sometimes, 4 = often, 5 = very often, 6 = always)

| The use of ICT equipment | Mean | Std. Deviation |
|---|---|---|
| Computers | 3.34 | 1.72 |
| Lecture management systems (LMS) | 3.17 | 1.79 |
| Recording devices | 2.66 | 1.74 |
| Cameras | 1.59 | 1.38 |
| Mobile Phones | 3.45 | 2.18 |
| Projectors | 3.48 | 1.72 |
| Interactive board | 3.00 | 2.20 |
| N = 40 | 2,96 | 1.02 |

Our results showed that ICT integration of mathematics lecturers are still limted. The use of websites to support teaching activities is in between rarely and sometimes (M = 2.43, SD = 1.09 in Table 5). In addition, ICT skills of mathematics lecturers are very different (Table 6).

**Table 5.** The use of websites to support teaching activities of mathematics lecturers (1 = never, 2 = rarely, 3 = sometimes, 4 = often, and 5 = always)

| Using websites for teaching | Mean | Std. Deviation |
|---|---|---|
| Using Google | 4.17 | 0.76 |
| Using Wikipedia | 1.76 | 1.15 |
| Using Weblogs | 2.07 | 1.03 |
| Using Facebook | 1.69 | 1.20 |
| Using Email | 3.03 | 1.38 |
| Using Chat, Forum | 1.83 | 1.0 |
| N = 40 | 2.43 | 1.09 |

**Table 6.** ICT skills of mathematics lecturers

| ICT skills | Mean | Std. Deviation |
|---|---|---|
| Can easily use teaching aids and software | 3.34 | 0.86 |
| Can learn to use teaching aids and software | 3.55 | 0.91 |
| Have ability to use necessary teaching aids and software | 3.59 | 1.02 |
| Opportunities to use teaching aids and software | 2.66 | 0.86 |
| N = 40 | 3.29 | 0.91 |

Analysing results on SPSS showed that there are significant correlations between the use of ICT equipment and the development of ICT skills (R(28) = 0.4, P = 0.03), and between the use of websites (Wikipedia, Facebook, Email) and the development of ICT skills (R(28) = 0.52, P = 0.00). However, there is a negligible correlation between the accessibility to ICT equipment and the development of ICT skills (R(28) = 0.25, P = 0.44).

## 4.2 LMS systems for pre-service teachers are not rich

Results from our surveys showed that the ability to use ICT equipment and the accessibility to learning systems of pre-service mathematics teachers are good (55% of pre-services mathematics teachers have computers). Although 100% pre-service mathematics teachers have smart phones, but only 26% use smart phones for learning (Table 7). The use of LMS systems is very limited (Figure 2). Most of them use Google Classroom and the MOET's connected website (about 43%), while only 6% of pre-service mathematics teachers use the LMS systems of their universities.

**Table 7.** The use of ICT equipment for learning of pre-service mathematics teachers

| Devices | No. of pre-service teachers | No. of pre-service teachers use this device | Percentage (%) |
|---|---|---|---|
| Smart phone | 297 | 78 | 26% |
| Laptops | 297 | 162 | 55% |
| Personal computers | 297 | 30 | 10% |
| Ipads | 297 | 27 | 9% |

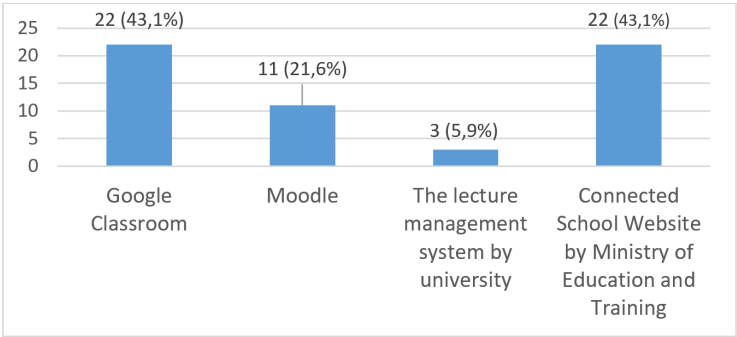


**Fig. 2.** The use of LMS systmes of pre-service mathematics teachers

## *5* Discussion and Conclusion

In the context of the Industry 4.0, ICT integration in training pre-service teachers has many opportunites and also challenges. TPACK model which based on the basic requirements related to ICT, pedagogy methods, and subject knowledge, has the ability to be applied effectively in training future teachers [23]

The main objective of our study is to explore whether ICT integration can be applied as a supporting tool to develop competence of pre-service mathematic teachers at pedagogical universities in Vietnam. Its feasibility has been tested through: 1) The accessibility to ICT equipment in teaching of pre-service mathematics teachers and mathematics lecturers; 2) The level of use of ICT equipmet in developing competence for pre-service mathematics teachers; and 3) The level of use of websites to support teaching of pre-service mathematics teachers and mathematics lecturers. In general, ICT integration in developing comperence of pre-service mathematics teachers in Viet Nam is not feasible without paying more attention to improving accessibility to ICT equipment of mathematics lecturers.

We showed that ICT integration in training pre-service mathematic teachers is still limited. ICT skills of mathematics lecturers are largely different, and the application of ICT in training pre-service mathematics teachers is not much [7]. It is important to improve ICT skills of mathematics lecturers, however, investment in facilities and accessibility to ICT equipment are more important because it will lead to the improvement of ICT skills of lecturers. It is clear that the more opportunity to use ICT in teaching, the higher their ICT skills will be. This means that the accessibility to ICT does not necessary related to improvement of ICT skills, but should enhance the access to the use of ICT equipment in schools.

In can be seen that pre-service mathematics teachers' skills and accessibility to ICT equipment are good. Although, there are many types of technological devices, pre-service mathematics teachers have the habit of using laptop in studying, partly because of its bigger screens and easier to use. However, the use of LMS systems is still limited. Pre-services mathematics teachers use computers and the Internet to study, but most of them find information on webtsites and social networks. This highlights the fact that there is currently very little public material databases, and the MOET need to provide stronger supports to students [8] [9] [10].

In near future, ICT integration in supporting learing, and developing competence of pre-service teachers will become indispensable in the era of the Industry 4.0. The ability to use ICT effectively will help pre-service teachers prepare for the rapid change of the modern education. Moreover, ICT integration is more and more appreciated by educators due to its potential advances in various aspects. However, in the current context of Vietnamese pedagogical universities, ICT integration is not very feasible, as the consequence of the ability to access new technologies of lecturers, as well as the number and the quality of LMS systems that support student learning.

This study does not explore the feasibility of building solutions for ICT integration in training competence for pre-service teachers, such as building an E-learning online learning system, identifying technical tools to design online courses for students,

organizing online learning systems combining with b-learning, or using video analyzing software combining with micro-teaching to develop competence of pre-service teachers. These can be potential research directions in the future.

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