

## A Study of Information and Communication Technology Competencies for Learning of Dental Students at Naresuan University, Thailand

Tipruthai Prayoonwong<sup>1\*</sup>, Nattan Krodkaw<sup>2</sup>, Phachara Siripraphonroj<sup>2</sup>,  
Sirikorn Saedan<sup>2</sup>, Hatayrat Meejitr<sup>2</sup>

1. Department of Preventive Dentistry, Faculty of Dentistry, Naresuan University, Phitsanulok, THAILAND.
2. Faculty of Dentistry, Naresuan University, Muang, Phitsanulok, 65000 THAILAND.

### Abstract

The aims of this study were to investigate and compare the differences of information and communication technology (ICT) competencies for learning of undergraduate dental students at the Naresuan University, Thailand.

Three online versions of questionnaires were developed by the researchers for evaluating generic and specific ICT competencies for preclinical and clinical dental students. A total of 351 undergraduate dental students, in the 2018 academic year, were asked to complete the online version of the questionnaires.

Both preclinical and clinical dental students assessed most of their generic ICT competencies in terms of domain mean scores, as “at moderately high level”. There was no statistically significant difference in generic ICT competencies among participants from each class year of the preclinical level. However, a significant difference was found between the fourth- and the sixth-year clinical level, in domain 4 of knowledge dimension ( $p < 0.05$ ). Regarding the most specific ICT competencies, both levels of dental students assessed their competencies in term of domain mean scores as between “average and moderately high level”. The first-year dental students assessed their specific ICT knowledge and skill as “low level” compared to the second- and third-year dental students ( $p < 0.01$ ). A significant difference of specific ICT competency was also found between the fourth- and the sixth-year dental students in domain 2 of knowledge and skill dimension ( $p < 0.05$ ).

The results of this study can be used to develop the educational management and systems based on ICT in the Faculty for enhancing quality of education.

**Clinical article (J Int Dent Med Res 2020; 13(1): 258-269)**

**Keywords:** Information and communication technology, ICT, Competency, Dental students.

**Received date:** 17 October 2019

**Accept date:** 21 November 2019

### Introduction

According to the 20-year Long Range Plan for the Higher Education of Thailand B.C. 2561 – 2580,<sup>1</sup> the importance of developing learning skills for the 21<sup>st</sup> century is given emphasis to produce and develop graduates of quality and capability of lifelong learning and self-adjustment ability. Including such skills on university curricula are a challenge for all academic institutions in Thailand. In the future, this will also affect students' academic success even more in the future. One of the learning skills of the 21<sup>st</sup> century is information and

communication technology (ICT). Therefore, it is necessary to help students to increase their abilities to be proficient in their studies and develop their confidence in the ICT competency for the future.

The rapid development and increasing growth of ICT has important implications for all aspects of dental education. ICT is swiftly becoming an intrinsic part of dental education.<sup>2-6</sup> Those changes affect the learning lives of dental students. Dental students are required to achieve a level of ICT competencies that will enable them to write basic documents; give oral presentations using computers or other technologies; access their online academic information; use the Internet, email, and library databases and/or other search facilities to find dental literature; and use specific software programs or tools for learning.<sup>3, 4</sup> For the clinical environment, especially at the dental hospital of Naresuan

#### \*Corresponding author:

Tipruthai Prayoonwong  
Faculty of Dentistry, Naresuan University  
99 Moo 9, Muang, Phitsanulok, 65000 THAILAND  
E-mail: [tipruthai@hotmail.com](mailto:tipruthai@hotmail.com)

University, dental students need to be familiar with online dental databases; online dental queue systems; online dental unit booking systems; online dental record booking systems; online patient searching systems; online payment systems; online dental prescription systems; and digital radiography.

At the school of dentistry, the use of ICT as a tool to support dental teaching and learning is highly desired and has become rapidly widespread. Thus, dental students must be competent in this respect. However, studies on students' competence with ICT are few, and there have been no studies on ICT in education involving dental schools in Thailand. Therefore, the aims of this study were to investigate and compare the differences of ICT competencies for learning of undergraduate dental students at the Naresuan University, Thailand.

### Materials and methods

A descriptive cross-sectional study was conducted of all 351 undergraduate dental students at the Faculty of Dentistry, Naresuan University, Thailand in the 2018 academic year. Students from the first to third year (preclinical level) and fourth to sixth year (clinical level) were asked to complete the online self-administered questionnaires.

Three questionnaires which were developed by the researchers, based on a synthesis of the studies<sup>7-11</sup>, consisted of 1) the 44-items questionnaire for evaluating generic ICT competencies for learning of preclinical and clinical dental students, 2) the 26-items questionnaire for evaluating specific ICT competencies for learning of preclinical dental students, and 3) the 57-items questionnaire for evaluating specific ICT competencies for learning of clinical dental students. Each questionnaire included three parts. The first part covered the demographic characteristics of the participants including sex, age, and class year. The latter part of questionnaires was a self-assessment of ICT competencies which were divided into three dimensions: knowledge, skill, and attitude. Where questions assessed ICT knowledge, participants responded on the 5-point Likert scale, running from 'extremely understanding' to 'not understanding or unknown'. Questions regarding the level of ICT skill, participant assessed their skill as: 5 = High level of competence - extensive

experience in the skill area; 4 = Moderately high level of competence - good experience in the skill area; 3 = Average level of competence - some experience in the skill area; 2 = Low level of competence - little experience in the skill area; and 1 = No level of competence - no experience in the skill area. Regarding the levels of concern on each attitude item, the responses were coded over a 5-point scale from 'least important' to 'very important'. The last part of the questionnaire required an open-ended answer, where participants were free to write about their suggestions for using ICT for learning at the Faculty.

Content validity of the three questionnaires was tested by five independent content experts per each questionnaire with Index of Item-Objective Congruence between 0.60 – 1.00. The internal consistency of all questionnaires was determined through Cronbach's alpha coefficient with the overall reliability of co-efficient of 0.90.

### Statistical Analysis

The quantitative data were processed and analyzed by frequency, percentage, mean, and standard deviation (SD) in the Statistical Package for the Social Sciences (SPSS Statistics 17.0 for Windows, Chicago, IL, USA). The one-way analysis of variance (ANOVA) were used to test for significance of observed associations. A significant ANOVA was followed by post-hoc comparisons using Tukey's Honestly Significant differences tests. The level of statistical significance for all tests was set at P-value < 0.05. The scores were simply divided into five levels. Because of the unequal score for each domain, we transformed raw scores into a 0 – 10 point scale in all domains in order to compare the magnitude among domains. Score interpretations are shown in Table 1. The qualitative data were analyzed and performed independently by four of the researchers who used multiple detailed readings of the raw data to allow key themes and categories to emerge. After joint discussions, a coding frame was then used to carry out the analysis.

This study was approved by Naresuan University Institutional Review Board (IRB No. 0565/61), Thailand. Participation in this study was voluntary and all participants remained anonymous.

## Results

The results of this study were presented based on three questionnaires.

### **The result of evaluating generic ICT competencies for learning of preclinical and clinical dental students**

A total of 253 students completed the generic ICT competencies questionnaires, giving an overall response rate of 72.1 percent. The response rates of the different class years are presented in Table 2. Among participating students, females were the majority (68.8 percent) and most respondents were within the age range of 20 – 22 years old (52.2 percent).

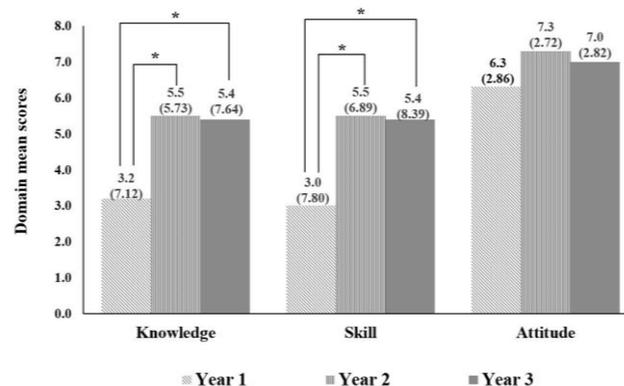
The results of domain and item mean scores of generic ICT competencies of preclinical (N = 126) and clinical (N = 127) dental students are illustrated in Table 3. Both preclinical and clinical students judged their generic ICT competencies in terms of domain mean scores as at a moderately high level, with only domain 4 of knowledge dimension and domain 1 of skill dimension of participants assessing their competencies as being at an average level. Domain 4 of skill dimension were also rated as being at an average level by preclinical students. Furthermore, there was no statistically significant difference in generic ICT competencies among participants from each class year of preclinical level. However, a significant difference was found between the fourth and the sixth year, clinical level, in domain 4 of knowledge dimension ( $p < 0.05$ ).

### **The result of evaluating specific ICT competencies for learning of preclinical dental students**

One hundred and twenty-two out of 158 preclinical dental students (77.2 percent) at Naresuan dental school completed the specific ICT competencies questionnaire. The response rates of the different class year varied with responses from 92.5 percent of first-year students, 83.3 percent of second-year students, and 71.2 percent of third-year students. A total of 66.4 percent of preclinical participating students were female and the preclinical students' age range was 20 – 22 years old, which was the majority of respondents (74.6 percent).

As shown in Table 4, preclinical dental students (N = 122) assessed their specific ICT competencies varied from low to moderately high level. A difference of domain mean scores (SD)

of specific ICT competencies of preclinical dental students is displayed in Figure 1. The results show that a greater number of the first-year dental students assessed their ICT knowledge and skill as being a lower level than the second- and third-year dental students ( $p < 0.01$ ).



$p$ -value < 0.01

**Figure 1.** A difference of domain mean scores (SD) of specific ICT competencies of preclinical dental students (N = 122).

Abbreviations: SD, standard deviation.

### **The result of evaluating specific ICT competencies for learning of clinical dental students.**

A total of 122 clinical students participated in the study, achieving an overall response rate of 59.6 percent. Individual class response rates for the fourth to the sixth years were 77.4 percent, 43.6 percent, and 62.0 percent, respectively. Most of the participants were female (70.3 percent) and age range was 23 – 25 years old (57.9 percent).

The results of domain and item mean scores of specific ICT competencies of clinical dental students (N = 121) are shown in Table 5. Regarding specific ICT competencies of the clinical level, students rated their ICT competent in term of domain mean scores between average and a moderately high level. A difference of domain mean scores (SD) of specific ICT competencies of clinical dental students is illustrated in Figure 2. A significant difference was found only between the fourth- and the sixth-year dental students in domain 2 of knowledge and skill dimension ( $p < 0.05$ ).

### **The results of suggestions of using ICT for learning at the Faculty**

Preclinical and clinical dental students made suggestions about using ICT for learning in the Faculty. Students noted that improved

Internet availability and connection speed; increased online teaching materials and learning software; and the provision of basic ICT which use training programs specific in dentistry, should be considered in the Faculty. They also expressed a need for more training of the ICT used in the research study - for example - the SPSS program.

## Discussion

Several studies on the use of ICT in dental education and their potential use as an educational tool have been published.<sup>2-6,12-16</sup> However, there has been no study published of self-assessed ICT competencies regarding Thai dental students.

In this study, the dental students rated their most generic ICT competencies as at a moderately high level. This comes as no surprise in the digital world, where students in this era are familiar with ICT. Most dental students seemed entering the university with basic ICT competencies since all primary and/or secondary schools provided teaching those competencies. Moreover, the Faculty provides computer and ICT education as a part of the curriculum, both in the general and dental education program. However, some domain in generic ICT competencies were rated as at average level. It is possible that programs such as utility programs, calculation and analysis of revenue-expenditure, graphic design programs, were not used regularly by dental students.

For specific ICT competencies of preclinical dental students, the first-year students assessed their knowledge and skill domains less than the second- and third-year students; this may reflect freshman students had not yet taken the subjects that use those specific software programs. Moreover, the second- and third-year students had more experience of doing research and literature searching from academic online databases and electronic journals (E-journal) than freshman students. This result was consistent with specific ICT competencies of clinical dental students that the final year students rated their specific knowledge and skill about ICT used in dental hospital at the Faculty higher than the fourth-year students. During the clinical years of study, the sixth-year students had more experience with specific dental ICT used in the Faculty, such as practice

management programs and clinical support systems, than the fourth-year students.

Many studies report dental student's self-assessed ICT competency,<sup>3,12,15-17</sup> it is possible that they might assess their ICT competency as an over- or underestimation. Therefore, it is important to keep in mind that a self-assessed ICT competency may not be an accurate assessment of the actual levels. A realistic assessment of students' competency should be contributed by a routine and standardized measurement of computer and IT literacy.<sup>18</sup>

In the modern era, digital development and technology is now playing a paramount role in improving the student experience in dental education.<sup>19,20</sup> The new generations of students are more familiar with the use of ICT, and have better skills in it.<sup>6</sup> In this study, students also clearly expressed a need for more digital development and technology usage for teaching and learning in the Faculty. Examples of ICT use in education of health professionals<sup>2,19-22</sup> are computer information systems (CIS), electronic learning (E-learning), interactive classroom, computer supported independent study program of medical sciences, web-based learning, distance learning, virtual classroom, interactive distance learning, and others. The use of those ICT can improve the quality of education in several ways:<sup>2,21</sup> for example, enhancing students' motivation, engagement and collaboration; facilitating the acquisition of knowledge with possible repetition as many times as required; and providing the possibility to communicate easily and efficiently. Such a great challenge, ICT investments and implementation of learning materials and educational tools should be a high priority of dental schools to greatly enhance the learning process. However, on the cautionary side, it should be noted, that if the ICT is to be implemented, it is time consuming, expensive to develop and implement ICT for use in dental education.<sup>2</sup>

The quality of a survey is determined by the most common statistics, which is response rate.<sup>23,24</sup> A low response rate usually indicates as the most weakness of online version of questionnaires.<sup>24</sup> However, most response rates in this study were at a high level. It is possible that respondents with known access to the Internet are supposed to have a higher response rate than respondents without known access,<sup>25</sup> like this study which respondents were dental

students who are familiar with ICT. In addition, the advantages of the online version of the questionnaires used in this study are the quality of data regarding completeness<sup>25</sup>, ease of data gathering<sup>26</sup>, and minimal cost.<sup>26</sup>

Limitations of this study are the self-assessed nature of ICT competency may overestimate or underestimate, and the fact that Naresuan dental students may not be representative of all Thai dental students. Further research, which should be continuous, is needed to investigate the self-perception assessment of ICT competency in other schools, and to determine the actual ICT competency among this group of students.

### Conclusions

In summary, the results of the present study demonstrate that both preclinical and clinical students rated most of their generic ICT competencies in terms of domain mean scores as at a moderately high level. There was no statistically significant difference in generic ICT competencies among participants from each class year of the preclinical level. However, a significant difference was found between the fourth and the sixth year, clinical level, in domain 4 of knowledge dimension ( $p < 0.05$ ). Regarding the most specific ICT competencies, both levels

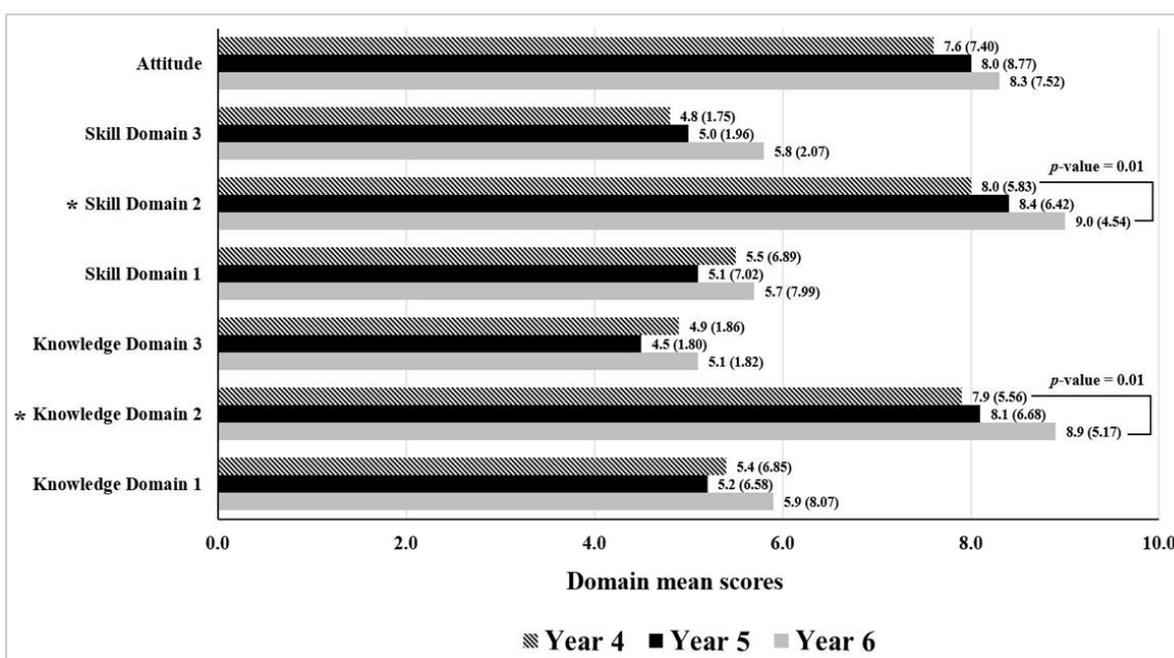
of dental students assessed their competencies in terms of domain mean scores between average and a moderately high level. More of the first-year dental students assessed their specific ICT knowledge and skill as low level compared to the second- and third- year dental students ( $p < 0.01$ ). A significant difference of specific ICT competency was also found only between the fourth- and the sixth-year dental students in domain 2 of knowledge and skill dimension ( $p < 0.05$ ). The results of this study can be used to develop the educational management and systems based on ICT in the Faculty for enhancing quality of dental students' education.

### Acknowledgements

The current research was granted by Naresuan University. The authors would like to thank all students and staffs in the Faculty of Dentistry, Naresuan University for their participation and support.

### Declaration of Interest

The authors have no conflict of interest and the article was supported by research grants from Naresuan University.



**Figure 2.** A difference of domain mean scores (SD) of specific ICT competencies of preclinical dental students (N = 122) Abbreviations: SD, standard deviation.

Item mean scores (Maximum score = 5)	Domain mean scores (Maximum score = 10)	Level of competencies
< 1.5	< 1.3	Least level of competence
1.5 – 2.4	1.3 – 3.7	Low level of competence
2.5 – 3.4	3.8 – 6.2	Average level of competence
3.5 – 4.4	6.3 – 8.7	Moderately high level of competence
≥ 4.5	≥ 8.8	High level of competence

Table 1. Interpretation of the item and domain mean scores of competencies

Class year	Number of dental students		Response rate (Percentage)
	Total	Response	
1	54	53	98.1
2	42	36	85.7
3	52	37	71.2
4	62	48	77.4
5	78	38	48.7
6	63	41	65.1
<b>Total</b>	<b>351</b>	<b>253</b>	<b>72.1</b>

Table 2. Number and percentage of preclinical and clinical dental students for evaluating generic ICT competencies

Domains and Items	Preclinical students		Clinical students	
	Mean (SD)	Level of competencies	Mean (SD)	Level of competencies
<b>Knowledge dimension</b>				
<b>Domain 1 Basic knowledge of ICT</b>	<b>6.9 (2.08)</b>	<b>Moderately high</b>	<b>6.4 (2.56)</b>	<b>Moderately high</b>
1. Definition of ICT	3.8 (0.67)	Moderately high	3.4 (0.90)	Average
1. Importance and benefits of ICT	4.2 (0.71)	Moderately high	3.8 (0.85)	Moderately high
1. Laws and mutual agreement to use ICT e.g. Computer Act	3.0 (0.82)	Average	3.1 (0.87)	Average
1. Choosing to use ICT properly	4.0 (0.66)	Moderately high	3.9 (0.73)	Moderately high
<b>Domain 2 Basic knowledge of mobile phones and/or tablets usage</b>	<b>8.5 (1.59)</b>	<b>Moderately high</b>	<b>8.0 (2.19)</b>	<b>Moderately high</b>
2. Basic mobile phones and/or tablets usage	4.7 (0.54)	High	4.4 (0.80)	Moderately high
2. Basic software mobile phones and/or tablets usage	4.5 (0.60)	High	4.3 (0.85)	Moderately high
2. How to care mobile phones and/or tablets	3.9 (0.81)	Moderately high	4.0 (0.94)	Moderately high

Domains and Items	Preclinical students		Clinical students	
	Mean (SD)	Level of competencies	Mean (SD)	Level of competencies
<b>Domain 3 Basic knowledge of computer hardware usage</b>	<b>7.7 (2.08)</b>	<b>Moderately high</b>	<b>7.6 (2.33)</b>	<b>Moderately high</b>
3.1 Basic computer usage	4.6 (0.64)	High	4.4 (0.84)	Moderately high
3.2 Using of computer peripheral devices	4.0 (0.92)	Moderately high	4.1 (0.87)	Moderately high
3.3 How to care your computer hardware	3.6 (0.95)	Moderately high	3.6 (0.99)	Moderately high
<b>Domain 4 Basic knowledge of computer software usage</b>	<b>6.0 (3.19)</b>	<b>Average</b>	<b>6.2 (3.27)</b>	<b>Average</b>
4.1 Microsoft Office programs e.g. Word, PowerPoint, Excel	3.7 (0.78)	Moderately high	3.8 (0.78)	Moderately high
4.2 Utility programs e.g. antivirus program	3.1 (1.00)	Average	3.4 (1.01)	Average
4.3 Multimedia programs e.g. media player program	3.7 (1.03)	Moderately high	3.7 (0.98)	Moderately high
4.4 Graphic design programs e.g. photo editing program	3.0 (1.00)	Average	3.1 (1.07)	Average
<b>Domain 5 Basic knowledge of Internet and network systems usage</b>	<b>8.3 (3.32)</b>	<b>Moderately high</b>	<b>7.8 (4.34)</b>	<b>Moderately high</b>
5.1 Internet connection and web browser e.g. LAN, Wi-Fi, 4G	4.0 (0.87)	Moderately high	3.8 (0.86)	Moderately high
5.2 Search engines	4.4 (0.69)	Moderately high	4.1 (0.87)	Moderately high
5.3 Social network e.g. Facebook, Line, Twitter, Instagram	4.6 (0.57)	High	4.4 (0.78)	Moderately high
5.4 File download and upload	4.4 (0.75)	Moderately high	4.2 (0.83)	Moderately high
5.5 How to use the Internet safely and privately	4.4 (0.71)	Moderately high	4.1 (0.88)	Moderately high
5.6 Shopping online via websites and/or applications	4.3 (0.77)	High	4.2 (0.93)	Moderately high
<b>Skill dimension</b>				
<b>Domain 1 Basic skill of ICT: Skill in using ICT for</b>	<b>6.0 (1.56)</b>	<b>Average</b>	<b>5.8 (1.63)</b>	<b>Average</b>
1.1 Data analysis e.g. calculation and analysis of revenue-expenditure	2.9 (1.03)	Average	3.0 (1.03)	Average
1.2 Solving various problems	4.0 (0.93)	Moderately high	3.7 (0.87)	Moderately high
<b>Domain 2 Basic skill of mobile phones and/or tablets usage</b>	<b>8.0 (1.28)</b>	<b>Moderately high</b>	<b>7.6 (1.50)</b>	<b>Moderately high</b>
2.1 Basic software mobile phones and/or tablets usage	4.3 (0.67)	Moderately high	4.1 (0.83)	Moderately high
2.2 How to care mobile phones and/or tablets	4.1 (0.81)	Moderately high	4.0 (0.85)	Moderately high
<b>Domain 3 Basic skill of computer hardware usage</b>	<b>7.9 (2.03)</b>	<b>Moderately high</b>	<b>7.8 (2.15)</b>	<b>Moderately high</b>

Domains and Items	Preclinical students		Clinical students	
	Mean (SD)	Level of competencies	Mean (SD)	Level of competencies
3.1 Basic computer usage e.g. turning on/off computer	4.5 (0.65)	High	4.3 (0.79)	Moderately high
3.2 Using of computer peripheral devices	4.0 (0.90)	Moderately high	4.1 (0.80)	Moderately high
3.3 How to care your computer hardware	4.0 (0.82)	Moderately high	4.0 (0.83)	Moderately high
<b>Domain 4 Basic skill of computer software usage</b>	<b>6.0 (3.34)</b>	<b>Average</b>	<b>6.4 (3.11)</b>	<b>Moderately high</b>
4.1 Microsoft Office programs e.g. Word, PowerPoint, Excel	3.7 (0.76)	Moderately high	3.7 (0.74)	Moderately high
4.2 Utility programs e.g. antivirus program	3.3 (1.06)	Average	3.5 (0.96)	Moderately high
4.3 Multimedia programs e.g. media player program	3.7 (1.04)	Moderately high	3.8 (0.95)	Moderately high
4.4 Graphic design programs e.g. photo editing program	3.0 (1.10)	Average	3.2 (1.03)	Average
<b>Domain 5 Basic skill of Internet and network systems usage</b>	<b>8.5 (3.29)</b>	<b>Moderately high</b>	<b>8.2 (4.17)</b>	<b>Moderately high</b>
5.1 Internet connection and web browser e.g. LAN, Wi-Fi, 4G	4.4 (0.75)	Moderately high	4.3 (0.84)	Moderately high
5.2 Search engines	4.5 (0.65)	High	4.2 (0.82)	Moderately high
5.3 Social network e.g. Facebook, Line, Twitter, Instagram	4.6 (0.61)	High	4.5 (0.72)	High
5.4 File download and upload	4.3 (0.72)	Moderately high	4.4 (0.82)	Moderately high
5.5 How to use the Internet safely and privately	4.3 (0.72)	Moderately high	4.1 (0.84)	Moderately high
5.6 Shopping online via websites and/or applications	4.2 (0.81)	Moderately high	4.3 (0.84)	Moderately high
<b>Attitude dimension</b>	<b>8.3 (2.71)</b>	<b>Moderately high</b>	<b>8.0 (4.17)</b>	<b>Moderately high</b>
1. Having morals and ethics in ICT usage e.g. respecting the rights of others	4.5 (0.67)	High	4.3 (0.74)	Moderately high
2. Realizing the use of ICT in the right way and not against the law	4.3 (0.74)	Moderately high	4.1 (0.93)	Moderately high
3. Always interesting in following the news and advancements of ICT	3.9 (0.78)	Moderately high	4.0 (0.84)	Moderately high
4. Realizing the importance, benefits, and precautions in using ICT	4.3 (0.65)	Moderately high	4.2 (0.78)	Moderately high
5. Accepting a mutual agreement to work with others e.g. following website group rules	4.5 (0.59)	High	4.3 (0.71)	Moderately high

**Table 3.** Domain and item mean scores of generic ICT competencies of preclinical (N = 126) and clinical (N = 127) dental students. Abbreviations: SD, standard deviation.

Domains and Items	Mean (SD)	Level of competencies
<b>Knowledge domain:</b> Usage knowledge about	<b>4.6 (8.15)</b>	<b>Average</b>
1. Information technology equipment in science laboratories e.g. programs in the Photometer and pH Meters	2.5 (1.02)	Average
2. QR Code system for the teaching and learning process	4.3 (0.79)	Moderately high
3. Online applications for teaching and learning process e.g. G Suite for education	3.8 (0.89)	Moderately high
4. Academic online database e.g. PubMed, ScienceDirect	2.5 (1.11)	Average
5. Electronic journal e.g. Journal of Dental Research	2.3 (1.08)	Low
6. Simulation applications for human gross anatomy e.g. Gray's Anatomy – Atlas, Human Anatomy Atlas 2019	3.2 (1.42)	Average
7. Laboratory Simulations in Physiology e.g. PhysioEx	2.7 (1.40)	Average
8. Simulation applications for dental anatomy e.g. BoneBox™ - Dental Lite, ToothView™	2.2 (1.29)	Low
9. Pathology slide viewing software e.g. Aperio ImageScope	1.9 (1.15)	Low
10. Electronic learning e.g. MOOC (Massive Open Online Courses), Khan academy	2.8 (1.24)	Average
<b>Skill domain:</b> Use of	<b>4.4 (9.13)</b>	<b>Average</b>
1. Information technology equipment in science laboratories e.g. programs in the Photometer and pH Meters	2.4 (1.12)	Low
2. QR Code system for the teaching and learning process	4.3 (0.93)	Moderately high
3. Online applications for teaching and learning process e.g. G Suite for education	3.8 (1.00)	Moderately high
4. Academic online database e.g. PubMed, ScienceDirect	2.3 (1.21)	Low
5. Electronic journal e.g. Journal of Dental Research	2.2 (1.16)	Low
6. Simulation applications for human gross anatomy e.g. Gray's Anatomy – Atlas, Human Anatomy Atlas 2019	3.1 (1.49)	Average
7. Laboratory Simulations in Physiology e.g. PhysioEx	2.7 (1.44)	Average
8. Simulation applications for dental anatomy e.g. BoneBox™ - Dental Lite, ToothView™	2.2 (1.31)	Low
9. Pathology slide viewing software e.g. Aperio ImageScope	2.0 (1.18)	Low
10. Electronic learning e.g. MOOC (Massive Open Online Courses), Khan academy	2.8 (1.31)	Average
<b>Attitude domain:</b> The importance of	<b>6.8 (2.84)</b>	<b>Moderately high</b>
1. The use of ICT to search academic information from Academic online database and E-journal	3.5 (1.21)	Moderately high
2. The use of ICT to support learning activities in the Faculty e.g. online examination	3.7 (1.01)	Moderately high
3. Policy on ICT of the Faculty e.g. the projects which provide information technology equipment sufficient for the needs of personnel, training programs for developing knowledge in ICT	4.0 (1.11)	Moderately high

**Table 4.** Domain and item mean scores of specific ICT competencies of preclinical dental students (N = 122). Abbreviations: SD, standard deviation.

Domains and Items	Mean (SD)	Level of competencies
<b>Knowledge dimension</b>		
<b>Domain 1 Specific knowledge about ICT for education in health sciences and dentistry</b>	<b>5.5 (7.23)</b>	<b>Average</b>
1. Information technology equipment in science laboratories e.g. programs in the Photometer and pH Meters	2.7 (1.05)	Average
2. QR Code system for the teaching and learning process	4.2 (0.85)	Moderately high
3. Online applications for teaching and learning process e.g. G Suite for education	4.0 (0.85)	Moderately high
4. Academic online database e.g. PubMed, ScienceDirect	3.6 (0.86)	Moderately high
5. Electronic journal e.g. Journal of Dental Research	3.5 (0.91)	Moderately high
6. Simulation applications for human gross anatomy e.g. Gray's Anatomy – Atlas, Human Anatomy Atlas 2019	3.3 (1.08)	Average
7. Laboratory Simulations in Physiology e.g. PhysioEx	2.6 (1.04)	Average
8. Simulation applications for dental anatomy e.g. BoneBox™ - Dental Life, ToothView™	2.9 (1.16)	Average
9. Pathology slide viewing software e.g. Aperio ImageScope	2.5 (1.10)	Average
10. Electronic learning e.g. MOOC (Massive Open Online Courses), Khan academy	2.5 (1.13)	Average
<b>Domain 2 Specific knowledge about ICT for education used in dental hospital at the Faculty</b>	<b>8.5 (5.78)</b>	<b>Moderately high</b>
1. Online patient searching system	4.4 (0.74)	Moderately high
2. Online dental record booking system	4.5 (0.65)	High
3. Online dental queue system	4.4 (0.72)	Moderately high
4. Online dental unit booking system	4.5 (0.67)	High
5. Online payment system	4.4 (0.71)	Moderately high
6. Online dental prescription system	4.3 (0.78)	Moderately high
7. Online digital radiography referring system	4.2 (0.84)	Moderately high
8. Online digital radiography viewing system	4.2 (0.79)	Moderately high
9. Online dental prosthetic laboratory delivering system	3.9 (0.99)	Moderately high
<b>Domain 3 Specific knowledge about ICT for education used in research study</b>	<b>4.48 (1.83)</b>	<b>Average</b>
1. Statistical analysis program e.g. SPSS	2.9 (0.95)	Average
2. Reference management programs e.g. EndNote	3.0 (0.94)	Average
<b>Skill dimension</b>		
<b>Domain 1 Specific skill about ICT for education in health sciences and dentistry</b>	<b>5.4 (7.31)</b>	<b>Average</b>
1. Information technology equipment in science laboratories e.g. programs in the Photometer and pH Meters	2.8 (1.03)	Average
2. QR Code system for the teaching and learning process	4.0 (0.93)	Moderately high
3. Online applications for teaching and learning process e.g. G Suite for education	3.8 (0.93)	Moderately high
4. Academic online database e.g. PubMed, ScienceDirect	3.6 (0.93)	Moderately high
5. Electronic journal e.g. Journal of Dental Research	3.4 (0.98)	Average
6. Simulation applications for human gross anatomy e.g. Gray's Anatomy – Atlas, Human Anatomy Atlas 2019	3.2 (1.10)	Average
7. Laboratory Simulations in Physiology e.g. PhysioEx	2.7 (1.04)	Average
8. Simulation applications for dental anatomy e.g. BoneBox™ -	2.9 (1.14)	Average

Domains and Items	Mean (SD)	Level of competencies
Dental Lite, ToothView™		
9. Pathology slide viewing software e.g. Aperio ImageScope	2.6 (1.11)	Average
10. Electronic learning e.g. MOOC (Massive Open Online Courses), Khan academy	2.6 (1.11)	Average
<b>Domain 2 Specific skill about ICT for education used in the dental hospital at Faculty</b>	<b>8.5 (5.78)</b>	<b>Moderately high</b>
1. Online patient searching system	4.5 (0.65)	High
2. Online dental record booking system	4.5 (0.66)	High
3. Online dental queue system	4.4 (0.71)	High
4. Online dental unit booking system	4.5 (0.65)	High
5. Online payment system	4.5 (0.67)	High
6. Online dental prescription system	4.4 (0.74)	Moderately high
7. Online digital radiography referring system	4.3 (0.76)	Moderately high
8. Online digital radiography viewing system	4.3 (0.72)	Moderately high
9. Online dental prosthetic laboratory delivering system	4.0 (1.03)	Moderately high
<b>Domain 3 Specific skill about ICT for education used in research study</b>	<b>5.2 (1.94)</b>	<b>Average</b>
1. Statistical analysis program e.g. SPSS	3.0 (1.04)	Average
2. Reference management programs e.g. EndNote	3.1 (0.97)	Average
<b>Attitude dimension: The importance of</b>	<b>8.0 (7.89)</b>	<b>Moderately high</b>
1. The use of ICT to search academic information from Academic online database and E-journal	3.8 (0.93)	Moderately high
2. The use of ICT to support learning activities in the Faculty e.g. online examination	3.8 (0.90)	Moderately high
3. Policy on ICT of the Faculty e.g. the projects which provide information technology equipment sufficient for the needs of personnel, training programs for developing knowledge in ICT	3.8 (0.87)	Moderately high
4. The use of online patient searching system	4.3 (0.78)	Moderately high
5. The use of online dental record booking system	4.4 (0.78)	Moderately high
6. The use of online dental queue system	4.4 (0.77)	Moderately high
7. The use of online dental unit booking system	4.4 (0.72)	Moderately high
8. The use of online payment system	4.4 (0.71)	Moderately high
9. The use of online dental prescription system	4.4 (0.81)	Moderately high
10. The use of online digital radiography viewing system	4.4 (0.73)	Moderately high
11. The use of online dental prosthetic laboratory delivering system	4.2 (0.86)	Moderately high
12. The use of ICT for research study e.g. statistical analysis program, reference management programs	4.0 (0.96)	Moderately high

**Table 5.** Domain and item mean scores of specific ICT competencies of clinical dental students (N = 121). Abbreviations: SD, standard deviation.

## References

1. Bureau of Policy and Planning, Commission on Higher Education. The 20-year Long Range Plan on Higher Education of Thailand B.C. 2561 – 2580 (In Thai). In: Bureau of Policy and Planning, Commission on Higher Education, editors. 1st ed. Bangkok: Prigwhan Publishing Ltd.; 2018.
2. Nattestad A, Attstrom R. Information technology in oral health education. Eur J Dent Educ 1997; 1(3): 101-7.
3. Cox S, Pollock D, Rountree J, Murray CM. Use of information and communication technology amongst New Zealand dental students. Eur J Dent Educ 2016; 20(3): 135-41.
4. Rajab LD, Baqain ZH. Use of information and communication technology among dental students at the University of Jordan. J Dent Educ 2005; 69(3): 387-98.

5. Mohamed AM, Aik TC, Yi LP, Abdullah D, Dom TNM. Dental students' attitudes and perceptions towards ICT resources and skills. *Procedia Soc Behav Sci* 2011; 18: 400-03.
6. Virtanen JI, Nieminen P. Information and communication technology among undergraduate dental students in Finland. *Eur J Dent Educ* 2002; 6(4): 147-52.
7. Paophanao S. The study of information technology and communication competencies for learning of undergraduate students in Rajamangala University of Technology Rattanakosin Wangkraikangwon Campus (In Thai) [Master of Education]. Graduate School: Silpakorn University; 2011.
8. Seelapkuea V. Essential information and communication technology competencies for university operations: a case study of Prince of Songkla University supporting staff (In Thai) [Master of Science Thesis]. Prince of Songkla University: Prince of Songkla University; 2011
9. Houshyari AB, Bahadorani M, Tootoonchi M, et al. Medical education and information and communication technology. *J Educ Health Promot* 2012; 1: 1-7.
10. Asaraj C, Seehamongkon Y, Poolpholamnoey W. The development of key core competency indicators in ability to use technology of the basic education core curriculum 2551 for high school students (In Thai). *JEM-MSU* 2014; 20(1): 49-64.
11. Harinvon U, Phunlaphawee K, Wiriyonom T, Chanyawudhiwan G. The competency in education information technology for teacher (In Thai). *Journal of Education: Faculty of Education, Srinakharinwirot University*. 2014; 15(2): 147-56.
12. Grigg PA, Stephens CD. A survey of the IT skills and attitudes of final year dental students at Bristol University in 1996 and 1997. *Eur J Dent Educ* 1999; 3(2): 64-73.
13. Lopez Jordi MD, Figueiredo MC, Barone D, Pereira C. Study and analysis of information technology in dentistry in Latin American countries. *Acta Odontol Latinoam* 2016; 29(1): 14-22.
14. Mattheos N, Nattestad A, Schitteck M, Attstrom R. Computer literacy and attitudes among students in 16 European dental schools: current aspects, regional differences and future trends. *Eur J Dent Educ* 2002; 6(1): 30-5.
15. Mattheos N, Schitteck MJ, Nattestad A, Shanley D, Attstrom R. A comparative evaluation of computer literacy amongst dental educators and students. *Eur J Dent Educ* 2005; 9(1): 32-6.
16. Uribe S, Marino RJ. Internet and information technology use by dental students in Chile. *Eur J Dent Educ* 2006; 10(3): 162-8.
17. Feldman CA. Dental student experience and perceptions of computer technology. *J Dent Educ* 1992; 56(3): 200-5.
18. Divaris K, Polychronopoulou A, Mattheos N. An investigation of computer literacy and attitudes amongst Greek post-graduate dental students. *Eur J Dent Educ* 2007; 11(3): 144-7.
19. Inquimbert C, Tramini P, Romieu O, Giraudeau N. Pedagogical evaluation of digital technology to enhance dental student learning. *Eur J Dent* 2019; 13(1): 53-57.
20. Jackson TH, Zhong J, Phillips C, Koroluk LD. Self-directed digital learning: when do dental students study? *J Dent Educ* 2018; 82(4): 373-78.
21. Masic I, Pandza H, Toromanovic S, et al. Information Technologies (ITs) in medical education. *Acta Inform Med* 2011; 19(3): 161-7.
22. Karimi S, Rahmani K, Veisi V, Afkhamzadeh A. Effects of social networking education on HIV/AIDS knowledge, attitude and practice in dentistry students. *J Int Dent Med Res*. 2019; 12(2): 617-21.
23. Rogelberg SG, Stanton JM. Introduction: Understanding and dealing with organizational survey nonresponse. *Organ Res Methods* 2007; 10(2): 195-209.
24. Baruch Y, Holtom BC. Survey response rate levels and trends in organizational research. *Hum Relat* 2008; 61(8): 1139-60.
25. Kongsved SM, Basnov M, Holm-Christensen K, Hjollund NH. Response rate and completeness of questionnaires: a randomized study of Internet versus paper-and-pencil versions. *J Med Internet Res* 2007; 9(3): 1-11.
26. Jones R, Pitt N. Health surveys in the workplace: comparison of postal, email and World Wide Web methods. *Occup Med (Lond)* 1999; 49(8): 556-8.