

Factors Influencing the Effective Use of Information Literacy in Pre-service Teachers in Thailand: The Mediating Role of Information Technology Usage

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Abstract

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This research aimed to investigate the impact factors that influence the Information Literacy (IL) of Thailand's pre-service teachers; and the roles of learning outcomes, including the causal relationship between Information Technology (IT) management, Teaching Skills (TS), and IT usage that affect the manipulation of the IL. The research employed a stratified random sampling approach, recruiting a total of 618 verified participants from five universities located in five regions of Thailand, and using a questionnaire survey method. The reliability of the research instrument accuracy was 0.8, based on structure equation modeling, while the GFI, CFI, AGFI, RMSEA, and SRMR values were 0.95, 1.00, 0.92, 0.045, and 0.02, respectively. Testing for the influence of the mediator variable indicated that the direct influence of IT management and TS on IL was 0.05 and 0.25, respectively, while the indirect influence of IT management and TS on IL through the mediator variable of the IT usage was 0.147 and 0.39, respectively. Thus, this study revealed that the mediator variable of the IT usage affected IL.

Keywords: IT Management, Teaching Skills, Use of Information Technology, Information Literacy, SEM

1. Introduction

With the rapid advancement in the global economy and Information Technology (IT) contexts, the development of people's literacy has rapidly evolved. More and more countries have formulated policies to enhance their citizens' competencies, including information literacy (IL) (Burbules, 2018; Inglehart, 2018; Shannon, 2018). In Thailand, the "Thailand 4.0 National Agenda" was recently implemented to achieve the same goal (Jones & Pimdee, 2017; Skeldon, 2018).

In 2025, there were up to 65.4 million internet users in Thailand, accounting for 91.2% of the country (Kemp, 2025). This reaffirmed that Thailand is well prepared for IT infrastructure upgrades as the accessibility to IT becomes more prevalent. In addition, in the era of combined information data and learning, classrooms in the 21st century require students to possess learning, teamwork, and communication skills, while being able to use media and information and communication technologies (ICT), and hence to obtain a good level of IT literacy (Fedorov & Mikhaleva, 2020; Hatlevik et al., 2018; Pheeraphan, 2013; Šorgo et al., 2017; Thomas et al., 2020). Moreover, IL is essential as a lifelong-learning approach (Jameson & Walsh, 2017; Kozikoglu & Onur, 2019; World Economic Forum & Boston Consulting Group, 2018).

Indeed, IL is a crucial factor for promoting lifelong learning and they are positively related to each other (Demirel & Akkoyunlu, 2017; Hee et al., 2019; Kozikoglu & Onur, 2019; Solmaz, 2017), where IL skills are fundamental for the lifelong learning, equipping learners with the capabilities to further apply their skills to physical or online classes that will expose them to a large amount of data. Thus, IL is vital for learning in this digital era (Falloon, 2020; Law et al., 2018; Reddy et al., 2020; UNICEF, 2019; Vuorikari et al., 2016; Yu et al., 2017) and it positively affects the learners' achievements and so is required for teaching (McKeever et al., 2017).

Particularly during the COVID-19 pandemic, when information is often distorted, IL approaches are an effective way to overcome or limit these problems (Association of College and Research Libraries [ACRL], 2020; American Library Association [ALA], 2020; CILIP, 2020; Guo & Huang, 2021; IFLA, 2020; Information Literacy Group [ILG], 2020; UNESCO, 2020a). According to an assessment of knowledge involving reading strategies, and in terms of the credibility of information sources in all OECD countries, Azerbaijan, Indonesia, Kazakhstan, the Philippines, and Thailand were found to have the lowest information credibility (Suarez-Alvarez, 2021). The Global Framework of Reference on Digital Literacy Skills for Indicator 4.4.2 indicated that Thailand was only ranked fifth out of the 10 ASEAN countries in terms of self-perceived digital competence levels (UNICEF, 2021).

Therefore, it is very important to improve the IL of Thai people, especially pre-service teachers, as they need to educate students regarding the same (Flierl et al., 2017; Gilman et al., 2017; Godbey, 2018; Information Literacy Spaces [ILS], 2020; McKeever et al., 2017). At the higher education level, IL normally employs ACRL IL standards, which are considered to be the standard approach to educate IL (Jackman & Weiner, 2017; Khailova, 2021; Sample, 2020). Moreover, the study found that IT or digital

applications affected the IL, and that the IL standards should be incorporated in the study process (Sorgo et al., 2017), while the level of ICT acceptance also affected the IL (Chen & Chengalur-Smith, 2015). Additionally, factors contributing to IL have several facets: online classes, teaching approaches, IT usage, and communications (Hammons, 2020; Humrickhouse, 2021; Moreno-Morilla et al., 2021). The level of IL was found to directly affect the intention of learning technology usage in Korea and Finland (Jang et al., 2021), resulting in greater personal ICT competencies, or interest related to an improved IL.

Students in the educational fields had a lower level of IL compared to those in information science and pedagogy courses (Pinto et al., 2019). A study on the IL of CHASS students at Nanyang Technological University, Singapore revealed that students in the communication and information field were more information literate compared to those from the fields of humanities and social sciences, arts, design, and media (Foo et al., 2013). In Thailand, students at Rajabhat Universities had varying IL levels based on their field of study. On average, students in the educational field tended to have a higher IL level than those in industrial technology, agriculture, and public health (Hiangrat et al., 2018). In addition, students in the Faculties of Education, Humanities and Social Sciences, Science, and Technology had the highest IL level, while those at the Faculty of Nursing were at the intermediate level (Amornsiriphong, 2018). Based on those findings, the factors promoting IL consist of the institution or faculty, courses, teachers, and pre-service students (Sirawong, 2018).

Several countries, including Thailand, are aware that IL will uplift their citizens, and so consider it as part of learning courses (UNESCO, 2020b). Due to these reasons, it still needs to clarify whether and which causal factors promote IL in students in order to be able to achieve educational improvement.

2. Research Objective

This study sought to evaluate which causal factors from IT management, IT usage, and TS affected the IL, with the flow chart of interactions and five hypotheses shown in Figure 1.

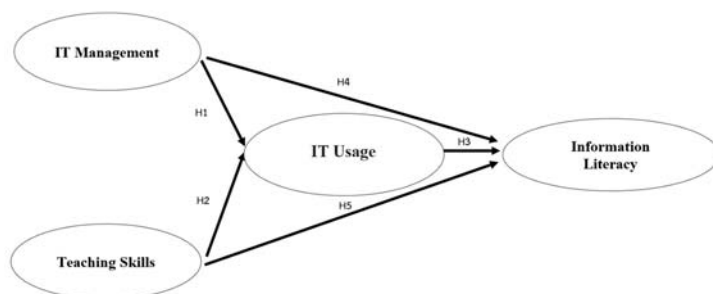


Figure 1 The interaction flow chart between IT management, IT usage, and TS affecting IL and showing the five hypotheses

Source: The researcher team (Thamsuwan et al.)

Hypotheses 1 *To what extent does the incorporation of IT management and IT usage affect IL?*

It is necessary for school administrators to consider that IT development is in part essentially related to education by defining a scope that also includes the infrastructure management, personnel development, research, funding, and control unit, in order to formulate policies and manage works related to educational technology (Bailey, 1998) and technology management and application, which will contribute to a better IL (Durodolu, 2016). Moreover, adequate provision of IT devices is an integral factor that promotes the IL of learners (Lorenz et al., 2019).

Hypotheses 2 *To what extent does teaching skills (TS) and IT usage affect the IL?*

A combination of teaching skills (TS) and IT usage can result in an improved learner's IL compared to that with TS alone (Drossel et al., 2017; Jinchi & Jie, 2021). Incorporation of IT usage and a proper teaching approach also influences individual perspectives and awareness, thereby promoting IL (Šorgo et al., 2017). Moreover, a class that integrates IT usage will benefit the students' IL (Xu and Chen, 2016).

Hypotheses 3 *To what extent does IT usage affect the IL?*

Overall, IT takes an integral role in education, especially computers and telecommunications, such as providing (i) learning to promote technologies, computer-assisted learning (CAI), and information systems; (ii) education management promoting technologies; and (iii) IT and interpersonal communications in the education field for better work performance

Moreover, IT usage can trigger thoughts and increase the interest of students in online learning, while WIFI usage also leads to educational growth in a digitalized way since students can study and comprehend relevant information anywhere at any time (Sarkar, 2012).

Hypotheses 4 *To what extents does IT management affect the IL?*

As a working hypothesis it is necessary for school administrators to consider that IT development is in part essentially related to education by defining a scope that also includes the infrastructure management, personnel development, research, funding, and control unit, in order to formulate policies and manage works related to educational technology (Bailey, 1998) and the Eleventh National Economic and Social Development Plan of Thailand (2012–2016). A summary of the service providers revealed that the rapid technological changes and IT advancement, biotechnology, and nanotechnology have led to economic and social shifts, in terms of opportunities and threats, and so it is necessary to maintain a prepared state for the potential rapid changes in the future. This requires systemic knowledge management and suitable technological application that are integrated with the competency of Thai society (Mukherjee, 2011).

Hypotheses 5 *At which level does TS affect the IL and how?*

Interdisciplinary teaching of IL contributes to a better development of learning scope and IL. This requires lessons to be aligned with the contexts of different guidelines in each subject,

reflecting the IL and the competency to further apply the knowledge to other fields (Kuglitsch, 2015). Developing a thesis can be improved if students are information literate, are able to critically analyze and criticize information to examine its credibility and the value of the findings, to identify an expert in the studied topic, and apply interdisciplinary knowledge (Dubicki, 2019).

3. Literature Review

3.1 Technology management (IT management)

Technological changes drive new offerings. Leading companies have committed to their technology development to ensure their competitiveness (Lai, 2017). Organizations strive for competitive advantages, particularly in personnel development in terms of their technological competency, since this can contribute to the company's value (Hughes, 2010). Technology management affects competitiveness, development, and adaptation, as well as the utilization of science and technology to create or improve products or services for several achievements (Argote, 2017). Moreover, knowledge management promotes better decision-making, which can lead to success (Belay et al, 2021). A study on the technology usage in human resource development found that 42% of personnel working in different locations use computers and the internet for work, and this percentage is tending to continuously increase. Therefore, each organization should define communication and collaboration tools and procedures to use technology as the fundamental approach for personnel development (Benson, 2002).

The use of an internal IT system may be difficult due to several reasons. For example, administrators do not value the integration of an IT system (Kongchawan, 2013). If it lacks support from the administrative level, it will potentially fail from the beginning (Whittaker, 1999, p. 23). Administrators need to possess leadership skills with broad visions, knowledge, expertise in technological integration, and prompt implementation. In terms of addressing this problem, many countries have implemented ICT courses in schools or carried out ICT-related educational reforms (Bereiter & Scardamalia, 2006; Fox & Henri, 2005; Greenhow et al., 2009; Jonassen et al., 2008; National School Boards Association, 2007). Schools, therefore, need IT development for the purpose of education, which covers infrastructure management, and personnel development to formulate policies and work management (Bailey, 1998). Therefore, administrators need to be well prepared for the shift, creative, and based on reformation and innovation. Also, they must be able to motivate or establish a mutual understanding and good teamwork to effectively achieve specific goals (Phiwohang, 2021). This corresponds to the research outcome of the American Institute for Research (AIR) (AIR, 2004, p. 23), which indicated that promotion, support, management, and execution were all crucial characteristics of administrators. If the management system and resource promotion are adequately supported by stakeholders, the outcome will turn positive. Moreover, IT strategic plans and potential communications, along with human resources and budgets, facilities, equipment, modern technology management, and effective planning, will lead to the development planning process of a successful

business (Phiwohang, 2021). Therefore, ICT is an important fundamental for millennial students to learn (Picatoste et al., 2018).

3.2 Teaching skills (TS)

The teaching skills of pre-service teachers that promote IL among university students include several parts. First, teachers should prepare lessons beforehand. Second, learning objectives should be informed to the learners. Third, class evaluation is provided for further improvement. Finally, IL assessment should be related to the work of learners (Lokse et al., 2017). The teaching approach is one factor that promotes IL among students (Kingsawat et al., 2015). Incorporation of TS and IT usage results in people being more information literate, compared to leveraging only TS (Drossel et al., 2017; Jinchi & Jie, 2021). Incorporation of IT and proper teaching approaches influences the perspectives and awareness of IL (Šorgo et al., 2017) and gives a better integration between IT, TS, and IL (Xu & Chen, 2016), as well as the perspectives related to technology to serve the standards and needs of the digital world (Kirschner, 2015).

When applying online media, the instructors need to ensure that there is a guideline and that the learners can form their individual learning environment (Cordell, 2013). Good teaching helps encourage students with a learner-centric approach (Bidabadi et al., 2016). Teachers' expertise in online teaching comes along with the students' readiness to move online, technology infrastructure, provision of content and learning resources, and the instructional design to provide a pedagogical foundation as a prerequisite for online learning (Govindasamy, 2002). Moreover, an active learning strategy encourages the students' participation and easily develops their understanding about information sources (Johnson & Barrett, 2017), while a flip classroom strategy together with online classes that promotes self-monitoring helps enhance their IL (Humrickhouse, 2021) and ensures a balance between physical and online classrooms (Vanslambrouck et al., 2018).

Teachers are suggested to integrate IL with their subjects (Hammons, 2020). The "Framework for IL for Higher Education", published by the ACRL (2016), emphasizes that IL education should be integrated into a "context". Teachers should improve the curriculum to align with current contexts, ensuring that the promotion of IL is based on the students' needs (Guo & Huang, 2021).

3.3 Use of IT (IT Usage)

Advances in emerging ICTs have created new opportunities in terms of globalization, acculturation, knowledge creation, and widespread diffusion of new practices (UNESCO, 2005). The use of IT is one factor contributing to Thailand's educational development and regional distribution of prosperity (Phuworawan & Namprasert, 2003), where IT facilitates learning, instructional teaching, independent study, problem solving, information searching, analyzing, critical thinking, communicational ability, and working and learning (Ratheeswari, 2018). Technological factors cover infrastructure planning, hardware, and software; while pedagogical factors include the analysis of contents, audience, goals, media, and design approach (Khan, 2005). Technological application in

teaching enhances the student's literacy, skills, and analytical ability (Suryani, 2010), which then allows them to achieve their goals. Educational technology is related to the design, development, use, management, and evaluation of the learning process to ensure an optimum and efficient learning (Earle, 2002).

Understanding the relationship with technology is increasingly important and there are several positive impacts to be obtained from using technology (Shaw, 2018). Using technology in younger children familiarizes them with the trial-and-error approach, while adults prioritize reasons and a step-by-step process (Chotijirawattana, 2019). The effective use of ICT can also improve the life quality, reduce educational gaps, and improve industrial performance (Tan, 2016).

Therefore, technology management is important and affects the advancement of IT, especially the internet, and facilitates global communication, trade, and participation in both business and consumer sectors (Sashi, 2012). For example, internet trade (Nilsuk, 2018) provides non-complicated information about quality (Gounaris & Dimitriadis, 2003).

3.4 Learning outcomes of IL: ACRL

A good IL provides the person with the ability to realize their information needs, and to search, identify, evaluate, and use it effectively (ACRL, 2000). For ICT literacy, it is interpreted as that if the person is able to use a computer and communication tools appropriately, they can then define, access, manage, evaluate, integrate, create, and communicate effectively and responsibly (Thammasaeng et al., 2016). The ACRL's IL Competency Standards for Higher Education consists of the five dimensions of (i) determine the extent of information needed (Misirli & Akbulut, 2013), (ii) access the needed information effectively and efficiently, (iii) evaluate the information and its source critically, and (iv) incorporate the selected information into one's knowledge base to achieve a specific purpose (Berphan, 2012; Moto et al., 2018; Pinto et al., 2019). The vital components for learning are the skills focused on the realization of what they are searching for, which contributes to educational achievements (Lau, 2006; Moto et al., 2018; Pinto et al., 2019).

At present, information takes a crucial role in daily life, and IT advancement results in a higher level and more rapid production and use of information. Therefore, people always need to be enthusiastic towards learning and be able to use technology for problem solving and decision making, which requires IL (Mamak, 2010). Mastery of ICT also has a significant impact on a nation's economic growth (Kraisuth & Panjakajornsak, 2017). Integrating IL into teaching different subjects helps develop the students to become more information literate (Adams et al., 2016; Harris, 2013; Wang, 2013).

4. Methodology

A quantitative method was used, as explained below.

4.1. Instruments

A questionnaire survey was used to collect data in Thailand, during February–April 2021. The questionnaire, which consisted of a total of 21 questions, comprised of six for technology management, and five each for TS, technology use, and IL factors. All the questions were based on a seven-point (1–7) Likert scale, which was used to assess the least to the most appropriate responses.

4.1.1 Information Technology Management (IT Management)

IT management refers to the systematic administration and oversight of computerized technological systems and associated IT databases within educational institutions. Operationally, this variable encompasses four core dimensions: (i) administrative processes governing technology implementation; (ii) computer infrastructure development and maintenance; (iii) the deployment of appropriate software for information technology and communication activities; and (iv) personnel development initiatives focused on enhancing IT competency and promoting its usage. Collectively, these dimensions facilitate organizational access to high-quality digital knowledge and information resources (Bailey, 1998; Goyal et al., 2010; Misirli & Akbulut, 2013; Moto et al., 2018).

4.1.2 Teaching Skills (TS)

Teaching skills represent the professional pedagogical competencies that educators demonstrate in their instructional practice. Operationally, this variable is characterized by teachers' possession of comprehensive subject matter knowledge and their capacity to employ diverse teaching methodologies effectively. Specifically, it involves the strategic selection and application of varied instructional approaches, the integration of educational media, and the purposeful incorporation of technology into the teaching-learning process to enhance educational outcomes (Goyal et al., 2010; Khammanee, 2012; Misirli & Akbulut, 2013).

4.1.3. Technology Usage

Technology usage denotes the practical application of technological tools and digital resources within the instructional context. Operationally, this variable reflects educators' competencies in leveraging technology to facilitate knowledge construction, enhance pedagogical effectiveness, and develop students' technological proficiency. It encompasses the integration of digital tools to support learning objectives, foster student engagement, and enable learners to acquire essential 21st-century skills necessary for achieving their educational and professional goals (Misirli & Akbulut, 2013; Moto et al., 2018; Pinto et al., 2019).

4.1.4 Information Literacy (IL)

Information literacy refers to the comprehensive set of competencies required for effective engagement with information in academic and professional contexts. Operationally, this variable covers both individual information literacy capabilities and institutional practices related to information handling. It is characterized by proficiency across five sequential stages: (i) identifying information needs and scoping information requirements; (ii) planning search strategies and gathering relevant information; (iii) evaluating information quality and credibility; (iv) managing and organizing information resources; and (v) presenting information ethically and effectively. This operational definition emphasizes both the cognitive processes and ethical considerations inherent in information work (Misirli & Akbulut, 2013; Moto et al., 2018; Pinto et al., 2019).

4.2 Sampling methods

The online questionnaire, comprised of the 21 questions outlined above (section 4.1) and shown below, was sent to 1,000 pre-service teachers from five regions in Thailand randomized by a Stratified Random Sampling technique, with stratification based on academic year (Years 1-4), followed by simple random sampling within each stratum to obtain the final sample from which 618 verified questionnaires were returned and these then formed the sample size. The information obtained was processed via the descriptive statistics of frequency distribution, percentage, standard deviation, and statistical analysis to find causal factors that affect IL.

4.3 Sample characteristics

The demography of the 618 pre-service teachers are summarized as follows. They were comprised of 72.7% females, 27.3% males; 53.7% fifth-year curriculum students, 45.6% fourth-year curriculum students, and 0.7% others. The identity of each participant was not revealed to comply with ethical concerns.

In terms of education, 46.9%, 35.8%, 14.2%, and 3.1% of the students had obtained a GPA of 3.01–3.50, over 3.50, 2.51–3.00, and less than 2.00, respectively. With respect to their age, 50.2%, 32.7%, 14.6%, 2.6% of the students were aged 21–22, 19–20, over 22, and 17–18, respectively.

For the frequency of IT usage, 68.9%, 12.3%, 9.5%, 8.7% of the students used IT that affected their IL daily, 3–4 times/week, 5–6 times/week, and 1–2 times/week, respectively.

4.4 Data analysis methods

Data were analyzed using various descriptive methods, bivariate inferential test, and confirmatory factor analysis and Structural Equation Modeling (SEM), a statistical technique employed to justify whether and to what extent the reviewed model is correct, compared to actual information or empirical data.

Table 1 shows the validation of the questionnaire data obtained from the 618 respondents. The internal consistency was evaluated in terms of the Cronbach Alpha score, with obtained values of 0.973, 0.983, 0.975, and 0.983 for the sections on technological management, TS, IT usage, and IL, respectively, with an overall score of 0.983. All alpha and composite reliability values exceeded 0.7 (Hair, et al., 2006), which indicated that the reliability of each construct was reasonably satisfied.

The convergent and discriminant validity were analyzed with factor loadings and average variance extracted (AVE). The construct reliability based on the factor loading of each question from the Exploratory Factor Analysis revealed that all the questions were subject to a construct reliability factor loading of between 0.620–0.870.

The AVE of each latent variable needs to be at least 0.5 (except TS at 0.418). However, TS values greater than 0.40 (Anderson & Gerbing, 1988) indicate that each latent variable adequately explains the variance of its observed variables. In addition, the CR of each latent variable should be at least 0.70 (Anderson & Gerbing, 1988; Hair et al., 2006). The analysis of causal factors revealed composite reliability (CR) and AVE values of 0.942 and 0.731, respectively, for IT management; 0.782 and 0.418 for TS; 0.920 and 0.696 for IT usage; and 0.928 and 0.720 for IL.

Table 1 Measurement scales

	Constructs	Factor loading	Alpha ^a	CR ^b	AVE ^c
IT management			0.973	0.942	0.731
1	Sufficient financial support for information research and development by administrators (TMA1)	0.834			
2	Sufficient software and hardware allocation with all-time information access (TMA2)	0.870			
3	Development for students' effective information usage (TMA3)	0.869			
4	High-speed internet in class connected to effective external information sources (TMA4)	0.869			
5	Teachers' IT knowledge and competencies (TMA5)	0.828			
6	Information sources promoting academic learning interested by students (TMA6)	0.860			
Teaching skills (TS)			0.983	0.782	0.418
7	Student-oriented classroom (TS1)	0.620			
8	Lesson planning (TS2)	0.648			
9	Several teaching approaches (TS3)	0.667			
10	Instructional media and technology employed (TS4)	0.648			
11	Learning evaluation and measurement (TS5)	0.648			
Use of IT			0.975	0.920	0.696
12	Students' effective learning time management (U1)	0.793			
13	Students' webpage-based information comparison ability (U2)	0.817			
14	Capability to use e-mails and ability to use effectively (U3)	0.842			
15	Students' effective search engine usage (U4)	0.856			
16	Ability to use Microsoft Office programs, or gather knowledge and disseminate information through the Internet (U5)	0.861			
Information literacy (IL)			0.983	0.928	0.720

	Constructs	Factor loading	Alpha ^a	CR ^b	AVE ^c
17	Ability to define characteristics and scope of needed information (IL1)	0.856			
18	Ability to analyze information needs and effective access necessary data (IL2)	0.856			
19	Being aware of related information resources (IL3)	0.864			
20	Ability to accept data at will (IL4)	0.858			
21	Being aware of laws related to information usage/intellectual property and to ethically use information (IL5)	0.807			

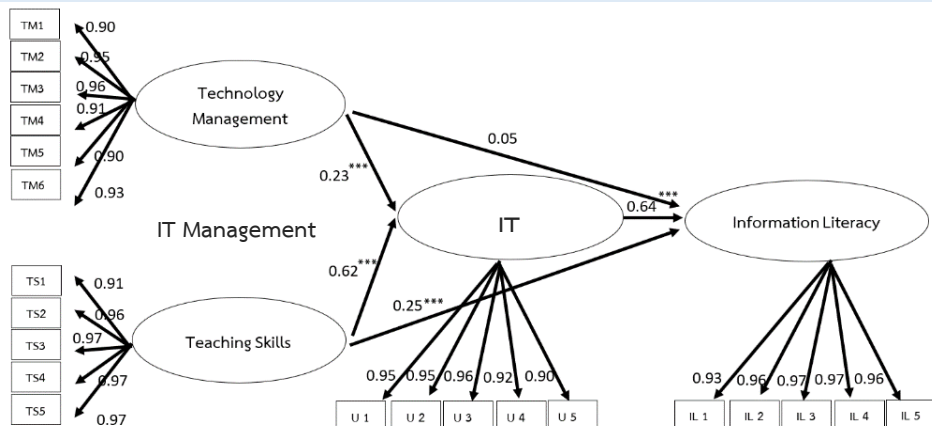
^a Cronbach's alpha ^b Composite reliability ^c Average variance extracted

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1	1																				
2	.908**	1																			
3	.866**	.892**	1																		
4	.845**	.879**	.926**	1																	
5	.851**	.872**	.913**	.929**	1																
6	.788**	.811**	.792**	.807**	.822**	1															
7	.784**	.798**	.798**	.811**	.824**	.948**	1														
8	.759**	.780**	.795**	.802**	.815**	.925**	.945**	1													
9	.768**	.784**	.800**	.818**	.823**	.919**	.940**	.940**	1												
10	.745**	.754**	.758**	.771**	.773**	.884**	.905**	.911**	.889**	1											
11	.626**	.630**	.623**	.600**	.611**	.633**	.631**	.609**	.628**	.637**	1										
12	.646**	.641**	.618**	.606**	.615**	.639**	.641**	.618**	.619**	.633**	.874**	1									
13	.658**	.660**	.638**	.625**	.634**	.654**	.658**	.648**	.659**	.661**	.870**	.908**	1								
14	.621**	.610**	.585**	.573**	.582**	.607**	.610**	.597**	.598**	.617**	.802**	.878**	.876**	1							
15	.634**	.648**	.641**	.633**	.623**	.643**	.639**	.626**	.655**	.633**	.802**	.818**	.866**	.801**	1						
16	.657**	.673**	.636**	.642**	.631**	.662**	.658**	.649**	.653**	.668**	.825**	.866**	.894**	.887**	.882**	1					
17	.699**	.687**	.682**	.683**	.689**	.719**	.723**	.710**	.711**	.694**	.678**	.677**	.682**	.665**	.699**	.704**	1				
18	.723**	.731**	.723**	.713**	.733**	.761**	.750**	.746**	.743**	.716**	.688**	.683**	.691**	.672**	.709**	.716**	.911**	1			
19	.717**	.725**	.719**	.699**	.718**	.751**	.750**	.746**	.735**	.734**	.717**	.718**	.730**	.719**	.749**	.755**	.903**	.936**	1		
20	.733**	.750**	.739**	.723**	.742**	.765**	.769**	.761**	.751**	.735**	.704**	.705**	.723**	.699**	.739**	.740**	.880**	.930**	.947**	1	
21	.731**	.737**	.732**	.721**	.732**	.757**	.758**	.750**	.749**	.725**	.701**	.696**	.698**	.677**	.733**	.721**	.876**	.929**	.931**	.942**	1
Mean	4.96	5.02	5.14	5.20	5.23	4.98	5.03	5.03	5.09	4.98	4.71	4.63	4.78	4.84	4.95	4.80	5.17	5.17	5.19	5.17	5.19
S.D.	1.576	1.595	1.624	1.630	1.649	1.609	1.602	1.603	1.596	1.643	1.802	1.832	1.832	1.970	1.777	1.819	1.658	1.639	1.673	1.655	1.627

Table 2 Mean, standard deviation, and correlation

Note: Off-diagonal elements are the correlational variables. ** represents $p < 0.05$

5. Result



*** represents $p < 0.001$

Figure 2. SEM analysis of the impact factors influencing the effective use of IL of pre-service teachers in Thailand: the mediating role of the IT usage

Source: The researcher team (Thamsuwan et al.)

This research developed a framework based upon the literature and a hypothesis to explain its topic (Figure 2). The variables in the research framework consisted of IT management and TS, while the independent variable was IL and the transmitter was IT usage.

Goodness of Fit between the model components and empirical data

Table 3 indicated that all the GFIs between the model components and empirical data passed the criteria, where the χ^2 -test value was 2.27 ($\chi^2/\text{df} = 375.26/165$; $p = 0.000$), GFI was 0.95, CFI was 1.00, and AGFI was 0.92. Moreover, the RMSEA and SRMR were 0.045 and 0.020, respectively. It can be concluded that the diagram is positively consistent with the empirical data.

With respect to the SEM analysis, IT management (SEM 1) had a chi-square value of 0.355 ($\chi^2/\text{df} = 1.42/4$; $p = 0.84082$), GFI of 1.00, CFI of 1.00, and AGFI of 1.00 with a RMSEA and SRMR of 0.00 and 0.017, respectively. The TS (SEM 2) had a chi-square value of 0.260 ($\chi^2/\text{df} = 0.52/2$; $p = 0.84082$), GFI of 1.00, CFI of 1.00, and AGFI of 1.00 with a RMSEA and SRMR of 0.00 and 0.0007, respectively. The IT usage (SEM 3) had a chi-square value of 2.13 ($\chi^2/\text{df} = 6.41/3$; $p = 0.093$), GFI of 1.00, CFI of 1.00, and AGFI of 1.00 with a RMSEA and SRMR of 0.043 and 0.0029, respectively. Finally, the IL (SEM 4) had a chi-square value of 2.13 ($\chi^2/\text{df} = 6.41/3$; $p = 0.093$), GFI of 1.00, CFI of 1.00, and AGFI of 0.98 with a RMSEA and SRMR of 0.043 and 0.0026, respectively.

Table 3 The GFI between model components and the empirical data

GFI	Criteria	Measurement
χ^2 -test (Hair et al., 2010; Hu & Bentler, 1999)	< 0.05	0.00
χ^2/df (Hu & Bentler, 1999; Marsh & Hocevar, 1985)	$< 1.00\text{--}5.00$	2.27
GFI (Chau & Hu, 2001; Hair et al., 2010)	≥ 0.95	0.95
AGFI (Kline, 1994)	≥ 0.90	0.92
NFI (Hair et al., 2010)	≥ 0.80	0.99
CFI (Bagozzi & Yi, 1988; Hair et al., 2010)	≥ 0.90	1.00
RMSEA (Brown & Cudeck, 1993; Hair et al., 2010)	< 0.08	0.045
SRMR (Hair et al., 2006)	≤ 0.08	0.020
RMR (Hair et al., 2006)	≤ 0.05	0.021

GFI = goodness of fit; AGFI = adjusted goodness of fit; NFI = Bentler-Bonnett normed fit index; CFI = comparative fit index; RMSEA = root mean square error of approximation; SRMR = standard root mean squared residual; and RMR = root mean residual.

The SEM analysis revealed the direct influence of IT management and TS on IL was 0.05 and 0.25, respectively, whilst the indirect influence of IT management and TS through the mediator variable of IT usage on IL was 0.147 and 0.39, respectively. Thus, the mediator use of IT has an influence on the IL and so the mediator variables were analyzed based on Hypothesis 3 and elaborated as follows:

Table 4 Regression analysis result for mediator

Variable	Model 1	Model 2	Model 3	Model 4
U1 Learning time management				0.147** (0.051)
U2 Data comparison		0.335*** (0.042)	0.270*** (0.045)	0.170** (0.056)
U3 E-mail usage and communications				
U4 Search engines			0.227*** (0.058)	0.219** (0.058)
U5 Internet-based data usage and presentation	0.838*** (0.021)	0.546*** (0.041)	0.392*** (0.056)	0.361** (0.057)
R²	0.838	0.854	0.858	0.860
Adjusted R²	0.702	0.729	0.734	0.737
F-value	1456.37	829.970	569.699	434.343

Note: N = 618; Standard errors are in parentheses. ** and *** represent $p < 0.05$ and $p < 0.01$, respectively.

For the stepwise multiple regression of IT usage that affects the impact factors (Table 4), the following four models were derived:

Model 1 with one factor (U5): U5 Beta of 0.838, R^2 of 0.838; Adjusted R^2 of 0.702; $p = 0.01$.

Model 2 with two factors (U5 and U2): U5 Beta of 0.546 and U2 Beta of 0.335, with the forecast of impact factor against the use of information accounting for R^2 of 0.854, Adjusted R^2 of 0.729, and $p = 0.01$.

Model 3 with three factors (U5, U2, and U4): U5 Beta of 0.392, U2 Beta of 0.270, and U4 Beta of 0.227, with the forecast of impact factor against the use of information accounting for R^2 of 0.858, Adjusted R^2 of 0.734, and $p = 0.01$.

Model 4 with four factors (U5, U4, U2, and U1): U5 Beta of 0.361, U4 Beta of 0.219, U2 Beta of 0.170, and U1 Beta of 0.147 with the forecast of impact factors against the use of information accounting for R^2 of 0.860, Adjusted R^2 of 0.737, and $p = 0.05$.

Factor U5 is the ability to use and present information through the Internet. It is the first integral factor of all the models. The Internet is an important information resource through which we can search for extensive information from anywhere. Many countries, including Thailand, have tried to provide effective internet-based learning. The Internet is the starting port for conveying information, as data exchange via the Internet affects the user's IL (Suwanroj et al., 2019). The ability of IT and Internet users to share newly obtained knowledge with peers and to use social media and present

projects through PowerPoint are increasingly important factors that promote IL (Misirli & Akbulut, 2013). For example, more online classes and lessons (Altbach, 2007), where sharing of user-generated contents through social media forms personal behaviors (Pinheiro, 2017) and the use of social media provides more than interpersonal interactions as it also provides an awareness of digital skills (Ata & Yildirim, 2019). Understanding the relations of people with technology is increasingly important, with positive impacts being contributed by IT usage (Shaw, 2018).

The Internet modernizes our life and helps keep us updated (Tondeur et al., 2011; Weber & Kauffman, 2011). It helps people explore relations and gain new knowledge anywhere at any time. Schools apply the Internet to facilitate access to needed information for students (George et al., 2006). Incorporation of a computer and the Internet facilitate communications and offers an information source that is increasingly vital for education. However, good information must come from a reliable source (Maybee, 2005). It was found that most of the undergraduates at Carnegie Mellon University, USA, preferred libraries and the Internet, as the Internet is an information source that is important to education and a large multimedia source that promotes teaching and learning (George et al., 2006).

Rapid development of digital technology also leads to IL, because the information is regularly received and updated (Ata & Yildirim, 2019). People are often attracted to use ICT to satisfy their curiosity by using an ICT platform through the Internet (Venkatesh et al., 2014). Frequency of information device use is an important variable that urges information processing (Van Deursen & Van Dijk, 2011), resulting in IL.

6. Discussion

This research found that the model corresponded to the empirical data. The causal factor having the highest factor load for IL was IT usage (0.64), followed by TS (0.62) and IT management (0.23).

Incorporating the causal factors of IT usage and TS will result in learners having a greater IL than when using only the causal factor of TS, as teaching by employing several different approaches including the appropriate media and technology; and measurement and evaluation skills can lead to a more effective IT usage.

Also, incorporating the causal factors of IT usage and IT management will also result in learners becoming more information literate than when relying on only IT management, as policy-based IT management helps enhance the teachers' and students' preparedness for effective teaching and learners can always access general and academic information.

By and large, the higher the frequency of IT usage the more affect upon the IL, with the most effect on the level of IL was from daily IT usage, followed by 3–4 times/week, and 1–2 days/week, respectively. The IT usage is a positive factor for IL, while technology literacy and IL are positively correlated. Incorporating IT in classes and IT management are crucial factors that promote the IL of learners (Lorenz et al., 2019).

Incorporating technology with TS was reported to result in learners being more information literate than when relying only on TS (Jinchi & Jie, 2021; Drossel et al., 2017), which corresponds to this study and also to another study where incorporating IT with suitable teaching approaches influenced the perspectives and awareness to promote IL (Šorgo et al., 2017). In addition, incorporating online classes with a flip classroom strategy was found to provide a better IL, while incorporating the use of technology with IT management resulted in a better IL than when relying on only the factor of IT management (Humrickhouse, 2021). Previous research studies have supported that IT management using technological resources will promote a greater learning efficiency, more communication, and greater information exchange (Malik et al., 2018). The provision of ICT resources can lead to a greater IL, while IT management that allows learners to access IT devices or their own IT device positively affects the IL (Šorgo et al., 2017).

The factor of IL is related to the IT competency (Lorenz et al., 2019), corresponding to the factors that promote IL that are in part related to the learners and IT usage. That is, learners are required to be able to effectively manage their learning time (Kingsawat et al., 2015). Pinto et al. (2019) found that the factors promoting IL involve searching-retrieving Internet information, using informal electronic sources, using electronic secondary sources, and disseminating information on the Internet, in accord with Baggia et al. (2016), who specified the factor of IT usage included searching for information, working with office tools, communicating, and the ability to compare information. Likewise, Misirli & Akbulut (2013) specified the ability to compare information discovered from different websites as a factor for IL, while Pinto et al. (2019) included assessing the quality of information, knowing the typology of information sources, and determining whether the information has been updated. Moreover, it was found that the factor of ICT usage is also vital in achieving a higher IL for learners in the 21st century (Moto et al., 2018).

Organized plans covering teaching skills and IT management can result in a better IL among students, allowing them to accept information at will, scope information, analyze needs, and efficiently and effectively access the necessary data. In addition, they will be more aware of the relevant laws, and lawfully and ethically use information (ACRL, 2000). The ACRL Information Literacy Standard consists of five dimensions, including the effective information usage and an understanding of the contexts (Berphan, 2012). At present, information is increasingly growing and so people need to always seek new knowledge and use technology as a tool to solve problems, because IL is increasingly vital in everyday life (Mamak, 2010).

7. Conclusion & Recommendation

The result indicates that the influence of IT use is a factor that supports the causal factors in terms of IT management and TS for IL support.

1) The TS involves taking several teaching approaches, use of suitable media and IT, and evaluation skills, which can promote IL if they are incorporated with IT.

2) Well planned IT management, resources allocation, and skill promotion among teachers lead to the promotion of IL among learners.

These concepts should be used to address a shared vision of teaching and learning with ICT and so underpin the importance of ICT-related collaboration as well as pedagogical reasoning with regards to ICT equipment (Lorenz et al., 2019), as learners can always access information. Therefore, IT usage enhances the opportunities for learners to access more information and use more effective and efficient IL skills. In this regard, the integration of IL based on frameworks, such as ACRL (ACRL, 2000), or other standards, with IT usage to promote IL among students should be considered. The IT management should correspond to the digital environment to enhance IL (ACRL, 2017) and align with the definition of IL in a proper way. Cyber literacy includes the ability to use the internet, communications, and websites (Karpati, 2011; Leahy & Dolan, 2010). Therefore, IL requires all the above factors.

These findings will serve as guidelines for enhancing curricula and improving information technology management in teacher education institutions, thereby fostering the development of information literacy—a critical competency for the twenty-first century.

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