HOW ACADEMIC MAJORS IN NON-STEM AFFECT DIGITAL LITERACY: THE EMPIRICAL STUDY

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Abstract

Digital literacy is important capacity for students' learning in the world of rapid changes in technology. This article aimed to study digital literacy among non-STEM undergraduate students. The study covered the component of 4 skills, i.e., operation skills, thinking skills, collaborative skills, and awareness skills. The hypothesis set in the study was academic major in non-STEM has different digital literacy. When each component was separately studied, digital literacy among non-STEM students should be different as well. The participants in the study were 378 non-STEM undergraduate students of Prince of Songkla University, Surat Thani Campus. The research instrument was digital literacy measurement. Inferential statistics were used in the data analysis to compare two independent groups. The results support hypotheses that the sample in non-STEM undergraduate students with different academic majors had different levels of digital literacy. Students major in a language had higher mean scores than students major in management. When each component was separately studied, students with different academic majors had different levels of digital literacy in each component. Students major in language had higher mean scores than students major in management in all components. This article mentioned an important point about digital literacy of non-STEM undergraduate students so as to be a guideline for stakeholders to determine strategies, set policies and make plans to develop digital skills among non-STEM students, which is highly important to students in the era of rapid changing technology.

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1. Introduction

Digital technology is shaking up the world with disruption challenge to structures and patterns of economic activities, socialization, learning and interaction between individuals (Office of the Education Council, 2020). Digital disruption is a transformation that is caused by emerging digital technologies and business models. Digital innovation contributes to changes in the operations of businesses, especially communication, transport, finance, banking, public health, tourism (Office of the Army Secretary, 2020) or even education that enters into the era of digital education. Thus, human digital skills need to keep

pace with such changes. Meanwhile, every corner of the world has to confront the pandemic of COVID 19 which is the factor accelerating the higher use of technologies. Consequently, possessing digital skills is extremely vital. It is not about individual survival, but also a factor important to propel country economy (Electronic Transactions Development Agency, 2020).

According to statistical data released by the International Institute for Management Development, the IMD World Digital Competitiveness Ranking 2020 report ranked digital competitiveness rankings. Of the 63 participating countries, the top three countries with digital capabilities were found to be the United States, Singapore, and Denmark. Thailand ranked 39th out of all member states and ranked 3rd compared to the five participating ASEAN member states (International Institute for Management Development, 2020). Therefore, Thailand must accelerate the development of people in the country to have the skills ready for today's digital age and rapid change in knowledge, technology development, and along with changes to increase digital competitiveness and drive the country's economy sustainably (Electronic Transactions Development Agency, 2020).

The education sector is therefore an important part of developing people to be digitally intelligent. In education in the 21st century, instructors only play a role in helping guide and design activities, to creating conditions that will allow students to assess their learning progress. There are many forms of education and teaching innovations broken down according to the characteristics of the learner (Dhurakij Pundit University, 2020), and digital literacy is a major driver for today's learners.

Previous studies have found that researchers are currently focused on studying digital literacy with learners in science, technology, engineering, and mathematics (STEM), such as research by Baterna, Mina and Rogayan Jr (2020) studying the digital literacy of STEM learners in two public high schools in Zambales, Philippines. The results showed that STEM students had digital knowledge in terms of accessing and evaluating data, data use and management, media analysis, media product creation, effective technology application, and technological interaction, with significant differences in the scope of student digital literacy when grouped by gender and class. Iroaganachi, Opeke, Babalola and Soyemi (2021) studied the intention of choosing a girl's STEM career path in a country's middle school, Nigeria found that digital literacy skills can greatly influence their willingness to choose STEM career paths.

Besides, researcher gave importance to comparisons studies between students who major in science, technology, engineering, and mathematics (STEM) and students who major in humanities, arts, literature and management (non-STEM). For example, research by Thongsri, Shen and Yukun (2019) conducted a comparison study on digital skills in using mobile devices for language learning among STEM and non-STEM students. The study found that STEM students had higher computer self-efficacy scores and overall satisfaction scores higher than non-STEM students. It was also found that computer self-efficacy affecting efficiency of using mobile devices for language learning in STEM student was higher than in non-STEM students with a statistical significance level.

Based on the literature review, the researcher found a gap in previous research that focused on studying the context of STEM students. However, a study on digital skills of non-STEM students, the context of developing countries like Thailand should not be overlooked. According to the database report of Thai University Central Admission System in 2020, students had a higher tendency to choose non-STEM majors than STEM majors. Academic majors with the highest number of students were non-STEM academic majors. The way universities admitted the highest number of non-STEM stems was due to students' demands (Council of University Presidents of Thailand, 2021). It also reported that careers gaining popularity these days are blogger, YouTuber, streamer or influencer (Chutinun-Sanguanprasit, 2018). Consequently, universities should enhance significant skills, such as digital skill, to non-STEM students to ensure they have capabilities to propel the country accordingly. Therefore, 2 questions in this study consist of:

1. Are there any differences in digital literacy of academic majors in non-STEM?
2. How do academic majors in non-STEM possess digital literacy in practical skills, thinking skills, collaborative skills and self-awareness skills?

This study provides 2 contributions. The first one is it helps fulfill the gaps of previous research focusing on studying digital skills in STEM students. However, students currently are considerably interested in studying non-STEM academic majors. Therefore, this research focuses on an in-depth study on digital skills of non-STEM students in terms of operation skills, thinking skills, collaborative skills, and awareness skills. The second one is this research creates a practice guideline for stakeholders in Ministry of Education, educational institutions or teachers to determine strategies, set policies, make plans for developing digital skills to non-STEM students.

2. Related Theories and Research

2.1. Characteristics of Non-STEM Major

Science, Technology, Engineering, and Mathematics these disciplines are collectively known as STEM. The fields of study on human society include language, communication, history and archeology combined into an interdisciplinary department known as non-STEM. These two are the major disciplines in academics. STEM is about detail-oriented results while non-STEM deals with human thinking and patterns. Non-STEM courses are very broad and general and unlike STEM courses, they do not have precise technicalities to be followed.

In terms of internet and computer usage, the frequency of use by the non-STEM group was once a week, while the frequency of use by the STEM group was daily. In terms of efficiency and skills in digital technology and academic management, the non-STEM group had less efficiency and skills than the STEM group (Das & Bhattacharyya, 2023). This is because most non-STEM subjects are theoretical and contain minimal technical detail in the curriculum. But there are exceptions for Commerce and MBA subjects. In the non-STEM group, there are differences within the group, for example, the management field has more opportunities to use technology and computers than the language field. which depends on different course descriptions. Non-STEM major is diverse and have different focus areas. For instance, management majors focus on business management, HR management, marketing, and accounting. Language majors study the alphabet or language, emphasizing communication and the history and values of the nations that use that language. Humanities major focus on literature, culture, history, philosophy, religion, visual arts, and performing arts.

2.2. The Importance of Digital Literacy for Non-STEM

In the age of Digital Transformation, Digital literacy skills are essential. Some non-STEM departments, such as MBA, Commerce, and Economics, have statistical applications in their syllabus that allow these students to be more technologically proficient than the other non-STEM departments' students (Das & Bhattacharyya, 2023). The importance of digital literacy skills for non-STEM is becoming increasingly apparent as technology continues to envelop daily lives from social interactions, communications, and education, to basic human life, including professional life. Nowadays, communication has significantly developed; people do not communicate through talking like in the past but use technology to communicate more. Studying history or archeology involves searching online for records. The language has developed new words in the modern era. Non-STEM groups should learn to solve fundamental human problems through technology and use digital skills to make their work easier. Digital literacy and the ability to use technology effectively are now considered essential for modern advancement and success. Thus, digital literacy for non-STEM groups will not only help bridge the talent gap. However, it can generate many ideas to create a better, more livable future.

2.3. Digital Literacy

Over the last few decades, technology is changing rapidly and has spread across the globe, connecting people together in a whole new way. As a result, citizens of all countries do not only have to learn to use new technologies, but also to use new technologies. But we also need to learn how to interact with each other. The skills made up of these abilities are combined under the term 'digital literacy'. Digital literacy refers to the ability to use computers as an open and effective tool to collect, create, convert, and use data

securely. This capability covers technical skills in using software and using digital devices, as well as cognition and skills to effectively retrieve, evaluate, and interact with digital data (Lazonder, Walraven, Gijlers & Janssen, 2020). Digital awareness has become the necessary ability to successfully control everyday tasks and routines in the 21 centuries, as technology is everywhere in our daily lives and infiltrates all sectors of society (Jin, Reichert, Cagasan, de la Torre & Law, 2020).

Researchers studying digital literacy used different terms, meanings and competing definitions of these competencies. A possible explanation for this may be a different understanding of researchers coming from different disciplines. However, some researchers recognize that digital literacy is primarily related to technical and operational skills. While others see it as an emphasis on cognitive and social-emotional (Porat, Blau & Barak, 2018), many conceptual frameworks and empirical tests of digital literacy are proposed. Digital literacy has different components in many contexts, but with this research focused on studying the digital literacy of undergraduate non-STEM students in Thailand, in order to conform to the context in which the study of research refers to the digital skills components of undergraduates based on Wawta and Ujsara (2016) research, with digital literacy studies of undergraduate students, who have already researched these four skills that can indicate the digital literacy of undergraduate students. It consists of 4 components. including Operation skills, Thinking skills, Collaboration skills and Awareness skills.

Component 1: Operation skills refer to the ability to perform tasks or use technology for communication and use of digital media both in everyday life and for learning.

Component 2: Thinking skills refer to the ability to think in different ways, providing complex advanced thinking to understand, evaluate and create the use of computer and communication technologies, and digital media.

Component 3: Collaboration skills refers to the ability to collaborate with groups of people in a digital environment, where they may have different backgrounds in ideas, cultures, values or knowledge, but collaborate to accomplish any task or activity, as well as create a group or behave in the role of a group member and share digital information with a group of people.

Component 4: Awareness skill refers to the conduct of computer technology and communication and the use of digital media ethically and legally by recognizing the integrity of society, knowledgeable, understanding, and complying with rules and laws, and being courteous, as well as knowing to protect yourself from the dangers and risks that may arise from the use of computer technology and communications and digital media.

2.4. Related Research

A review of research related to the five years from 2015 to 2020 showed that there was a focus on studying the digital skills of many STEM students (Sulaeman, Efwinda & Aristya-Putra, 2022). As a result, the study of the digital skills of non-STEM students also has interesting gaps and can be filled with this research.

The research then reviewed several previous studies, such as those from Wawta and Ujsara (2016), that found that undergraduates studying in different discipline groups, had statistically significant differences in digital literacy at .05, based on research hypotheses number two. Undergraduates studying in science and technology have higher digital literacy than students studying humanities and social sciences, as well as research by Kanjana (2019) that studied the digital literacy of undergraduates at Walailak University. By comparing exam results between discipline groups, the health sciences group had higher digital literacy than science and technology groups and humanities and social sciences groups. In addition, a study by Pisut, Namtip, Thadthong and Sutthinan (2019) that studied the digital literacy skills of undergraduate students, Rajabhat University, found that students in science and liberal arts groups had statistically significantly higher levels of digital literacy than social sciences at .05.

Research by Jin et al. (2020) research that developed appropriate tests for measuring digital literacy performance across different ages using data from three age groups (one from primary school and two from secondary schools). The results showed that secondary school students received higher levels of digital literacy compared to primary school students, and found gender gaps in digital literacy among secondary school students. A study by Apiola, Lokkila and Laakso (2019) studied digital learning practices in intermediate computer science courses from a sample of 141 people studied at the University of Turku, Finland, which found that time was used differently based on different grades.

According to the review of relevant literature, a tendency of research studies on today's digital literacy is learned. Nevertheless, previous research studies were not conducted on in-depth study of digital skills of non-STEM students in terms of practical skills, thinking skills, collaborative skills, and awareness skills. This research possibly has a positive effect on stakeholders to gain benefits for strategy design and policy setting to develop digital skills among non-STEM students, enabling to reduce a gap of digital skills between STEM and non-STEM students more or less.

3. Research Conceptual Framework

Based on the previous literature review, a conceptual framework was structured to focus on the study of digital literacy among non-STEM groups as shown in Figure 1 and 5 research hypotheses were established as follows:
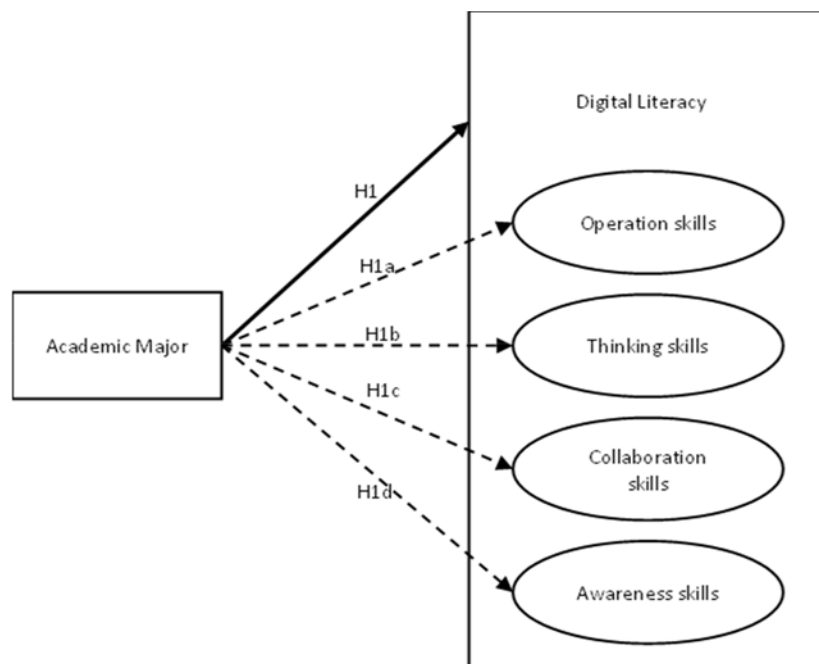

Figure 1. Research model

Hypothesis 1 (H1): Non-STEM students with different academic majors have different levels of digital literacy.

Hypothesis 1a (H1a): Non-STEM students with different academic majors have different levels of digital literacy in terms of operation skills.

Hypothesis 1b (H1b): Non-STEM students with different academic majors have different levels of digital literacy in terms of thinking skills.

Hypothesis 1c (H1c): Non-STEM students with different academic majors have different levels of digital literacy in terms of collaboration skills.

Hypothesis 1d (H1d): Non-STEM students with different academic majors have different levels of digital literacy in terms of awareness skills.

4. Methodology of Research

According the research objective that aimed to investigate levels of digital literacy of non-STEM undergraduate students, an empirical study design was use starting from studying theories, setting hypotheses, conducting a survey, collecting data, and testing hypotheses. The procedural of the study is shown in Figure 2 and details of how to conduct the study are shown below:
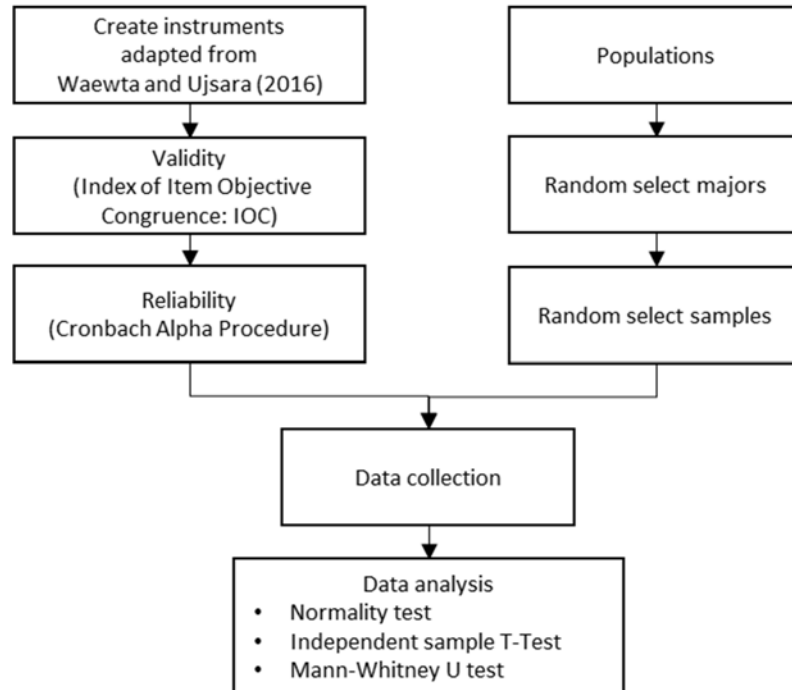
Figure 2. The procedural of the study

4.1. Population and Sample

Population in the study was 1,942 non-STEM undergraduate students of Prince of Songkla University Surat Thani Campus for the 2021 academic year (https://reg.surat.psu.ac.th/stdsum_index.php). Two-stage sampling method was used to select the sample. The first step is randomly selecting academic majors; language and management majors were obtained. The second step is randomly selecting the sample from the name list obtained from the first step. The sample consists of 320 students. The sample size was determined using Krejcie and Morgan table (Krejcie & Morgan, 1970).

4.2. Research Instrument

Digital literacy scale for undergraduate students was used, based on the research of Waewta and Ujsara (2016) The scale is divided into 2 parts as follows:

Part 1: General information: gender, faculty, academic major, and equipment used.

Part 2: 40-item digital Literacy scale by selecting the level of knowledge or practice.

Component 1: Operation skills consists of three indicators:

1. Cognition refers to understanding information and communication technology and digital media, which can be discriminated against in an appropriate way to use technology for various situations and to distinguish which subjects can use automated work technology.

2. Invention refers to the ability to integrate and apply information and communication technology and digital media to create new work, knowledge or innovation.

3. Presentation refers to the ability to present digital information in a variety of ways, with the option to effectively present the right format for the target audience and results.

Component 2: Thinking skills consists of three indicators:

1. Analysis refers to the ability to consider, discriminate, interpret, find relationships of key components in digital information. It is organized in various ways, such as sorting, categorizing, categorizing, sorting, and categorizing. Calculate statistics, etc.

2. Evaluation refers to the ability to determine the value of digital information as to which information is related to the need for exploitation, accuracy, and trustworthy, as well as misinformation/disinformation, propaganda, and hate speech.

3. Creativity refers to the interest in thinking or solving problems or answering a particular question in a variety of ways, flexible and positive thinking, leading to inventions that are exotic and beneficial to the public.

Component 3: Collaboration skills consisting of three indicators:

1. Teamwork refers to the ability to use information and communication technology and digital media to collaborate with others by cooperating with groups of either leadership or follower roles and using their full potential to work together to achieve the group's goals.

2. Networking means the ability to create and become a member of various online networks to build relationships and contribute to mutual benefits.

3. Sharing means the ability to share digital information through the technology of the preacher and communication in the appropriate form and channels, taking into account valuable and useful information to the recipient.

Component 4: Awareness skill consisting of three indicators:

1. Ethics refers to be aware of what to do through digital media, correct and courteous to use netiquette, as well as respect the differences and inequality of societies in the use of information and communication technology and digital media.

2. Legal literacy refers to knowledge, understanding, and practice of laws and regulations relating to the use and access of information, media, and digital devices.

3. Safeguarding self means being aware of the dangers that may occur to yourself on the Internet, preventing potential risks, and being able to manage their personal information to be safe.

Items in the survey instrument followed a five-point Likert scale format. The content validity of the research tools was assessed using the Index of Item Objective Congruence (IOC) analysis, with IOC values ranging from 0.60 to 1.00. The opinions of five experts were considered in this assessment. The try-out of the aforementioned scale was conducted with 35 non-sample undergraduate students. The reliability was determined by considering Cronbach's alpha coefficient. Each component of items had acceptable reliability values, i.e., component 1: operation skills = .861, component 2, thinking skills = .869, component 3, collaborative Skills = .775, and component 4, self-awareness skills = .890. Therefore, the scale can be used to collect data.

4.3. Data Collection

Data were collected in the form of online data collection. Before data were collected, the research objective and relevant details were explained including the attachment of "the letter of consent for

research participation". If respondents agree, a measurement form will be filled up and submitted. If respondents disagree, a measurement form will not be filled up. Online measurement form is created and QR code is distributed to the target sample of 350 persons. Completeness of answering to questions is examined. Incomplete measurement forms are excluded, and 219 complete measurement forms are obtained.

4.4. Data Analysis

First, the data normality was tested with the Kolmogórov-Smirnov test. The results are as shown in Table 1. For normally distributed data, the independent sample T-Test method was used to compare digital literacy skills between academic majors, and the Mann-Whitney U test was used for non-normally distributed data. The 0.05 significant level was applied. The data analysis was conducted using the SPSS software.

Data	Academic majors	Kolmogórov-Smirnov test		Normally Distributed
		statistic	*p*-value	
Digital Literacy	Language	0.051	0.200	Yes
	Management	0.070	0.200	Yes
Operation skills	Language	0.068	0.200	Yes
	Management	0.079	0.200	Yes
Thinking skills	Language	0.074	0.073	Yes
	Management	0.081	0.200	Yes
Collaboration skills	Language	0.087	0.014	No
	Management	0.087	0.152	Yes
Awareness skills	Language	0.200	0.000	No
	Management	0.139	0.000	No

Table 1. Normality test of data

5. Data Analysis and Results

5.1. The Results of Comparison of Group Variables with Digital Literacy

From data analysis results, the independent sample t-test was used to test digital literacy between students with 2 academic majors. For H1, the descriptive and hypothesis testing results are shown in Table 2. Table 1 shows that the average scores of digital literacies of students with language major and students with management major were 4.25 and 3.98 respectively. According to hypothesis testing results, the average scores of digital literacies of students from both academic majors were different with statistical significance. (t = 3.74, p < 0.001). Thus, H1 is supported.

Academic majors	Descriptive statistics				Hypothesis Testing	
	n	Mean	SD	SE	t-statistic	p
Language major	133	4.25	0.429	0.037	3.74	<0.001
Management major	86	3.98	0.575	0.062		

Table 2. Digital literacy (Descriptive Statistics and Hypothesis Testing Result between two groups)

5.2. Comparison Results Between Variables in the Academic Majors and the 4 Components of Digital Literacy Were Operation Skills, Thinking Skills, Collaborative Skills, and Awareness Skills.

5.2.1. Academic Majors and Operation Skill Digital Literacy

Comparison analysis results of the average scores between student with language major and management major are shown in Table 3. From Table 3, the average operation skills score of students with language major was 3.97 higher than the average operation skills score of students with management major, 3.63

and according to hypothesis testing result, it is greater with statistical significantly (t = 4.05, p < 0.001). Thus, H1a is supported.

Academic majors	Descriptive statistics				Hypothesis Testing	
	n	Mean	SD	SE	t-statistic	p
Language major	133	3.97	0.559	0.048	4.05	<0.001
Management major	86	3.63	0.677	0.073		

Table 3. Operation skills (Descriptive Statistics and Hypothesis Testing Result between two groups)

5.2.2. Academic Major and Thinking Skill Digital Literacy

Digital learning score comparison analysis results in thinking skills between students with language major and students with management major are shown in Table 4. The results showed that the average thinking skills scores of students with language major and students with management major were 4.18 and 4.00 respectively. Hypothesis testing using t-test found the average thinking skills score of students with language major is significantly greater than the average thinking skills score of students with management major at the significance level of 0.05. (t = 2.19, p = 0.015). Thus, H1b is supported.

Academic majors	Descriptive statistics				Hypothesis Testing	
	n	Mean	SD	SE	t-statistic	p
Language major	133	4.18	0.563	0.049	2.19	0.015
Management major	86	4.00	0.635	0.068		

Table 4. Thinking skills (Descriptive Statistics and Hypothesis Testing Result between two groups)

5.2.3. Academic Major and Collaborative Skills Digital Literacy

Comparison analysis results of collaborative skills of students from both groups are shown in Table 5. From Table 5, the average collaborative skills scores of students with language major and students with management major were 4.32 and 4.03 with the median 4.25 and 4.12 respectively. Hypothesis testing using the Mann-Whitney U test found that students in different majors had significantly different scores in collaborative skill (p=0.003). The result show that the average collaborative skills score of students with language major was greater than the average collaborative skills score of students with management major. Thus, H1c is supported.

Academic majors	Descriptive statistics			Hypothesis Testing	
	n	Mean	Median	SD	U	p
Language major	133	4.32	4.25	0.507	4378.50	0.003
Management major	86	4.03	4.12	0.685		

Table 5. Collaborative skills (Descriptive Statistics and Hypothesis Testing Result between two groups)

5.2.4. Academic Major and Awareness Skills Digital Literacy

Digital literacy scores in awareness skills of students with language major and students with management major were collected and analyzed. Results are shown in Table 6. Data analysis results found that awareness skills average scores of students with language major and students with management major were 4.55 and 4.27, and the median are 4.69 and 4.42 respectively. According to the comparison of the central tendency scores using the Mann-Whitney U test, students in different majors had significantly different scores (p = 0.002), which language major had the higher average awareness skills score than students with management major. Thus, H1d is supported.

Academic majors	Descriptive statistics				Hypothesis Testing	
	n	Mean	Median	SD	U	p
Language major	133	4.55	4.69	0.486	4286.00	0.002
Management major	86	4.27	4.42	0.659		

Table 6. Awareness skills (Descriptive Statistics and Hypothesis Testing Result between two groups)

6. Discussion

Based on the analysis results of digital literacy of non-STEM students, it was found that students with different academic majors had different levels of digital literacy in accordance with the hypothesis 1. The analysis results could answer the 1st research question that different academic majors in non-STEM had different levels of digital literacy, which was different from previous studies (Wawta & Ujsara, 2016; Kanjana, 2019; Pisut et al., 2019) most likely conducted on the comparison between STEM and non-STEM and found that STEM students had higher digital literacy skills than non-STEM students. This study shows that non-STEM students have different digital literacy within the group as well as students with language major have higher digital literacy than students with management major. In addition, the analysis results divided by components, i.e., operation skills, thinking skills, collaborative skills, and awareness skills of non-STEM students, found the average scores between students with language major and students with management major were different with statistical significance in accordance with the hypothesis 1a-1d. Students with language major had higher average scores than students with management major in all components. As most digital technologies are international instruments; therefore, the language used is also international language, enabling students with language majors are more advantageous in learning and utilizing digital technology (Hafner, Chik & Jones, 2015) which could answer the 2nd research question that non-STEM students with different academic majors have different levels of digital literacy in operation skills, thinking skills, collaborative skills, and awareness skills. Comparing the results with previous studies using the same instrument (Wavata & Ujsara, 2016), the values obtained for each skill were higher than in previous studies. Due to changing times and situations such as Covid-19, technology has been used progressively.

Research results can also be explained by a different curriculum focus. The management major focuses on business management, HR management, marketing, and accounting. Therefore, students in this field will learn and use a variety of management tools to support business operations. These tools are designed to be user-friendly and compatible with the needs and preferences of modern users, enabling them to implement these tools swiftly and effectively. The language major, on the other hand, focuses on communication skills, grammar skills (listening, speaking, reading, writing), and subject-specific skills including literature, language, and culture, which are often more relevant to humans than technology. As a result, the language major generally has fewer digital skills in comparison to the management major.

7. Conclusion

This research aimed to study digital literacy of non-STEM undergraduate students of Prince of Songkla University Surat Thani Campus in response to 2 research questions. The findings from the study could respond to the 1st research question that non-STEM students with different academic majors have different levels of digital literacy. Students with language major have higher average scores than students with management major. With regard to the 2nd research questions, the digital literacy analysis results separated by each component found students with different academic majors have different levels of digital literacy in operation skills, thinking skills, collaborative skills, and awareness skills as students with language major have higher levels of digital literacy than students with management major in every component.

Moreover, the research provides 2 contributions; the first one is it helps fulfill the gaps of previous research since an in-depth study was conducted among non-STEM students, digital literacy was studied by separating 4 components, i.e., operation skills, thinking skills, collaborative skills, and awareness skills. The study results indicated factors affecting different levels of digital literacy among students, namely,

academic majors, since students in each group have different preference and aptitude, encouraging them to have different levels of digital literacy. The second contribution is the study results shall be highly beneficial for generating a practice guideline for stakeholders to make plans and design strategies for developing digital literacy among non-STEM students. Awareness of differences among students should be raised according to their aptitudes and academic majors to ensure students have better digital literacy skills and preparedness for learning in the 21st century.

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