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Model of Sustainable Collaborative Network for Educating Digital Literacy: A Case Study of Schools in the Sub-districts of Nakhon Pathom Province, Thailand

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Abstract

This study aimed to investigate the need for digital literacy for teachers in schools in the sub-districts of Nakhon Pathom Province; to design a model of teacher digital literacy development and create a model of a sustainable collaborative network for educating digital literacy in schools in the sub-districts of Nakhon Pathom Province, Thailand. The research was action research. The samples were teachers from schools in the sub-districts of Nakhon Pathom Province; by selecting schools from the Office of Nakhon Pathom Primary Education Service Area Office 2, 32 teachers from Phutthamonthon District, Bang Len District, Nakhon Chai Si District, and Sampran District. The findings indicated that the digital literacy needs assessment of teachers, based on the application of OCSC (2020) digital literacy framework, suggested that the highest $PNI_{modified}$ score was 0.492 for Using Digital Media Creation Software, whereas the lowest $PNI_{modified}$ score was 0.205 for Using the Internet. The model of a sustainable collaborative network for educating digital literacy in schools in the sub-districts of Nakhon Pathom Province is developed based on the system theory and education philosophy as core principles. The model consists of 4 main components such as 1) education philosophy; 2) input from external driving forces, organization factors, operation factors, and teachers' factors; 3) processing factor in developing digital learning management skills and building a sustainable collaborative network; and 4) output of students, teachers, school administrators and schools.
Keywords: sustainable collaborative network, educating digital literacy, quality schools

Introduction

Digital technology has advanced significantly, making life more comfortable than ever before. These advancements extend beyond robotics, artificial intelligence engineering, data science, and biotechnology; they've also positively impacted health science, medical technology, education, sports science, and agriculture. In education, quality education is one of the components of the United Nations' Sustainable Development Agenda for 2030. It aims to ensure inclusive and equitable quality

education for all, and requires emerging digital technologies as vital tools (Haleem et al., 2022). However, for humans to create and exploit these technologies successfully and efficiently, they need to be equipped with digital literacy to advance accurately, securely, and ethically. It is accurate to say that digital literacy has become a life skill or a key competence (Telecentre Europe, 2014). In particular, teachers play a vital role in preparing learners, especially children and young generations, to become accomplished citizens in a digital society. As a matter of fact, teachers themselves need proficient digital literacy skills to pass on their knowledge and foster sustainable development in learners. These skills help meet learning outcomes, ensures readiness for a highly competitive job market, and foster lifelong learning, equipping individuals to independently seek new knowledge.

Moreover, the COVID-19 pandemic has drastically prompted the global community to transform into a new and unfamiliar way of life, accelerating the immediate adoption of digital technology beyond anyone's expectation. All school-age and working-age citizens, regardless of their readiness, inevitably needed to rapidly train and develop their digital literacy to keep up with their studies and work professionally. In particular, teachers, who are educational professionals at the heart of the human resource development process, needed to urgently enhance their digital understanding and practice using various online support tools, especially for teaching and learning, in forms of upskilling or reskilling. Otherwise, they could not continue their duties and would feel left behind. This new mode of living and working has persistently continued into the post-COVID-19 era, when everyone has become so accustomed to studying and working remotely that not everyone would like to return to their routine onsite. This shift has steadily grown from the new normal to the next normal. Consequently, it is undeniable that digital literacy has become a necessity and an important factor in everyone life, predominantly for study and work, in the digital age. Furthermore, the World Economic Forum now regards digital literacy as a crucial life skill in the 21st-century toolbox (Yottabyte, 2023).

One of the characteristics of a quality school is having quality teachers. These educators need to develop their methods for sustainable student learning. However, studies on teacher competencies in Thai contexts have found that teachers still lack numerous capabilities. These include not only advanced knowledge and understanding of the teaching and learning process, but also attitudes and skills in planning and learning design, facilitating learning activities, using digital media and innovation for learning, measuring and evaluating of learning outcomes, managing classrooms, and demonstrating learning leadership (Youngtrong, 2016; Sriwongrat & Chanruechai, 2017). In addition, these studies found that teachers still tend to rely on traditional teaching and learning management methods. This could be due to several reasons, such as a lack of knowledge and understanding, and/or negative attitudes towards active learning approaches. For instance, they might regard such learning methods as complex, beyond their abilities, or impractical for actual classroom implementation (Chomcheun, 2016; Sripanya & Namwan, 2017). In terms of students during the COVID-19 pandemic, there have been several problems and obstacles to their learning. These include limited student-teacher interaction, inadequate ICT infrastructure and computer access, unstable internet connectivity, inappropriate home learning environments, lack of concentration, insufficient feedback from the teacher, poor self-discipline, and social isolation (Aroonsrimarakot et al., 2022).

Networking in education is the process of creating social connections among individuals, groups, or organizations with similar objectives to communicate or

exchange knowledge, skills, or resources. Although professional development, including the acquisition of digital literacy, has traditionally been undertaken on an individual basis, the concept of collaboration and networking in education has received substantial attention in research (Mujis et al., 2011) and has been integrated into professional development as well. The fact that networking in education is encouraged to promote sustainability (Rauch, 2016) has gained wide recognition. It not only provides spaces for exchange, but also helps manage conflicts between differing interests (Rauch, 2016), and minimizes redundant training. Some projects or training programs in Thailand, for instance, have not been sustained. After the completion of these projects, the target groups or trainees who participated in the training programs often find themselves unable to continue implementing the learned skills by themselves. The implementation often halts after the projects are completed or when there is a lack of funding support. Therefore, this study aims to sustain the teachers' collaborative network, facilitating the education of students' digital literacy, mutual support in enhancing digital knowledge and skills, and resource sharing for digital learning.

Consequently, this research aimed to investigate the need for digital literacy among teachers in schools within the sub-districts of Nakhon Pathom Province; to design a model of teacher digital literacy development, and create a model of a sustainable collaborative network for educating digital literacy in schools in the sub-districts of Nakhon Pathom Province.

Literature Review: The Concept of Digital Literacy and the Office of the Civil Service Commission of Thailand Digital Literacy Framework

The European Commission (2008) characterized digital literacy as crucial skills, encompassing fundamental ICT and computer competencies for retrieving, creating, storing, presenting, assessing, and exchanging information, in addition to communication and participation in online collaborative networks. Furthermore, the Royal Society of England (2012) described it as the confidence, safety, efficiency, and effectiveness in using computers, including proficiency in office software, e-mail, and presentation software, creation and editing of images, audio, and video, and using web browsers, search engines, and other internet tools.

In Thailand, digital literacy (DL) is understood as the capacity to comprehend and utilize digital media and technologies creatively, promptly, and securely (Office of the Education Council, 2019). The Office of the Civil Service Commission (OCSC) (2020) defines it as the competencies needed for understanding and using readily accessible tools, equipment, and digital technologies like computers, phones, tablets, software, and online media, maximizing benefits for studying, routine and strategic work processes, communications, and collaborative work. This encompasses four dimensions: use, understand, create, and effectively apply digital technologies. The OCSC framework, termed the OCSC Digital Literacy Framework in this study, spans nine aspects: Using Computers, Using the Internet, Using Computers/Devices Securely, Using Presentation Software, Using Word Processing Software, Using Spreadsheet Software, Using Digital Media Creation Software, Collaborative Working Online, and Using Digital Media Securely.

The Concept of Learners' Online Lessons Learning Process

The use of online media in class

The internet provides numerous tools and applications that teachers can utilize at no cost. These tools can be selected based on the users' specific needs, such as facilitating interactive learning or assessing cognitive abilities. Examples of effective web-based tools for classroom use encompass text and image-sharing platforms, video resources, presentation tools, storytelling aids, and Learning Management Systems (Bower & Torrington, 2020).

The learners' online lessons learning process

Online learning, or e-learning, represents an educational innovation that transforms traditional methods of learning by utilizing advanced technology such as the internet, intranet, extranet, satellite broadcasts, and virtual classrooms. These platforms all share a common element: communication technology acting as a medium for learning. Leveraging Internet technologies facilitates interactive, high-quality education that's accessible to people globally without geographic or temporal limitations. Hence, online learning significantly contributes to making lifelong education accessible to everyone (Pamfilie et al., 2012).

According to Yazid et al. (2021), e-learning is a form of learning driven by technology. It encompasses a wide array of learning methods including Computer-Based Learning, Web-Based Learning, Virtual Classrooms, and Digital Collaboration. These learning modes leverage various electronic media such as the Internet, intranet, extranet, satellite broadcasts, audio/video tapes, interactive TV, and CD-ROMs, allowing learners to engage with their education in flexible, diverse ways.

Online learning or e-learning consists of four key components: 1) lesson content; 2) a learning management system; 3) communication, and 4) examination and assessment. A learning management system acts as a center to determine the order of the content in the lesson, deliver lessons through computer networks to learners, evaluate the success of lessons, and supervise and support all services provided to students. This system, known as an e-Learning Management System or LMS, is considered a crucial element of e-learning. What distinguishes e-learning from other distance learning methods is its adoption of a two-way communication format used in learning that increases learners' interest and alertness toward the lesson. This format is a tool that helps learners contact, inquire, discuss, and exchange ideas between learners and teachers. Communication can be categorise into two types: Real-Time categories, such as Chat (Message, Voice), White Board/Text Slide, Real-Time Annotations, Interactive Poll, Conferencing, and Non-Real-Time types, such as Web-Board, e-mail. The fourth component, examination, and assessment, evaluates learners' performance and comprehension (Bradley, 2021).

The Concept of Sustainable Goals 4 and Digital Literacy

The concept of sustainable development, adopted by all United Nations member states in 2015, provides a shared action blueprint for all developed and developing countries with 17 sustainable development goals (SDGs) that are to be achieved by 2030. These goals aim to reduce poverty and deprivations, improve health and education, reduce inequality, stimulate economic growth, and address concerns about

climate change, including water, energy, climate, oceans, urbanization, transport, science, and technology. This study adopts the concept of Sustainable Goals 4 (Quality Education) which aims to ensure inclusive and equitable quality education and promote lifelong learning opportunities for all. Goal 4.2 aimed to ensure by 2030 that all girls and boys have access to quality early childhood development, care, and pre-primary education, so they are ready for primary education. Goal 4.4 seeks to substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs, and entrepreneurship by 2030. Goal 4.A proposes to build and upgrade education facilities that are child, disability, and gender-sensitive and provide safe, nonviolent, inclusive, and effective learning environments for all. Lastly, Goal 4.C aims to substantially increase the supply of qualified teachers by 2030 through international cooperation for teacher training in developing countries, especially least developed countries and small island developing states (United Nations, 2023).

As the COVID-19 pandemic has impacted global education systems, schools, colleges, and universities worldwide were closed to control COVID-19. School closures varied both in terms of length and timing. In some countries, these closures disrupted the end of a school year, while in others, they delayed the start of the school year, or still in others, they coincided with a previously scheduled break. It is clear that school closure brought difficulty to schools, teachers, and especially students, who experienced decreased learning opportunities. To continue teaching and learning, online or digital learning became a mainstream distance learning method used as an urgent solution to solve school closure problem. Many countries have been implementing remote education programs. However, many children from poorer households cannot access the Internet or did not have devices such as computers, TVs, or even radios at home. More than 1 billion children are at risk of falling behind due to school closures. Students lacking access to the technologies needed for home-based learning have limited means to continue their education. Some students faced the risk of never returning to school, undoing years of progress made in education around the world (Tadesse & Muluye, 2020; UNESCO, 2023; World Economic Forum, 2020).

Research Methodology

The study for the first research objective employed a quantitative research methodology using both an online and paper questionnaire.

The digital needs assessment questionnaire consisted of 2 parts. Part 1 included questions regarding personal information such as gender, age, education level, teaching experience, work position, and subjects or groups of subjects taught. Part 2 is the needs assessment consisting of 36 questions in 9 dimensions. It was synthesized from the OCSC Digital Literacy Framework. Each dimension had 4 items, and a 5-point Likert scale was used to assess teachers' digital literacy needs. Table 1 presents the new descriptions of each of the OCSC digital literacy dimensions proposed in this study.

Table 1

9 Dimensions of Digital Literacy in this Study and their Description

9 Dimensions of the OCSC Digital Literacy Framework	Description
1. Using Computers	1.1 Ability to use computers.
	1.2 Ability to understand how computer functions.
	1.3 Ability to use computers to create various tasks.
	1.4 Ability to use computers to apply in digital education.
2. Using the Internet	2.1 Ability to use the Internet.
	2.2 Ability to understand how the Internet works.
	2.3 Ability to use the Internet to create various tasks.
	2.4 Ability to apply the Internet to digital education.
3. Using Computers/ Devices for Security	3.1 Ability to configure basic security for computers/devices
	3.2 Ability to understand how to configure additional security functionalities for computers, Internet, and office programs.
	3.3 Ability to choose, buy and install accessories for security of computers and the Internet.
	3.4 Ability to apply security to digital education and teach students.
4. Using Presentation Software	4.1 Ability to use common presentation software to perform basic functions (i.e., open; close; create; save; edit; delete; insert tables, objects, audio, and video).
	4.2 Ability to understand how presentation software operates.
	4.3 Ability to use presentation software in creation of intermediate tasks (i.e., add and save audio and video, insert slide background music, insert narration on each slide, set up and manage transitions and animations).
	4.4 Ability to apply presentation software to digital education (i.e., creation of advanced tasks such as storyboarding, prototyping, creating educational games).
5. Using Word Processing Software	5.1 Ability to use common word processing software to perform basic functions (i.e., open, close; create; save; edit; delete; insert text, page numbers, images, and footer, and header).
	5.2 Ability to understand how word processing software works.
	5.3 Ability to use word processing software in creation of intermediate tasks (i.e., manage documents and templates, advanced editing and formatting features, creating custom elements).
	5.4 Ability to apply word processing software to digital education (i.e., creation of advanced tasks such as report, curriculum vitae (CV), brochure and infographic).
6. Using Spreadsheet Software	6.1 Ability to use common spreadsheet software to perform basic functions (i.e., open, close; create; save; edit; delete; calculate, apply formulas, and create graphs).

9 Dimensions of the OCSC Digital Literacy Framework	Description
	6.2 Ability to understand how spreadsheet software performs its tasks.
	6.3 Ability to use spreadsheet software in creation of intermediate tasks (i.e., format data, conditional formatting, searching for data, analysing data with What-If, analysing statistical data managing data using Pivot Tables and Pivot Charts, data analytics).
	6.4 Ability to apply spreadsheet software to digital education (i.e., creation of advanced tasks such as creating a worksheet/workbook for each class; creating forms for filling out information and collecting information; separating worksheets for recording the history of individual students).
7. Using Digital Media Creation Software	7.1 Ability to use common digital media creation software to perform basic functions (i.e., create, save, edit, delete).
	7.2 Ability to understand how digital media creation software runs.
	7.3 Ability to use digital media creation in creation of intermediate tasks (i.e., creating e-books, videos, games, posters, and infographics; editing photos; designing websites using templates).
	7.4 Ability to apply digital media creation software to digital education (i.e., creation of advanced tasks such as creating online lessons for teaching and learning and disseminating).
8. Collaborative Working Online	8.1 Ability to use digital technology to submit work for online collaboration.
	8.2 Ability to understand how to use social media and social network websites for online collaboration.
	8.3 Ability to post comments on web or social networking applications.
	8.4 Ability to apply the concept of collaborative working online to digital education (i.e., using collaboration software such as Google Docs, Google Sheets, Google Slides, Google Forms, Google Classroom; and video conferencing software such as Zoom, Webex, Teams, Meet, etc.)
9. Using Digital Media Securely	9.1 Ability to use digital media creatively according to the design thinking concept.
	9.2 Ability to understand how to use digital technology wisely and safely.
	9.3 Ability to create, retrieve, track, and examine the validity and reliability of digital media.
	9.4 Ability to use digital technologies, programs, or applications and apply them to promote and manage digital education safely and securely.

The digital needs assessment questionnaire was initially analyzed using descriptive statistics. Subsequently, the PNI$_{modified}$ formula (Wongwanich, 2007, cited in Wongwanich, 2019) was applied to prioritize the digital literacy needs of teachers.

$$PNI_{modified} = (I - D) / D$$

when   I (Importance)   =   The mean of what should be (expectation)
   D (Degree of Success) =   The mean of what is (authenticity)

The PNI$_{modified}$ describes the difference between what is today and what it should be tomorrow. It can therefore be used to prioritise needs. When the PNI$_{modified}$ score is a value of 0.30 or higher, that need is considered to be an urgent need (Phaichit et al., 2019). The needs are prioritised in descending order, where the need with a higher PNI$_{modified}$ score indicates the precedence over the one with a lower PNI$_{modified}$ score.

For the second objective, the development of digital literacy potential, the sample group identified the following essential needs for skill development: 1) Using Digital Media Creation Software, 2) Using Spreadsheet Software, and 3) Using Digital Media Securely. Hence, the research project organized a forum to brainstorm ideas for creating appropriate media. The research team conducted a workshop introducing necessary programs and teaching participants how to use tools for creating online lessons.

The research team jointly designed activities based on the needs of developing digital skills that the participants wanted. They wanted to improve their skills in using the ZOOM, Cloud Meeting, and the PowToon animation program with activities as follows:

1. Conduct a training workshop on the use of the online meeting program ZOOM and Cloud Meeting, providing thorough instruction on the user interface and essential tools for the program.
2. Prepare information before creating an animated lesson, such as developing a storyboard, scripting, organizing course content, and more, as outline in Figure 1.

Figure 1
Steps for Creating an Animated Lesson Using PowToon
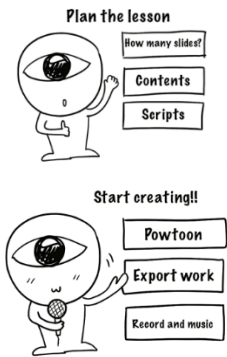
3. Provide training on creating animated lessons using the PowToon online program, with an emphasis on utilizing essential tools.
4. Group schools by district for collaborative lesson design and preparation of key information needed to create animated lessons.
5. Each school group creates animated lessons with PowToon and related software such as video editing programs and e-book creation tools.
6. Establish a forum and collaborative space during the workshop to facilitate resource sharing, strengthen network relationships, and encourage common goal achievement.

The third research objective utilized a qualitative approach to develop a model of a sustainable collaborative network for educating digital literacy. Documentary research and focus group discussion were employed to construct this model of a sustainable collaborative network for educating digital literacy in schools in the sub-districts of Nakhon Pathom Province based on the results from the digital literacy needs and the teacher digital literacy development model. The key informants were 32 teachers from schools in the sub-districts of Nakhon Pathom Province, who attended the workshop for this study. During the focus group discussions, teachers were encouraged to discuss and share strategies to sustain the collaborative network for educating digital literacy; ways to share knowledge, learning resources, and resources for creating an online learning program, as well as identifying needs for support from the government, school administrators, or research team. Content analysis was employed to analyse the data from the focus group discussions.

Research Findings

The findings of the studies are presented as follows.
The findings of the need for digital literacy for teachers in schools in the sub-districts of Nakhon Pathom Province
The general information of 32 respondents was summarized based on gender, age, education level, teaching experience, work position, and subjects or groups of subjects taught .The results found that there were more female teachers (68.75%) than male teachers (31.25%), with an average age of 36 years. Most respondents graduated with a bachelor's degree (59.37%), with an average teaching experience of 8 years. Most of them were at the practitioner level (31.25%), followed by assistant teachers (21.87%). Additionally, each teacher taught more than one subject group.

Regarding the needs assessment, the findings were summarised by category and by items. The category (dimension) or item with a higher PNI $_{modified}$ score indicated that the teachers had higher needs in that dimension or item than those with a lower PNI $_{modified}$ score. By category, it was found that the highest need for digital literacy education among teachers was for *Using Digital Media Creation Software* (PNI $_{modified}$ = 0.492), followed by the need for *Using Spreadsheet Software* (PNI $_{modified}$ = 0.386) and *Using Digital Media Securely* (PNI $_{modified}$ = 0.360), all of which are categorised as urgent needs, as the PNI $_{modified}$ score were greater than 0.300. Table 2 exhibits the overall needs assessment for teacher digital literacy.

Table 2

Overall Needs of Digital Literacy for Teachers

Dimension	Expected Situation (I) Mean	Current Situation (D) Mean	PNI modified = (I-D)/D	Rank
1. Using Computers	4.63	3.80	0.218	8
2. Using the Internet	4.66	3.87	0.205	9
3. Using Computers/Devices for Security	4.62	3.43	0.346	4
4. Using Presentation Software	4.73	3.86	0.224	7
5. Using Word Processing Software	4.73	3.66	0.291	6
6. Using Spreadsheet Software	4.67	3.37	0.386	2
7. Using Digital Media Creation Software	4.64	3.11	0.492	1
8. Collaborative Working Online	4.72	3.59	0.314	5
9. Using Digital Media Securely	4.73	3.48	0.360	3

Considering individual items, there were 36 items in total across the nine dimensions. The findings revealed that the three items with the highest PNI modified scores belonged to the dimensions of *Using Digital Media Creation Software*, *Using Spreadsheet Software*, and *Using Digital Media Securely*, respectively, as detailed in Table 3

Table 3

The Top 10 Items with the Highest PNI modified Scores

Rank	Item	Dimen-sions	Mean of I	Mean of D	PNI modified Scores
1	Ability to apply digital media creation software to digital education (i.e., creation of advanced tasks such as creating online lessons for teaching and learning and disseminating) (7.4)	7	4.63	2.91	0.591

Rank	Item	Dimen-sions	Mean of I	Mean of D	PNI modified Scores
2	Ability to use digital media creation in creation of intermediate tasks (i.e., creating e-books, videos, games, posters, and infographics; editing photos; designing websites using templates) (7.3)	7	4.66	3.09	0.508
3	Ability to use spreadsheet software in creation of intermediate tasks (i.e., format data, conditional formatting, searching for data, analysing data with What-If, analysing statistical data, managing data using Pivot Tables, and Pivot Chart, data analytics) (6.3).	6	4.59	3.06	0.500
4	Ability to understand how digital media authoring software works (7.2)	7	4.59	3.13	0.466
5	Ability to choose to buy and install devices/accessories for securing computers and Internet devices (3.3)	3	4.63	3.19	0.451
6	Ability to use word processing software in creation of intermediate tasks (i.e., manage documents and templates, advanced editing and formatting features, creating custom elements) (5.3)	5	4.75	3.34	0.422
7	Ability to use basic digital media creation programs software (i.e., create, save, edit, delete) (7.1)	7	4.69	3.31	0.415
8	Ability to apply spreadsheet software to digital education (i.e., creation of advanced tasks such as creating a worksheet/workbook for each class; creating forms for filling out information and collecting information;	6	4.69	3.31	0.417

Rank	Item	Dimen-sions	Mean of I	Mean of D	PNI modified Scores
	separating worksheets to record the history of individual students). (6.4)				
9	Ability to use digital technologies, programs, or applications to promote and manage digital education safely and securely (9.4)	9	4.72	3.38	0.396
10	Ability to understand how to configure additional security functionalities for computers, Internet, and office programs. (3.2)	3	4.53	3.25	0.394

As seen in Table 3, the three items with the highest PNI modified scores was *Item 7.4: ability to apply digital media creation software to digital education (i.e., creation of advanced tasks such as creating online lessons for teaching and learning and disseminating)* (PNI modified = 0.591) of *Dimension 7*, followed by *Item 7.3: ability to use digital media creation in the creation of intermediate tasks (i.e., creating e-books, videos, games, posters, and infographics; editing photos; designing websites using templates)* (PNI modified = 0.508) of *Dimension 7, and Item* 6.3 *ability to use spreadsheet software in the creation of intermediate tasks (i.e., format data, conditional formatting, searching for data, analysing data with What-If, analysing statistical data managing data using Pivot Tables and Pivot Charts, data analytics*) (PNI modified = 0.500) of *Dimension 6.* This revealed that teachers are particularly interested in improving their digital literacy in *Digital Media Creation* and *Spreadsheets* more urgently than other dimensions or items with a lower PNI modified score.

Additionally, the items with the three lowest PNI modified scores were from the dimensions of *Using Computers* and *Using the Internet*, as presented in Table 4.

Table 4
The Least 10 Items with the Lowest PNI Modified Scores

Rank	Item	Dimen-sions	Mean of I	Mean of D	PNI modified Scores
26	Ability to understand how word processing software works (5.2)	5	4.72	3.81	0.239
26	Ability to post comments on web or social networking applications (8.3)	8	4.72	3.81	0.239
28	Ability to use computers to create various tasks (1.3)	1	4.63	3.75	0.235

Rank	Item	Dimen-sions	Mean of I	Mean of D	PNI modified Scores
29	Ability to use the Internet in accessing digital technology for educational management efficiently (2.4)	2	4.69	3.81	0.231
29	Ability to use basic word processing software (i.e., open, close; create; save; edit; delete; insert text, page numbers, images, and footer and header) (5.1)	5	4.69	3.81	0.231
31	Ability to use computers to access digital technology for education effectively (1.4)	1	4.63	3.78	0.225
32	Ability to understand how the presentation software works (4.2)	4	4.75	3.94	0.206
33	Ability to use common presentation software to perform basic functions (i.e., open; close; create; save; edit; delete; insert tables, objects, audio and video) (4.1)	4	4.75	4.03	0.179
34	Ability to understand how the Internet works (2.2)	2	4.59	3.91	0.174
35	Ability to use computers (1.1)	1	4.63	3.97	0.166
36	Ability to use the Internet (1.2)	1	4.69	4.09	0.147

As can be seen in Table 4, the three items with the lowest PNI modified score were *Item 1.2 ability to use the Internet* (PNI modified = 0.147), followed by *Item 1.1 ability to use computers* (PNI modified = 0.166) of *Dimension 1, and Item* 2.2 *ability to understand how the Internet works* (PNI modified = 0.174) of *Dimension 2.* This revealed that the teachers possess digital literacy or competencies in *Using the Internet* and *Using Computers* and do not need to further improve their literacy in these dimensions.

Develop the Potential of Learning Management in Digital Literacy

Since one of the objectives of the project is to develop the potential of learning management in digital literacy for members of the digital literacy education management network in schools in the sub-districts, this study aims to enhance the positive attitude towards the development and application of technology in the classroom and creative multimedia creation abilities of the project participants. The

results of the research found that the training helped participants develop their knowledge and research potential. The participants were teachers in various subjects, some of whom had no research experience. While this project did not provide direct research training and networking, digital literacy training encouraged and fostered knowledge exchange at the network level, potentially enhancing participants' research knowledge. According to Khan et al. (2016), the research examined the evaluation of a training program on research capacity development among elementary school teachers through experimental research. The results showed that the experimental group had greater research abilities than the control group.

The potential for learning management according to the principles of learning theory among project participants increased after the training. This was due to the networking among the participants, combined with the knowledge and professional skills that the research participants, who were teachers, already had, especially regarding learning theory. It can be concluded that this project enhances the capacity for learning management according to the principles of learning theory. Teaching and learning according to these principles influence students' academic success, which aligns with the findings of Gokmenoglu, Demir, & Eret (2013).

The research team collected data on digital literacy and its application trends in the classroom prior to the training. The average total score is quite low. However, after attending training, especially in media creation skills, digital literacy skills and their application trends in the classroom are on the rise. Workshops are, therefore, important for improving attitudes towards the utilization of technology in teaching and learning. Teachers' attitudes, resources, and skills are important factors that contributes to learning to use technology in schools (Browning, 2006).

Creating a Sustainable Collaborative Network for Educating Digital Literacy

The third objective aims to create a model of a sustainable collaborative network for educating digital literacy in schools in the sub-districts of Nakhon Pathom Province by combining the documentary research (Ilgen, Hollenbeck, Johnson & Jundt, 2005; Cropley & Dave, 1978; Knowles, Swanson & Holton, 2005; Marcia et al., 2004; OECD, 2015), results from needs of digital literacy assessment, model of teacher digital literacy development and conducting focus group discussion with 32 teachers from schools in the sub-districts of Nakhon Pathom Province who attended the workshop of this study. The findings indicated that a practical model of a sustainable collaborative network for educating digital literacy in schools in the sub-districts of Nakhon Pathom Province is developed by system theory and education philosophy as core principles. The four components of a model of a sustainable collaborative network for educating digital literacy in schools in the sub-districts of Nakhon Pathom Province are presented as follows.

1. Education philosophy of the model of a sustainable collaborative network for educating digital literacy is a principle for implementing the model. It consists of 4 main components: (1) concept of Sustainable Goals 4 (Quality Education) that aims to ensure inclusive and equitable quality education and promote lifelong learning opportunities for all; (2) lifelong learning philosophy that covers all types of learning for life; (3) andragogy that focuses on teachers' need and interest, teachers' experience, teachers' self-directed learning and providing opportunities and freedom to learn for teachers; and (4) pedagogy that focuses on each stage of child development.

2. Input of the model of a sustainable collaborative network for educating digital literacy is a key success factor that supports the process of implementing the model to achieve the Sustainable Goals 4 and ensure that teachers and students continuously develop their digital literacy. It consists of four main components: (1) external driving forces that affect schools such as emerging infectious diseases or pandemics, education policies that support digital learning, various learning platforms and open sources are free of charge, affordable and easy to access, affordable price of learning gadget and computer; (2) organization factors such as education policies from government and local government, vision and organizational support in digital learning from school administrators, organizational culture and Memorandum of Understanding between schools as official agreements to collaborate in educating digital literacy; (3) operation factors such as teachers' knowledge in digital literacy and digital learning, information, equipment and information technology and digital system in schools; and (4) teachers factors such as teachers' responsibility, passion and learning motivation, information technology and digital skills.

3. The processing factor of a sustainable collaborative network for educating digital literacy involves the development of teachers' abilities to manage digital literacy education within their schools. It consists of two main components: (1) the process of developing digital learning management skills consists of a needs assessment before implementation, including requirements to support the development of digital learning management skills; organizing activities to develop potential in managing digital literacy education through a variety of methods; and evaluation after carrying out potential development activities; and (2) the process of building a sustainable collaborative network for educating digital literacy consists of network search and network development, and to explore the readiness and desire to work together as a collaborative network for educating digital literacy. Lessons learned and body of knowledge were retrieved to continue the development of teachers' potential. Discussions were conducted in the teaching activities development plan, and supervision was required to ensure and enhance the quality of a collaborative network for educating digital literacy.

4. The output of a sustainable collaborative network for educating digital literacy is the results that occur in the process of implementing a sustainable collaborative network for educating digital literacy. These consist of four factors: (1) students (fruitful learning, developing digital skills, being a lifelong learner, and bringing digital skills to enhance knowledge); (2) teachers (improving teaching performance and learning management, enhancing self-esteem, and coping with changes in information technology and digital); (3) school administrators (achieving educational indicators, coping with changes in information technology and digital including other driving factors affecting the schools); and (4) schools (proactive and creative change, satisfaction from parents and students, responding to the needs of stakeholders).

Discussion

The findings suggested that the teachers expressed their highest needs for the use of digital content creation software, spreadsheet software, and using digital media securely. This might be because the COVID-19 pandemic has unexpectedly called for the digital literacy needs for teachers at all levels so instantly. Teachers needed to catch up with this drastic pace of change to stay in line with their profession. They had to adapt how they taught by creating more digital and captivating content for students to learn. Or, students would become unmotivated and disengaged from learning, resulting in a lack of knowledge and skills at the level they were supposed to be learning. The research results confirmed these statements and precisely pointed out that teachers articulated a lower need for common software or applications that they have already been accustomed to than sophisticated and unfamiliar software such as digital media creator software or spreadsheet software.

So, recognising the needs of teacher digital literacy has confirmed areas of digital literacy for teachers that are missing and what areas the teachers already have. This would help the supervisors and top management to decide on areas that they wish their staff to improve and issue the right policy accordingly. The results are in line with the study undertaken by Pawlicka et al. (2022), which attempted to address the question "has the pandemic made us more digitally literate." They studied the perception levels of digital competence and cybersecurity awareness, as well as the relationships between digital literacy and ages, and the cybersecurity awareness and feeling safer when working online or vice versa, of the Polish female scientists and teachers working at the universities. The results revealed that 1) the perceived level of the subjects' general digital literacy has increased during the COVID-19 pandemic, 2) the perceived level of the subjects towards cybersecurity awareness was low, 3) the youngest respondents had the highest level of digital skills; and 4) the perception level of respondents' cybersecurity awareness was associated with the fact that they were provided with digital skills and cybersecurity-related training and supported by their employers. Hence, it can be said that the pandemic has contributed to the increase in the respondents' digital literacy; and surprisingly, the increase in cyber security awareness has not occurred alongside the gaining of respondents' digital literacy.

For participants who have used animation media in the classroom, it was found that animated teaching media can motivate students to learn. Shute & Rahimi (2007) stated that the development of computer technology resulted in the enhancement of lesson plans to support students' learning in various ways. This aligns with the research findings that after the project, participants applied their own animation media in the classroom. Students were introduced to a variety of channels and lessons. All project participants who used animation media shared the same opinion: students became more active and involved in classroom learning. Furthermore, animation media could foster a better learning atmosphere. Dalgarno & Lee (2010) stated that the application of technology in the classroom can enhance the learning atmosphere as well.

After completing the digital literacy learning management potential development project for members of the digital literacy education management network in quality sub-district schools, most of the participants planned to use multimedia or technology in the classroom in the future. It is expected that multimedia, especially animation, will be able to enhance teaching and learning effectively and enable teachers to create motivation and enthusiasm for students as well, especially for elementary school children. This is in line with the findings of Ruchi & Mishra (2014), who found that

students aged 7-11 years old liked animation and demonstrated desirable learning behaviors. This means that animation or cartoon media can effectively engage students at the primary level.

The model of a sustainable collaborative network for educating digital literacy in schools in the sub-districts of Nakhon Pathom Province aims to build a sustainable network in which teachers can work together in their schools to educate students in digital literacy; continuously develop digital skills for teaching and learning; share knowledge and learning resources, and resources for creating online learning programs. Two of the key success factors in the model that teachers are concerned about are the Memorandum of Understanding between schools as an official agreement to collaborate in educating digital literacy. With this MoU, schools will be able to manage budgets and share resources with other members of the network, which also leads to the sustainability of the network. The second is support from school administrators that allow teachers to focus on educating digital literacy and sharing resources with others. Teachers reflected that the model of a sustainable collaborative network for educating digital literacy is suitable for schools in the sub-districts of Nakhon Pathom Province and can generalize this model to schools in other regions of Thailand that have similar rules and regulations. This result is in line with the study of Ilgan, Aktan & Üztemur (2022). Teachers preferred to learn and gain more knowledge about information technology in education for teaching and learning during the pandemic, but most teachers didn't have time to participate in professional development activities due to their workloads, lack of incentives and unaffordable professional development fees. Some teachers started learning about technology in education by exchanging material and knowledge with other teachers, co-teaching, and peer coaching. The sustainability of this model is also in line with the study of Erten (2022) about distance education during the COVID-19 pandemic, which indicated that teachers have knowledge and skill for using ICT in education to conduct distance learning during the pandemic by receiving shared information, training, and support from their school administrators and partners.

Conclusions

As a result of the study, the needs assessment findings were summarized by category and by items. The dimension or item with a higher PNI $_{modified}$ score meant that the teachers had higher needs than the dimension or item with a lower PNI $_{modified}$ score. By category, it was found that the highest need for digital literacy education of teachers was for Using Digital Media Creation Software (PNI modified = 0.492), followed by the need for Using Spreadsheet Software (PNI modified = 0.386), and Using Digital Media Securely (PNI modified = 0.360), all of which are categorized as urgent needs, as the PNI modified score is greater than 0.300. Additionally, by items, in total, all 9 dimensions comprised 36 items in the questionnaire. The findings revealed that the 3 items with the highest PNI $_{modified}$ scores were from the dimensions of Using Digital Media Creation Software, Using Spreadsheet Software, and Using Digital Media Securely, respectively. The item with the highest PNI $_{modified}$ score was Item 7.4 ability to apply digital media creation software to digital education (i.e., creation of advanced tasks such as creating online lessons for teaching and learning and disseminating) (PNI $_{modified}$ = 0.591) of Dimension 7, followed by Item 7.3 ability to use digital media creation in the creation of intermediate tasks (i.e., creating e-books, videos, games, posters, and infographics; editing photos; designing websites using templates) (PNI

modified = 0.508) of Dimension 7, and Item 6.3 ability to use spreadsheet software in the creation of intermediate tasks (i.e., formatting data, conditional formatting, searching for data, analyzing data with What-If, analyzing statistical data, managing data using Pivot Tables and Pivot Charts, data analytics) (PNI modified = 0.500) of Dimension 6.

This revealed that the teachers would like to improve their digital literacy in these areas: Digital Media Creation and Spreadsheets more urgently than other dimensions or items with a lower PNI $_{modified}$ score. The item with the lowest PNI revised score was Item 1.2 internet usability (corrected PNI = 0.147), followed by Item 1.1 computer usability (corrected PNI = 0.166) of Dimension 1, and Item 2.2 ability to use the Internet. Understanding how the Internet works (PNI modified = 0.174) of the second dimension, indicates that teachers are digitally literate or capable of using the Internet and computer. Therefore, there is no need to improve knowledge of these dimensions.

The results of the research found that the training helped participants develop their knowledge and research potential. The participants were teachers in various subjects, some of whom had no research experience. While this project did not provide direct research training and networking, digital literacy training encouraged and fostered knowledge exchange at the network level, which could enhance participants' research knowledge. The research examined the evaluation of a training program on research capacity development among elementary school teachers through experimental research. The results showed that the experimental group had more research abilities than the control group. Participants in the project saw an increase in the potential for learning management according to the principles of learning theory after the training due to the networking of the participants, together with the knowledge and professional skills of the teachers that the research participants had, especially in learning theory.

The research team collected results on digital literacy and its application trends in the classroom prior to the training. The average total score was quite low. However, after attending training, especially in media creation skills, digital literacy skills and their application trends in the classroom were on the rise. Workshops are therefore important for attitudes towards the application of technology in teaching and learning. Teachers' attitudes, resources, and skills are important factors in learning to use technology in schools.

Creating a sustainable collaborative network for educating digital literacy aims to establish a model of a sustainable collaborative network for educating digital literacy in schools in the sub-districts of Nakhon Pathom Province. This is achieved by combining the documentary research results from the needs of digital literacy and the model of teacher digital literacy development, as well as conducting a focus group discussion with 32 teachers from schools in the sub-districts of Nakhon Pathom Province who attended the workshop of this study.

The findings indicated that the practical model of a sustainable collaborative network for educating digital literacy in schools in the sub-districts of Nakhon Pathom Province is developed using system theory and education philosophy as core principles. The four components of a model of a sustainable collaborative network for educating digital literacy in schools in the sub-districts of Nakhon Pathom Province are presented as follows.

The education philosophy of the model of a sustainable collaborative network for educating digital literacy is a principle for implementing the model. It consists of four main components.

The input of the model of a sustainable collaborative network for educating digital literacy is a crucial success factor that supports the implementation of the model to achieve Sustainable Goals 4 and ensure that teachers and students continuously develop their digital literacy.

The processing factor of a sustainable collaborative network for educating digital literacy is a process of teacher development to have the ability to manage digital literacy education at the schools. It consists of two main components.

The output of a sustainable collaborative network for educating digital literacy is the results that occur in the process of implementing a sustainable collaborative network for educating digital literacy. These consist of four factors.

Recommendations

Policies should be established to prepare performance agreements (PA) with school administrators. These policies should focus on developing a network for digital literacy education and include the development of teachers' digital literacy management skills as a part of the performance assessment.

A Memorandum of Understanding (MOU) should be signed with relevant agencies and educational institutions in the area. This networked agreement will provide concrete support for teachers collaborating within a digital literacy education management network.

The development of digital literacy education management skills should be continuously encouraged. This could involve skill development opportunities such as inviting knowledgeable teachers from within schools or school networks to lead training sessions, and guest speakers from outside should also be invited.

An Individual Digital Literacy Development Plan should be established to help teachers develop all nine digital literacy skills that meet individual needs. This plan should enhance the management of teaching and learning, making it more efficient and effective.

School administrators should actively participate in policy formulation aimed at developing digital literacy teaching and learning skills for teachers. This involvement will ensure concrete and effective dissemination of research results to educational institutions and networks.

Needs assessments involving students, teachers, and schools should be conducted. It should focus on the benefits of learners. Needs or deficiencies should be identified, addressed, and fulfilled to facilitate access to digital learning media for more learners. This will ensure inclusive and equitable quality education and promote lifelong learning opportunities for all, ensuring access to quality education for students at all levels.

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