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Online Program to Empower Teacher Learning to Develop Students' Digital Literacy Skills

Sukruthai Promrub[1], Wirot Sanrattana[2]

[1] Mahamakut Buddhist University, Isan Campus, Thailand. Email: Sukruthai.lake@gmail.com
[2] Mahamakut Buddhist University, Isan Campus, Thailand. E-mail: wirsan@kku.ac.th

Abstract
This study aims to employ Research and Development (R&D) Methodology to create an *"Online Program to Empower Teacher Learning to Develop Students' Digital Literacy Skills"* based on the notions of *"Knowledge and Action is Power"* and *"Students are the Ultimate Goal of Any Educational Management."* It consists of teacher learning development projects and a project where teachers use learning outcomes to help students progress. Six sets of teacher learning manuals and one workshop manual for instructors to apply learning outcomes to student development were created as a result of the R1&D1 to R4&D4 stages. According to the results of experimenting with manuals in the R5&D5 stage with 10 teachers and 60 students using one group pretest-posttest design experimental research in a school that is representative of educational opportunity expansion schools under the Office of the Basic Education Commission, it was found that the developed manuals were effective according to the research hypothesis: 1) teachers had test results of learning outcomes that met standard criteria 90/90, 2) the teachers' post-test results were significantly higher than the pre-test-results, and 3) the students' post-test results were significantly higher than the pre-test results. It demonstrates that the manuals for learning and implementation for teachers in the developed online program are effective and can be disseminated for the benefit of the population of educational opportunity expansion schools under the Office of the Basic Education Commission across the country.

Keywords: Digital Literacy Skills, Online Program, Empower Teacher Learning, Research and Development

1. Introduction

In today's world, we currently live in the era of digital technology. As a result of digital technology, the way we work has changed, and many industries are facing digital disruption. At present, technological advancements have caused a variety of changes. Every industry, therefore, must learn to adapt to the changing conditions, and the educational system is one of them. The role of digital technology has changed the ways through which people learn. For example, so-called online classrooms, as well as e-learning, have the potential to improve learning over the long term (Loveless, 2019). It is also essential for students to properly utilize the information and to express their opinions about fast-growing digital technology (Western Sydney University, 2018). Digital technology has the ability to offer a wide range of skills, which will be necessary for future employment. The students, who lack digital literacy skills, can be likened to those, who cannot read or write, and may find themselves at a disadvantage (Lynch, 2017). Therefore, the new generation of students should learn about digital technology and gain an understanding of it so that their skills can be up-to-date and can be applied to benefit them, society, and the country

in the future. The role of education is to equip students with the necessary skills and information. In regard to Thailand's current situation, this presents a challenge to the education system. The production and development of labor in the education sector remains in line with the potential and readiness of each educational institution and places focus on the quantity of learners rather than on the learners' quality. As a result, most graduates lack essential skills, such as English language skills and digital literacy skills (Office of the Education Council, 2017).

According to studies by Govconnection (n.d.), Living Medicareful (2018), National Library of New Zealand (n.d.), Purposeful Technology (n.d.), Speed Matters (n.d.), University of Southern California. (n.d.), and Victoria (2018), students with digital literacy skills have the ability to increase their learning efficiency, creativity, memory, and implementation. Teachers with digital literacy skills are able to inspire students to use technology and to expand their learning opportunities. Teachers can leverage digital literacy skills to encourage students to use the proper technologies in a variety of learning environments. Teachers with digital literacy abilities can also collaborate with co-workers to share technology and to increase student learning results, while also developing a more sophisticated teaching style. It also assists schools in reducing inequity, which can help to increase competition opportunities and equality.

Consequently, taking care of students and providing them with an up-to-date education, as well as with opportunities to enhance their skills in using the appropriate technology is essential in the digital era. Today, students represent a group of individuals, who have grown up in the digital age. Every child should be able to learn and to fluently use both the internet and communication technology. Therefore, preparing the skills to use in learning digital technology is important for becoming a good digital citizen (Wongyai, 2017), particularly in the context of rapidly changing information technology and in an era in which the Thai government is paying more attention to the digital environment. Therefore, digital learning is a critical issue since Thailand has not yet created a clear standard for digital learning technology that can be used as a norm for education and for teaching at various levels (Lenarat, 2017).

However, Thai students are increasingly using digital media, by which communication, education, entertainment, and other activities are facilitated. If users are illiterate or lack digital literacy abilities, it may result in social problems. Therefore, students in the digital era should be educated and their digital literacy skills should be strengthened (Khamcharoen & Phonnikornkit, 2018).

The Ministry of Education has policies and a focus on governmental organizations. They seek to have the organizations adhere to the framework of planning and allocating budgets so that quality education can be established in every dimension and so that funding can be wisely spent to make certain that learners of all ages have opportunities and equality in education in fiscal year of 2021. As a result, digital learning platforms and technology should be developed and utilized as learning resources for students. By using digital skills as a tool of management, education management policies can increase the country's competitiveness. Effective learning at all learning levels and educational services are measures for the application of digital technology that can encourage and support learners to develop their own learning methods in response to their needs and aptitudes, as well as to build a knowledge-based society in order to create continuous learning throughout life (Ministry of Education, 2020).

In accordance with the importance of using digital media with the students as mentioned above, the researchers were interested in developing an online program that could empower the teachers' learning and could assist them in developing their students' digital literacy skills by utilizing Research and Development (R&D) methodology. According to Sanrattana (2018), the innovations that have been developed through the R&D methodology are intended to be used to develop personnel and to improve the quality of the work. It is challenging today to set new expectations in agencies or to change the work paradigm from old to new in contexts where the personnel still lack knowledge and skills, and where many innovative principles, concepts, and theories in education are constantly emerging. Moreover, the educational personnel is expected to put the knowledge into action and to contribute the power to perform their duties more efficiently and effectively in acordance with the concepts of: *"Knowledge and Action are Power"* or the statements: *"Make Them Know What to Do, Then Encourage Them to Do What They Know"* or *"Link to On-the-Job Application."*

According to R&D methodology, the researchers believe that R&D methodology can support the importance of establishing digital literacy skills because R&D methodology has the ability to enhance the development of innovations for online learning in a digital society and to lead to more effective learning and implementation. Currently, digital literacy skills are very important and are new skills for teachers to learn and understand. Since they are one of the essential skill sets for 21st century education, the students' skills need to be further developed to meet the ultimate goal of providing more effective education in accordance with the concept of teacher professional development, for which developing benefits for the students must be considered as the ultimate goal (Gusky, 2000; Hoy & Miskel, 2001) and which is alignment with the statement: *"Student achievement should be the ultimate goal of any teacher professional development activities"* (Kampen, 2019).

The online program to empower the teachers' learning to develop students' digital literacy skills as a result of utilizing R&D methodology in schools was used in the experimental area at the Bannongwaengworawit School, which is an educational opportunity expansion school under the Office of the Basic Education Commission. The findings were disseminated for the benefit of the research population, which consist of the educational opportunity expansion schools under the Office of the Basic Education Commission across the country. These findings were in accordance with the R&D principle of placing the emerging innovation from the experiment in one of the experimental areas in which the characteristics were representative of the population. When the results from the experiments revealed that an innovation had been effective in accordance with the specified criteria, it was disseminated to benefit the referenced research population. In particular, it was an online program that had been developed in accordance with the new digital era, rather than a document-based program, which would have been used in the traditional printing era. This was beneficial in more efficiently and effectively disseminating the innovations, which had been developed for the benefit of the referenced population in the research.

2. Literature Review

From the perspective of academics or related organizations, the researchers investigated the ideas, concepts, and theories that were beneficial to the development of the students' digital literacy skills in six areas:

1. **The definition of digital literacy skills** was based on the viewpoints of: Common Sense Media (2020), Heick (n.d.), Loewus (2016), Loveless (n.d.), Lynch (2017), Renaissance (n.d.), and Western Sydney University (n.d.).
2. **The definition of digital literacy skills** was based on the viewpoints of: Govconnection (n.d.), Living Medicareful (2018), National Library of New Zealand (n.d.), Purposeful Technology (n.d.), Speed Matters (n.d.), University of Southern California. (n.d.), and Victoria (2018).
3. **The characteristics indicating digital literacy skills** were based on the perspectives of: British Columbia (n.d.), Heick (n.d.), Media Smarts (n.d.), Quizlet (n.d.), The University of British Columbia (2011), and Williams (2016).
4. **The guidelines for developing digital literacy skills** were based on the perspectives of: Applied Educational System (n.d.), Devaney (2016), National Library of New Zealand (n.d.), Pappas (2017), Ruesink (2014), Stenger (2018), Turnipseed (2020), Webwise (n.d.), and Williams (2016).
5. **The steps for developing digital literacy skills** were based on concepts from: Equip Team (2019), Killen, Beetham and Knight (2017), Murphy (2019), Roscorla (2010), and Spencer (2018).
6. **The assessment of digital literacy skills** was based on concepts from: Cote and Milliner (2018), Cote and Milliner (2017), Covello (2010), and Rodríguez-de-Dios, Igartua and González-Vázquez (2016).

According to the results of the literature review on the six issues, the researchers integrated the recommendations of the developmental guidelines, which were the principles, concepts, techniques, methods, and the activities, as inputs and established the recommendations of the developmental procedure as process. The expected characteristics of development were taken as an output to demonstrate a systematic approach to the academic alternative proposals, or as the expected theory after teacher development. On a constant and ongoing basis, teachers would choose those options, which were regarded appropriate and consistent with the student's context. Table 1 shows a conceptual framework for teachers' learning and implementation.

Table 1: The systematic approach of academic or theoretical alternative proposals for teachers' learning and implementation

Input Suggestions Principles / concepts / techniques / process / activities for developing digital literacy skills	**Process Suggestions** Procedures for developing digital literacy skills	**Output Suggestions** Characteristics or expected qualities of students with regard to digital literacy skills
Applied Educational System (n.d.) 1. Digital literacy resource roundup from Edutopia 2. Be internet awesome from google 3. InCtrl is a website with lessons and activities that teach key concepts of digital literacy 4. Common sense education 5. Business & IT center21 from applied educational systems **Devaney (2016)** 1. Engage in strategic implementations 2. Focus on students as makers 3. Build industry-education partnerships 4. Develop smart collaborations: Governments **National Library of New Zealand (n.d.)** 1. Digital content 2. Curating content 3. Copyright and creative commons **Pappas (2017)** 1. Encourage self-exploration 2. Create an online resource guide 3. Set some ground rules 4. Evaluate current e-learning strategy 5. Include digital literacy simulations 6. Encourage learner-generated e-learning content 7. Host a live event **Ruesink (2014)** 1. Basic computer skills 2. Advanced computer/tech skills 3. Online safety 4. Content evaluation 5. Online job search **Stenger (2018)** 1. Emphasis the importance of critical thinking 2. Use social media for learning and collaborating	**Equip team (2019)** 1. Refocus lab time on digital literacy 2. Model digital literacy in the library 3. Enhance core classes with digital literacy 4. Better yet, think big picture **Killen, Beetham and Knight (2017)** 1. Vision and intent 2. Design and construct 3. Explore and contextualize 4. Support and consolidate **Murphy (2019)** 1. Articulate the program's vision 2. Build an implementation model 3. Scope a framework for alignment 4. Engage teachers throughout the program launch and beyond **Roscorla (2010)** 1. Map existing community resources and offer small grants 2. Support a national network of summer learning programs 3. Create a digital and media literacy youth corps 4. Build interdisciplinary bridges in higher education 5. Create district level initiatives 6. Partner with media and technology companies 7. Develop online measures of media and digital literacy 8. Start an entertainment education initiative 9. Host a statewide, youth-produced public service announcement competition 10. Support an annual conference and educator showcase competition **Spencer (2018)** 1. Harness the power of whole-school software	**British Columbia (n.d.)** 1. Research and Information Literacy: apply digital tools to gather, evaluate, and use information 2. Critical thinking, problem solving, and decision making 3. Creativity and innovation 4. Digital citizenship 5. Communication and collaboration 6. Technology operations and concepts **Heick (n.d.)** 1. Comprehension 2. Interdependence 3. Social Factors Curation **Media Smarts (n.d.)** 1. Use 2. Understand 3. Create 4. Digital media are networked 5. Digital media are persistent, searchable and shareable 6. Digital media have unknown and unexpected audiences 7. Digital media experiences are real, but don't always feel real 8. How we respond and behave when using digital media is influenced by the architecture of the platforms, which reflects the biases and assumptions of their creators **Quizlet (n.d.)** 1. Technology: It must work; it must be appropriate; learners must be able to use it 2. Must be fast enough for the activity to work effectively 3. The language used must be appropriate for the learners 4. Use a teaching style that is supportive of a different

Input Suggestions Principles / concepts / techniques / process / activities for developing digital literacy skills	**Process Suggestions** Procedures for developing digital literacy skills	**Output Suggestions** Characteristics or expected qualities of students with regard to digital literacy skills
3. Provide guidance on how to avoid plagiarism 4. Teach students to manage their online identity 5. Help students manage digital distractions 6. Provide authentic contexts for practice 7. Guide students out of their comfort zone **Turnipseed (2020)** 1. Stress the importance of coding and basic technology application skills 2. Encourage innovation by revising vs. reinventing the wheel. 3. Teach students how to determine the reasonability of an answer. 4. Prioritize student engagement over all else. 5. Push for access to technological resources and solutions in schools. **Webwise (n.d.)** 1. Critical thinking 2. Online safety skills 3. Digital culture 4. Collaboration and creativity 5. Finding information 6. Communication and netiquette 7. Functional skills **Williams (2016)** 1. Tutor knowledge 2. Advance planning and adaptability 3. Appropriate teaching style	2. Collaborate and share best practice online 3. Bring personal IT equipment to use 4. Reviewing Policies 5. Learning management integrates various disciplines such as Science (S), Technology (T), Engineering (E) and Mathematics (M): STEM Clubs 6. Updating the curriculum	learning environment. make the learning accessible 5. Timing 6. Knowledge and expertise - in digital literacy 7. Knowledge and expertise - in teaching 8. Know your learners **The University of British Columbia (2011)** 1. Reading and writing 2. Global reach **Williams (2016)** 1. Ability 2. Skills 3. Knowledge **AND** Please refer to the development assessment form on digital literacy skills of students from the appendix and from https://bit.ly/3usp607

3. Research questions

According to the on-line program, which is based on the notions of "Knowledge and Action are Power" and "Students are the Ultimate Goal of Any Educational Management" and which can empower teacher learning to assist in developing the students' digital literacy skills, there were two projects: 1) Teacher's Learning Development on Digital Literacy Skills Development; and 2) The Implementation of Learning Outcomes by the Teachers to Enhance Digital Literacy Skills of Students, the research questions were as follows: a) *What content does the manual contain for each project?,* b) *After the experiment, do the teachers' test results meet the standard 90/90 after applying each project manual in the field with the experimental research methodology?,* c) *Do the teachers have post-test results that are significantly higher than the pre-test results?,* and d) *Do the students have post-test scores on digital literacy skills that are significantly higher that the pre-test scores?*

4. The Research Hypothesis

The project manuals were created, checked for quality, and revised. The research tools were created for usage in the experimentation, while carrying out operations that were believed to yield quality research results, trials were conducted with the manuals in the field. Therefore, the research hypothesis was established. The online program, which would empower teacher learning to develop the digital literacy skills of students, would be determined to be effective in light of the following: 1) teacher's post-test scores would meet the standard of 90/90 and would be significantly higher than their pre-test scores, and 2) the students' post-test scores on digital literacy skills would be significantly higher than the pre-test scores.

5. Research Methodology

5.1. Concepts and Procedure

According to the concept of Sanrattana (2018) on the development of an online program to empower teacher learning to develop students' digital literacy skills through the Research and Development (R&D) methodology, innovations, which are developed through the R&D processes are intended to be used to develop personnel so that the quality of work could be improved. There were some phenomena or empirical data showing importance of having the innovations. At present, there are many principles, concepts, and theories in the field of education that are considered to be innovative. It is expected that if the personnel working in education have knowledge and if they are motivated to use the knowledge and to act upon it, then they will be empowered to perform their duties effectively under the notions of *"Knowledge and Action are Power" or "Make Them Know What to Do, Then Encourage Them to Do What They Know"* or *"Link to On-the-Job Application."*

The concept of studying the relevant literature is an important starting point for R&D because it contributes to information that can be used to develop online programs of which the projects are essential elements. The learning manuals or practical manuals, which are designed as self-learning modules in each project, are considered to be important components. In this research, the procedures of R&D, therefore, started from the study of related literature as R1&D1..R2&D2..R3&D3..Ri&Di as follows:

R1&D1: The study of the relevant literature on "definitions, significance, characteristics, developmental guidelines, developmental stages, and digital literacy skills assessment" for the establishment of an online program to empower teachers' learning in order to develop students' digital literacy skills consisted of two projects. Firstly, The Teacher's Learning Development Project on Developing Digital Literacy Skills was composed of six learning manuals: (1) Teacher Learning Development on Digital Literacy Skills, (2) Learning on the Significance of Digital Literacy Skills, (3) Characteristics or Qualities Indicating Digital Literacy Skills, (4) Learning the Developmental Guidelines of Digital Literacy Skills, (5) Development Procedures on Digital Literacy Skills, and (6) Learning on Digital Literacy Skills Assessment. Secondly, the learning outcomes, which were implemented by the Teachers to Improve the Digital Literacy Skills of the Students, consisted of one practical manual.

R2&D2: The focus group discussion technique was used with 10 teachers in a non-experimental school, Bansarngpandonnaphaeng School, to check for defects in the manual in terms of clarity, the usefulness of the content, the appropriateness of the language usage, and the format for presenting the content, etc.

R3&D3: The focus group discussion technique was used with 7 teachers from a non-experimental school, Chumchon Banphai Yingyong-uthit School, and with 8 teachers from Bansuanmonkrainun Wanghin School. In total, 15 people checked for flaws in the manual in terms of clarity, the usefulness of the content, the appropriateness of the language usage, and the format for presenting the content, etc.

R4&D4: A study of the additional relevant literature on the concept of assessing digital literacy skills was utilized to create two research tools as follows: 1) the teacher's learning outcome test on the contents of the 6 manuals, and 2) the assessment form, which focused upon the digital literacy skills of students.

R5&D5: A manual trial was conducted through pre-experimental research with one experimental group with a one group pre-test/post-test design. The experimental area was Bannongwaengworawit School, which teaches kindergarten to junior high school level and is an educational opportunity extension school under the Office of the Basic Education Commission. The purposive sampling method was used to determine the experimental group, which consisted of 5 primary school teachers (Level 2) and 5 secondary school teachers, totaling 10 teachers. There were 45 primary school students, who were targeted for developing digital literacy skills (Level 2), as well as 15 secondary school students (Years 1-3), which totaled 60 students. The experiment was conducted in the Second Semester of the Academic Year of 2021. The experiment was divided into 2 phases as follows:

Phase 1: Teacher Development was conducted for those, who were in the experimental group, and was conducted in accordance with Project Manual 1 through the method of online self-learning modules with the following activities and periods of operation:

1. The teachers in the experimental group were given information on how the research was conducted, and then they were evaluated to assess their knowledge before the experiment (pre-test). This process took 2 days.
2. The teacher development took place online by using the principles of the self-learning modules, which had been based on the developed project manual. The manual could be downloaded by accessing the website that had been created. The learning was carried out for 1 month without intervention from the researchers or anyone else.
3. Teachers in the experimental group examined the manual for defects and then took the post-test. This process took 2 days.
4. The teachers' post-test results were analyzed and compared with the standard 90/90, and then the teachers' pre-test and post-test results were compared by using the t-test. This process took 2 days.

Phase 2 : According to Project 2, the learning results were put into practice for the teachers, who were in the experimental group. It required the teachers to apply the learning results from the self-learning modules from Project 1 so that student development could be as effective as expected. The activities and the periods of operation are shown as follows:

1. The researchers met with the teachers in the experimental group to elaborate upon how the research was conducted and to assess the students' digital literacy skills before the experiment (pre-test).
2. The teachers in the experimental group brought the learning results to develop the digital literacy skills for students in accordance with the explanations in the practical manual in Project 2. The practice was carried out without intervention from the researchers or anyone else. This process took 2 months.
3. The teachers in the experimental group examined the manual for defects and assessed the digital literacy skills of the students. This process took 2 days.
4. The pre-test/post-test results were analyzed by using the t-test, and the process took 2 days.

5.2. Research tools

1. The teacher learning outcome test is multiple choice with 4 options. The purpose was to investigate the teachers' learning outcomes before and after the experiment according to Project 1. The objective was to determine whether or not the experimental group's learning outcomes had met the standard criteria of 90/90 and whether or not the post-test scores had been significantly higher than the pre-test. 1. The pre-test and the post-test were created according to content from the Project Manual 1, which consisted of definitions, significance, characteristics, developmental guidelines, developmental stages, and assessments. The test features were based on cognitive domain in accordance with Benjamin S. Bloom's concept, which categorizes behaviors into 6 levels, ranging from the lowest thinking skill to the most advanced thinking skill (i.e., remembering, understanding, applying, analyzing, evaluating, and creating) (Sanrattana, 2018). The test was an online Google form assessment in which the quality of the test had been verified in the following manner:

1.1 The content validity of the questions was verified using the Rovinelli and Hambleton method (1977), which is known as the Indices of Item-Objective Congruence (IOC) and which utilized 5 experts, who had expertise in

curriculum & teaching and in educational assessment & evaluation. The data analysis revealed that all questions had exhibited IOC values that had been higher than the specified threshold of 0.50, indicating that the content of the questions in the Pre-test/Post-test, utilized in this research, had been valid (content validity) and had met the objectives of the assessment (Chaichanawirote & Vantum, 2017).

1.2 The quality of the test was examined by using the test (the pilot) with 30 teachers in other schools, which were not in the experimental area, which included teachers from the Benjamitwittayakom School, Traikhamprachasan School, and the Banphaisaengthongprachasan School. The results of the experimental test showed the following: 1) all of the exams had achieved an index of difficulty, which was between 0.20 - 0.80 and a power of discrimination, which was from 0.20 to 1.00; 2) the reliability of the test, which was conducted by utilizing the Kuder-Richardson method, showed a KR coefficient of 20 of 0.905, which was higher than the specified criteria; but was equal to or higher than 0.70; and 3) the difficulty of the test was assessed by the mean scores of all samples, which were used as the criteria. If the average score were between 30-50% of the full score, it would be considered a test of reasonable difficulty. If the average score was lower than 30, then the test would be considered more difficult. Moreover, if the average score was higher than 50, then the test would be considered easier. From the results of the test, it was found that the average score for the teachers in the sample group had been 16.00 or 44.44 percent of the full score, indicating that the entire test had exhibited an appropriate level of difficulty.

2. The digital literacy skills assessment form had a rating scale of 5 levels (i.e., excellent, good, moderate, fair, and poor). It was created based on the results of a study, which had focused upon the characteristics or qualities of demonstrating digital literacy skills based upon the perspectives of: British Columbia (n.d.), Heick (n.d.), Media Smarts (n.d.), Quizlet (n.d.), The University of British Columbia (2011), and Williams (2016); and from studies, which examined the concept of evaluating digital literacy skills from the perspective of: Cote and Milliner (2017), Cote and Milliner (2018), Covello (2010), and Rodríguez-de-Dios, Igartua and González-Vázquez (2016). The assessment form was rated online by using Google form, in which the quality had been verified in the following ways:

2.1 Using the Rovinelli and Hambleton method, the content validity of the questions was verified by 5 experts, who had expertise in the fields of education administration, assessment, and evaluation. The data analysis revealed that all the questions had shown IOC values higher than the specified threshold of 0.50, which indicated that the content of the digital literacy skills assessment form used in this research had been valid (content validity) and had met the objectives of the assessment (Chaichanawirote & Vantum, 2017).

2.2 By using Cronbach's method, the alpha coefficient of confidence was examined by administering the digital literacy skills assessment test (the pilot) to 30 students in schools that were not in the experimental area. The students were selected from Banphaisaengthongprachasan School. The data analysis revealed that the alpha coefficient of confidence for the entire assessment form had been 0.978. Considering each aspect, the following information was found: 1) the digital technology skill had been 0.928, 2) the digital media access had been 0.809, 3) the manner in which the digital media was used had been 0.902, 4) the digital skills for searching for information technology had been 0.906, 5) the usage of the digital skills for becoming a digital citizen had been 0.898, and 6) the digital skills for digital protection and security had been 0.907. The alpha coefficient of confidence had been equivalented to or higher than the threshold of 0.70 (UCLA: Statistical Consulting Group, 2016). Therefore, it was shown that the digital literacy skills assessment form was able to be qualified and was deemed to be appropriate for usage with confidence.

5.3. Data Analysis

1. Data analysis was conducted to compare the teachers' learning outcomes after the experiment in accordance with the 90/90 standard and to measure the effectiveness of the manuals in the learning development project of the experimental group teachers. The first 90 refers to the percentage of the average teacher scores of the whole group from the test, and the last 90 refers to the percentage of teachers, who had been able to pass the test for all objectives (Yamkasikorn, 2008). The formula for calculating the first 90 was $\{(\Sigma X /N) X 100)\}/R$, in which ΣX represented the total score of the correct test results for each teacher, N represented the total number of teachers in the experimental group, and R represented the total points in the test. The formula for calculating the last 90 was (Y

x 100)/ N, in which Y represented the number of teachers, who had been able to pass the test across all objectives, and N represented the total number of teachers in the experimental group.

2. By using the dependent t- test, data analysis was carried out to compare the results of the teacher learning test before and after the experiment in accordance with Project 1, and to compare the results of the digital literacy skills assessment of the students before and after the experiment in Project 2 (Kanchanawasee, Pitayanon, & Srisuko, 2008).

6. Research Results

Regarding the research results in the R1&D1 stage, an online program to empower the teachers' learning to assist in developing the students' digital literacy skills consisted of 2 projects, and each project had a manual as follows:

1. The Teacher Learning Development Project on the development of digital literacy skills consisted of 6 manuals with self-learning modules, each of which presented the perspectives of academics or of related organizations as follows:

1.1 The manual for learning the definitions of digital literacy skills, presented perspectives from: Common Sense Media (2020), Heick (n.d.), Loewus (2016), Loveless (n.d.), Lynch (2017), Renaissance (n.d.); and from Western Sydney University (n.d.).

1.2 The manual for learning the significance of digital literacy skills presented content based on the viewpoints of: Govconnection (n.d.), Living Medicareful (2018), National Library of New Zealand (n.d.), Purposeful Technology (n.d.), Speed Matters (n.d.), University of Southern California. (n.d.), and Victoria (2018).

1.3 The manual for learning the characteristics or qualities for digital literacy skills, presented content, which was based on the perspectives of: British Columbia (n.d.), Heick (n.d.), Media Smarts (n.d.), Quizlet (n.d.), The University of British Columbia (2011), and Williams (2016).

1.4 The manual for learning the digital literacy skills development guidelines, presented content, which was based on the perspectives of: Applied Educational System (n.d.), Devaney (2016), National Library of New Zealand (n.d.), Pappas (2017), Ruesink (2014), Stenger (2018), Turnipseed (2020), Webwise (n.d.), and Williams (2016).

1.5 The manual for learning the developmental stages of digital literacy skills, presented content based on the perspectives of: Equip Team (2019), Killen, Beetham and Knight (2017), Murphy (2019), Roscorla (2010), and Spencer (2018).

1.6 The manual for learning the digital literacy skills assessment, presented content based on the perspectives of: Cote and Milliner (2018), Cote and Milliner (2017), Covello (2010), and Rodríguez-de-Dios, Igartua and González-Vázquez (2016).

2. Regarding the implementation of the learning outcomes for teachers to enhance digital literacy skills for students, there is a practical manual for teachers to use as a guideline for developing the digital literacy skills of students. A summary of the key points can be presented as follows: 1) the characteristics or qualities of digital literacy skills that students are expected to have, 2) the guidelines for developing digital literacy skills, and 3) the stages for developing digital literacy skills. At the end of the manual, there is teacher self-assessment, which focuses on the implementation of recommendations and the developmental guidelines, and which also includes comments in the form of reflecting upon how to improve the manual.

Remarks:

1) Please refer to every manual at:
http://online.anyflip.com/lwhoe/uqbz/mobile/?fbclid=IwAR1SXOSeU7bhtdSQLrTarprDXAplJpbAVtUyJbnI-wazBUENEnElZOry6_s

2) Please refer to the teacher practice level assessment form at: https://bit.ly/3b3tzfC
3) Please refer to the teacher's learning outcome test at: https://bit.ly/3DWxt7d
4) Please refer to the development assessment form on digital literacy skills of students at: https://bit.ly/3usp607

Considering the research results in the R2&D2 to R5&D5 stages, a manual consisting of self-learning modules as part of the teacher's learning development project and a practical manual for the implementation of learning outcomes to improve the digital literacy skills of students, were created. This also brought about the pre-tests/post-tests for the teachers and the digital literacy skills assessment form for the students, which contributed to the pre-experimental research. One experimental group, who received a one group pre-test/post-test design, was from Bannongwaengworawit School and was representative of the educational opportunity expansion schools under the Office of the Basic Education Commission. The experimental group consisted of 5 primary school teachers (Level 2) and 5 secondary school teachers, totaling 10 teachers. There were also 45-targeted primary school students (Level 2), and 15 students from Grades 1 to 3, making a total of 60 participants. The research findings were consistent with the research hypothesis: the online program to empower teachers' learning to develop students' digital literacy skills, consisting of 2 projects with a manual each, had been effective in the following ways:

1) The developed manual could be used to empower teachers to achieve learning in accordance with the 90/90 standard. Considering the first 90 standard criteria, the mean score for the post-test had been 33.9 out of a total of 36 points. The percentage was 94.17, which was higher than the specified threshold of 90 percent. Meanwhile, when considering the last 90 standard criteria for the 10 teachers, the percentage of teachers, who had been able to pass all the objectives of the test in the experimental group, was 98.33%, which was higher than the specified threshold of 90 percent.

2) The developed manual could be used to empower teachers to achieve higher learning outcomes given that the experiment showed a level of significance of 0.05 as shown in the t-test results in Table 2.

Table 2: The t-test results to compare the teachers' learning outcomes before and after the experiment

Testing	Sample sizes	Means	Standard Deviations	t
Before	10	29.00	2.357	12.043*
After	10	33.90	1.370	

* $p < 0.05$

3) The developed manual had enabled teachers to implement learning outcomes to develop students' digital literacy skills in accordance with the assessment results of the students after the experiment, which had been significantly higher than the pre-test at the 0.05 level, as shown in t -test in Table 3.

Table 3: The t-test results to compare the results of the students' digital literacy skills assessment before and after the experiment

Evaluations	Sample sizes	Means	Standard Deviations	t
Before	60	3.47	0.07	75.837*
After	60	4.48	0.07	

* $p < 0.05$

7. Discussion

The development of *"Online Program to Empower Teacher Learning to Develop Students' Digital Literacy Skills"* through Research and Development (R&D) methodology focused upon two concepts. The first was *"Knowledge and Action are Power"* because any developments in the past had often underscored that *"Knowledge is Power,"* which means transmitting the idea that having and sharing knowledge is the cornerstone of reputation and influence, and is, therefore, power. (Azamfirei, 2016). However, at present, some people have proposed different ideas by stating that, in addition to giving importance to knowledge, importance should be also placed on action. Regarding this, the following statements have been made: *"The great end of knowledge is not knowledge, but action"* or *"Knowledge is NOT power. Knowledge is only POTENTIAL power. Action is power."* - Tony Robbins

and *"Knowledge Is Power, but Knowledge Without Action Is Useless"* (Ofpad, the School of Genius, n.d.). This is consistent with the concept of Knowledge Management (KM), in which there is a process of gathering knowledge that has been scattered among individuals or that can be found in documents in order that this knowledge can be developed into a system that everyone in the organization can have access to and can use for his/her own self-development so that he/she can become knowledgeable and work more effectively (Lenin, n.d.). Moreover, according to Demarest's (1997) viewpoint on the KM process, KM consists of knowledge construction, knowledge embodiment, knowledge dissemination, and the use of knowledge. This is also consistent with a concept by Probst (1998), who stated that KM consists of knowledge identification, knowledge acquisition, knowledge development, knowledge transfer, knowledge storage, and knowledge utilization. It can be seen that the concepts of KM not only focus on the pursuit of knowledge and the acquisition of knowledge, but they also focus on putting knowledge into practice. Therefore, the development of this *"Online Program to Empower Teacher Learning to Develop Students' Digital Literacy Skills"* by utilizing R&D methodology, which was designed to focus on *"Knowledge and Action is Power,"* is an idea that should be encouraged, supported, and disseminated.

In addition, another concept that has been highlighted in this research is the concept of professional development for teachers, which considers that any development must take into account that providing benefits for the students is the ultimate goal (Gusky, 2000; Hoy & Miskel, 2001). This is consistent with the statement that *"Student achievement should be the ultimate goal of any teacher professional development activities"* (Kampen, 2019) and is also in line with the statement: *"Provide professional development that is comprehensive, ongoing, intensive and designed to improve the effectiveness of teachers and principals in raising student achievements."* (Hervey, n.d.). Moreover, Holloway (2006) stated that *"The right kinds of professional development for both teachers and school leaders can directly contribute to improved student performance."* Therefore, research that has been designed to focus on any activity of teacher professional development must acknowledge the benefit of students as the ultimate goal. This is also another idea that should be encouraged, supported, and disseminated.

The trial of the manual developed with the teachers and students in the schools that were in the experimental area took place during Semester 2 of the Academic Year of 2021 and during the time of the COVID-19 pandemic. This period was considered to be a catalyst for the project on teacher learning development and for the implementation of learning outcomes for teachers to more effectively assist in student development. In the education sector, the COVID-19 outbreak had accelerated the adoption of educational technology. Most educational institutions faced needs for online learning platform services. For some services, the institutions were able to develop them by themselves, while for others, they had to rely on a system developer, which contributed to the creation of more startups to meet the demand for distance learning services, such as Microsoft Teams, Google Classroom, Zoom, Coursera, EdX, Udemy, and MOOC, etc. In addition, there was an increase in learning through platforms, such as learning English or a third language directly from native speakers in the other countries via Voxy or Engoo, etc. (Chairatchaneeboon, 2020; Langworthy & Neufeld, 2017). Therefore, the COVID-19 outbreak has been considered a challenge of *"Turning crisis into opportunity."* In order to achieve the expected results, teachers were required to learn how to develop digital literacy skills and how to implement learning outcomes for student development.

However, in terms of developing digital literacy skills, English language proficiency is a major concern. Because Thai people, including Thai teachers, still lack skills in using English effectively. According to the English proficiency ranking conducted in 2021, the annual English Proficiency Index, which was carried out by the global language-education company, EF Education First, ranked Thailand at 100 out of 112 territories, in which English is not the native language (Bangkok Herald reporters, 2021). As a result of this ranking, the presentation of the content, related to the development of digital literacy skills in the teacher's learning manual, was translated from English to Thai. This resulted in clarity, as well as in inaccurate language expressions for communication. Despite this fact, supplementary measures were taken for those people, who were proficient in English and who wished to learn from the English-language references using the websites linked in the manual.

8. Recommendations

According to the findings, the *"Online Program to Empower Teacher Learning to Develop Students' Digital Literacy Skills"* is effective in enabling teachers to learn in accordance with the specified criteria. Teachers can also use the learning outcomes to help students significantly improve their digital literacy skills. The findings showed that the Online Program could be disseminated so that teachers in other schools under the Office of the Basic Education Commission nationwide can gain benefit. During its implementation, the concepts of *"Knowledge and Action are Power"* and providing benefits for the students should be considered, which is the ultimate goal of any educational management. According to Holloway (2006), the following actions should be taken: 1) the teacher's knowledge of the content and his/her teaching skills should be focused upon; 2) in an evidence-based way, the students' learning goals and the training outcomes should be considered; 3) a supportive culture for a learning community should be created among all members of the community; 4) student data should be used to inform professional development planning and should be a part of the training itself; 5) the training should be embedded in the daily work of the teacher; 6) training should be sustained over time; and 7) feedback and coaching should be permitted.

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Appendix: The student's digital literacy skills assessment form used in the research

The characteristics or qualities indicating Digital Literacy Skills	Level of agreement of the students				
	5	4	3	2	1
Digital technology skills					
1. I enjoy using computers.					
2. I want to learn more about computers.					
3. I can create documents using basic Microsoft Word.					
4. I can log in, log out, and use programs.					
5. I can use a printer.					
6. I can connect the computer to the Internet.					
7. I can input the URL in the address bar.					
8. I can download and save files from the Internet.					
9. I can create an account, username, and password on any website I want, such as *Line, Gmail,* or *Facebook.*					
10. I understand the basic functionality of the parts of computer hardware.					
Digital media access and usage behaviors					
11. I use online social applications.					
12. I use a mobile phone to access online social networks.					
13. I play computer games.					
14. I download and install programs.					
15. I have online messages.					
16. I share files with others on social media.					
Behaviors and etiquette when using digital media					
17. I properly spend time when using digital media.					
18. I can assess and select the proper sources on websites.					
19. I can tell whether the information is right, wrong, or appropriate before sharing it with others.					
20. I can select polite and appropriate words, icons, signs, images, and symbols.					
21. I can appropriately select digital tools at the right time.					
22. I know the appropriateness of posting images, messages, or video clips on digital media.					
Digital skills for technology operations					
23. I have knowledge and can use technology appropriately.					
24. I can choose and practice using applications on digital devices effectively.					
25. I can search and edit information on digital devices correctly and appropriately.					
26. I know how to use technological devices correctly.					
Digital skills for communication, collaboration, creativity, and innovation					
27. I use digital media for communication, interaction, and for working and learning with others.					
28. I communicate with others using a variety of digital devices effectively.					
29. I can receive and send information through email or applications like *Line* and *Facebook* on digital devices.					
30. I am good at using my digital knowledge to create works through digital devices on social media.					
Digital skills used in searching for information					

The characteristics or qualities indicating Digital Literacy Skills	Level of agreement of the students				
	5	4	3	2	1
31. I use digital devices to look up, analyze, assess, and to synthesize information from a variety of appropriate sources.					
32. I can evaluate, compare, and select appropriate sources of information.					
33. I can compare information from a variety of sources before judging whether it is reliable or not.					
Digital skills for digital citizenship					
34. I understand digital citizenship and my rights on social media.					
35. I understand the effects of illegally downloading music and movies.					
36. I understand the actions that should be avoided to not infringe upon the rights of others.					
37. I am responsible for my personal rights when using digital technology on social media.					
38. I create or write messages on social media that are respectful of the rights of others, as well as copyright and intellectual property laws.					
Digital skills for protection and security on digital world					
39. I know how to use the location identification feature on applications like Facebook.					
40. I appropriately use social media sharing settings in order to choose what others can see.					
41. I know the proper disclosure of personal information for personal security on social media.					
42. I regularly install and update anti-virus programs.					