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1. To encourage and publish knowledge and useful opinions in any field of study
2. To support academicians and teachers in creating work beneficial to the academic community
3. To stimulate and support education at the university level

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Editorial Note

The Interdisciplinary Research Review (IRR) was established with academic cooperation by the Nakhon Pathom Rajabhat University, The Royal Society of Thailand Committee of Interdisciplinary Research and Development, Rajabhat University (Western Group), and Rajamangala University of Technology Rattanakosin. This Issue, Volume 16 Number 6 (November – December 2021). This issue contains of eight interesting articles in multidisciplinary fields: (1) Interactive online learning development by learners' dominant aptitude result of VARK in computer-based learning and teaching course for computer education students, (2) A process of promoting the publication of research in academic journals among the Faculty of Nursing, (3) Development of sustainable consumption and production indicators for industrial sector according to circular economy principles in Thailand, (4) An evaluation of a Lexiles-based reading management system, (5) The contribution of emotional intelligence to academic engagement of undergraduate students in Thailand: the mediating role of self-efficacy, (6) Electrospun centella asiatica leaf extract-loaded poly (vinylalcohol)/ gelatin fiber mats as potential wound dressings, (7) Human resource management and development of government officer 4.0: A case study of the department of disaster prevention and mitigation, and (8) Community-based teaching and learning management as the foster family in Thailand: PLESS + OSCE Model.

The Editorial Board of the IRR encourages anyone to submit articles for evaluation and review. The processes of submission, review and publication of articles are described on the journal's website, <https://www.tci-thaijo.org/index.php/jtir>. The Editorial Board and Committees of the IRR sincerely thank all peer reviewers who have sacrificed their time to help us produce a better journal, and also wish to thank all teachers, researchers and other academicians for submitting their valuable research to this journal. Finally, we thank readers of our journal who help to spread the knowledge and benefits gained to others. With your feedback and suggestions, we will strive to improve the quality and relevance of the IRR.

Yongyudh Vajaradul
Editor
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Interactive online learning development by learners' dominant aptitude result of VARK in computer-based learning and teaching course for computer education students

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Abstract

The objectives of this research are to: 1) develop an interactive online learning by learners' dominant aptitude result of VARK in Computer-based Learning and Teaching Course for computer education students; 2) identify the effectiveness of interactive online learning media; 3) compare the learners' performance after receiving the treatment; and 4) find learners' satisfaction after receiving the treatment. The sample of this research is 26 3-year undergraduates of Nakhon Pathom Rajabhat University who enrolled in Computer-based Learning and Teaching Course in semester 2/2020, derived by cluster random sampling. The treatment of this research is the effectiveness of interactive online learning media development by learners' dominant aptitude result of VARK, and the research tools are a learning achievement test and a satisfaction test. The statistics used are percentage, average, standard deviation, and dependent t-test.

This research found that:

- 1) The media of the interactive online learning by learners' dominant aptitude result of VARK in Computer-based Learning and Teaching Course consists of 4 units: design of computer instruction, development of learning management on a cloud computing system, design of individual learning presented with a video demonstration, and filming and editing technique a video demonstration.
- 2) The effectiveness of media had been improved at E1/E2 or equal 81.41/80.22, which the maximum value is greater than the research standard at 80/80.
- 3) The learners' performance after learning with the interactive online learning by learners' dominant aptitude result of VARK is higher than that before learning at .05 level.
- 4) The learners' satisfaction after learning with the interactive online learning by learners' dominant aptitude result of VARK is at the highest satisfaction level.

Keywords: Interactive online learning, VARK, dominant aptitude result

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1. Introduction

Education is the fundamental foundation of a country's sustainable development from the National Education Act that stated that lecturers have a must to realize the significance of developing and improving children's performance and to enhance teaching potential. According to National Education Act 1999, Chapter 4, Education Management Section 24, Number 1 stated that the host of the learning management system will be responsible for educational concerns to craft a suitable content and activity that links to learners' interest and aptitude. This will be considered on individual differences [1]. It is also cited in National Education Act, Rajabhat University 2004, Chapter 1, General Chapter, Section 8, Number 5 that emphasize and strengthen lecturers; teaching potential to reach

the standard of the advanced profession [2]. To serve the standard of an advanced profession, the education personnel had to improve and develop their teaching potential. Moreover, the research had been conducted to improve their teaching performance and share this know-how with the public. Nowadays, there are many dynamic impacts on teaching methods. One of the most significant impacts is technology, 21st Century Skills [3], especially the characteristics that reflect the human basic educational foundation.

Individual learning performance will differentiate how they learn and how they implement their action [4]. The theory of VARK learning will assess the difference of learners' ability which can be specified into 4 groups: 1) Visual learners (Visual: V) who learn through visibility, 2) Aural learners (Aural: A) who learn through listening, 3.) Read and write learners (Read/Write: R) who learn through reading and writ-

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ing skills, and 4) Kinesthetic learners (Kinesthetic: K). Thus, the difference of learning style designs the media of learning as the researcher surveyed by applying the VARK Test in 16 items to 250 year 1–4 students majoring in computer education, Faculty of Science and Technology of Nakhon Pathom Rajabhat University, as shown in Figure 1.

Figure 1 showed a significant difference in learning aptitude between 4 groups (V, A, R, K) of year 1–4 students majoring in computer education, therefore the researcher created all 4 kinds of lessons.

Several influencing methods of developing education media both online and offline relate to learner extraction of the utmost proficiency. Roungrong [5] claimed that educational media or computer tasks are meant to utilize computer programs as an apparatus to allow self-learning in an attractive atmosphere; the program will be found in alphabets, letters, graphics, animation, and audio.

According to Tiantong [6], designing a computer program required a related aptitude of learners. Additionally, each awareness frame needs to acquire a direct interaction with learners such as question answering, and activity participation, not one-way communication.

Interactive online learning is designing a computer program to acquire a direct interaction with learners. This type of content responds to your explicit queries, staying genuinely interactive. Examples of such content include video games, high-fidelity simulations, immersive tutorials, problem sets, and so on. Interactive content will promote the experience of learning in real social ecologies or situations.

The Computer-Based Learning and Teaching is a compulsory course for the 3rd year students majoring in computer education, Faculty of Science and Technology of Nakhon Pathom Rajabhat University. This subject aimed to provide knowledge of learning society, learning in the information and communication technology era, information searching with computers, computer-based instrument invention for learning and teaching, and practice. As the tremendous scope course description, learners' understanding obstacle had been found. The revealed complication was the accumulated score throughout the semester. It implies that 1) the subject content is very intensive so that it requires to conduct an additional class for learners to gather all the contents; 2) the diversity of learners' education-varying from high school, non-formal education, and vocational certificate-produces a multi-perception of learning; 3) the primitive educational media is to convey content by documents and Power Points; and 4) the teaching time is limited.

To establish a niche from the authentic obstacles, the researcher considered that developing online education media by Learners' dominant aptitude with VARK in Computer-based Learning and Teaching Course for undergraduates will stress and accelerate

learners to achieve advanced proficiency. Besides, this developed media connects to technological aspects and it is fruitful for learners to access anytime and everywhere.

2. Objectives

This research has the following objectives:

1. To develop the interactive online learning development by learners' dominant aptitude result of VARK in Computer-based Learning and Teaching Course for computer education students.
2. To find the effectiveness of interactive online learning media.
3. To compare the result of learners' performance after receiving the treatment.
4. To find learners' satisfaction after receiving the treatment.

3. Research Hypothesis

1. The interactive online learning development by learners' dominant aptitude result of VARK in Computer-based Learning and Teaching Course for computer education students should own an excellent level of quality of content and media production techniques.
2. The effectiveness of media should improve at research standard with E1/E2 formula of 80/80.
3. The learners' performance after interactive online learning media treatment should be higher than before at a statistical significance of .05.
4. The learners' satisfaction after, interactive online learning media treatment should be scaled at an excellent level.

4. Scope of the Research

1. The variables used in the research were:
 - 1.1 The independent variable is the developed interactive online media by learners' dominant aptitude of VARK in Computer-based Learning and Teaching Course for computer education students of the Faculty of Science and Technology.
 - 1.2 The dependent variables are quality of content and media production techniques, learners' performance, and learners' satisfaction
2. The population is 76 3rd year students majoring in computer education of Nakhon Pathom Rajabhat University who enrolled in the Computer-based Learning and Teaching Course in semester 2/2020.
3. The sample is 26 3rd students of class 61/13 of Nakhon Pathom Rajabhat University in semester 2/2020, derived by cluster random sampling.

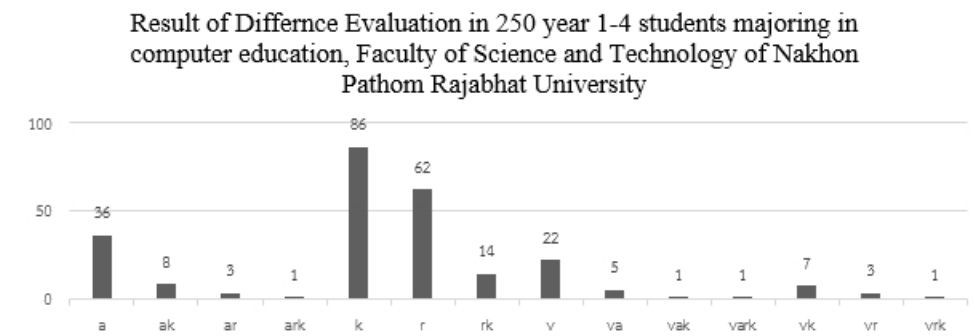


Figure 1: The result of evaluating the students' differences assessment by VARK.

5. Research Methodology

The researcher had applied ADDIE MODEL [7] to develop an interactive online Learning by learners' dominant aptitude result of VARK in Computer-based Learning and Teaching Course for undergraduates of Nakhon Pathom Rajabhat University, by designing teaching based on system approach theory. This is widely accepted to combine with computer education lessons because of macro scope manageable and closed system. The research is divided into 5 phases as follows:

1. **Analysis:** The researcher considered several major important factors in developing the teaching media. The learners' characters in the population of 76 3rd year students majoring in computer education that would be treated with the VARK test were analyzed. The result revealed that 68% are kinesthetic learners. The next process was to evaluate the students' needs in the Computer-based Learning and Teaching Course. Then the researcher had divided the content into 4 learning units: computer instruction design, development of learning management on a cloud computing system, design of individual learning presentation with a video demonstration, and filming and editing technique for video demonstration. Finally, the lesson media development strategy decision, outline planning, and overall scope media settlement had been conducted.

2. **Design:** The researcher determined objectives of behavioral learning outcomes of the media; set up course syllabus; designed lesson plans according to the learners' dominant aptitude by learning style V, A, R and K; developed the interactive online learning content based on the V, A, R, and K learning style; and initiated an evaluation form for the quality of content and media production techniques, learners' performance, and learners' satisfaction.

3. **Development:** The researcher handled as mentioned above as follows: prepared 135 exam items with 45 behavioral objectives with an IOC (The Index of Item Objective Congruence) evaluation from 3 experts. All 135 items had been graded between 0.67–1.00, which meant they are qualified to use in this research. The researcher selected 2 items from each ob-

jective, totaling 90 items, and administered this exam to students that had been treated in this research. Next were 1) finding a confidence level by KR-20 which was 0.65 or 65%, and 2) finding a P exam difficulty that which was 0.03–0.88. There were 2 too difficult items and 3 too simple items. The researcher, therefore, eliminated 5 items so the applicable exam was 85 items. It was divided into 3 parts: 35 items for pre-test, 35 items for post-test, and 30 items for mid-test. After that, the researcher developed the interactive online learning media and 3 experts had been evaluated this developed media. The result of expert evaluation confirmed that content is at an excellent level with $\bar{x} = 4.78$ and S.D. = 0.42, while media production technique is at an excellent level with $\bar{x} = 4.85$ and S.D. = 0.36.

4. **Implementation:** The researcher had developed this media since the previous class of 23 4th year students majoring in computer education of Nakhon Pathom Rajabhat University; and reexamined the accuracy, difficulty, control of the interaction of teaching materials, and imported erroneous and modified to further the process.

5. **Evaluation:** The media of interactive online learning by learners' dominant aptitude result of VARK in the Computer-based Learning and Teaching Course had been applied, evaluated, and reexamined to the sample to acquire effectiveness of teaching and learning media, learners' performance, and learners' satisfaction after receiving the treatment.

6. Results

1. The interactive online learning development by learners' dominant aptitude result of VARK in the Computer-based Learning and Teaching Course for computer education students consisted 4 learning units: 1) computer instruction design, 2) development of learning management on a cloud computing system, 3) design of individual learning presentation with a video demonstration, and 4) filming and editing techniques for a video demonstration. The content was created into 4 lessons. There were 5 developing phases as follows:

- 1) Learners took a pre-test.

2) Learners participated in the interactive online learning development by learners' dominant aptitude result of VARK in the Computer-based Learning and Teaching Course.

3) Learners took a mid-test of each learning unit.

4) Learners took a post-test.

5) Learners responded to a satisfaction form after receiving the learners' dominant aptitude result of VARK treatment in the Computer-based Learning and Teaching Course.

2. The result of interactive online learning development by learners' dominant aptitude result of VARK on 26 3rd year students in the class of 61/13 in semester 2/2020 derived by cluster random sampling are reported as shown in Table 1.

Table 1. The results of developed online learning materials.

Test score	N	Total Score	\bar{x}	Effectiveness
Score of mid-test (E1)	26	30	24.42	81.41
Score of post-test (E2)	26	35	26.73	80.22

According to Table 1, the effectiveness of media had been improved at E1/E2 equal to 81.41/80.22, while is higher than the research standard at 80/80.

3. The comparison of the result of learners' performance after receiving treatment of the interactive online learning by learners' dominant aptitude result of VARK as shown in Table 2.

Table 2. The results of comparison of learners' performance before and after receiving treatment.

Test score	N	Total Score	\bar{x}	S.D.	t	sig
Pre-Test	26	35	12.54	3.83	16.58*	0.00
Post-Test	26	35	26.73	2.93		

** With statistical significance at the level of .05, $df = 25$

According to Table 2, the learners' performance after receiving treatment of the interactive online learning development by learners' dominant aptitude result of VARK is higher than before with a statistical significance level at .05.

4. The result of learners' satisfaction after receiving treatment of the interactive online learning development by learners' dominant aptitude result of VARK is shown in Table 3.

In Table 3, the result of learners' satisfaction after receiving treatment of interactive online learning development by learners' dominant aptitude result of VARK is at an excellent level ($\bar{x} = 4.52$, S.D. = 0.56).

Table 3. The results of students' satisfaction after receiving treatment of interactive online learning development by learners' dominant aptitude result of VARK.

Evaluation report	\bar{x}	S.D.	Opinion
Content and Continuity of Lesson	4.69	0.46	Highest
Visual Language and Audio Font and Color	4.54	0.56	Highest
Lesson Management	4.47	0.62	High
Test	4.42	0.63	High
Total	4.43	0.50	High
	4.52	0.56	Highest

7. Research Discussion

1. The expert evaluation of the developed interactive online learning in the Computer-based Learning and Teaching Course confirmed that the content ($\bar{x} = 4.78$, S.D. = 0.42) and the media production techniques ($\bar{x} = 4.85$, S.D. = 0.36) are at an excellent level, which is greater than research standard. This is the results from the researcher's developing process before conducting this research, as well as analyzing importance and necessity elements to accomplish the research objective and to be capable of an authentic class.

2. After learning with the developed interactive online learning, the performance of 26 3rd year students of class 61/13 in the Computer-based Learning and Teaching Course has been improved with E1 is higher than E2 at 81.41/80.22, which is greater than the research standard with E1/E2 formula at 80/80. This is because learners were asked to take the test immediately after finishing each lesson. To develop the teaching media, the researcher designed the content to respond to the objectives. It is in line with the research of Srichailard & Sinthanakul [8] on "The Development of Web-based Instruction on A Learning Management System for A Competency-Based Lesson Plan with Blended Learning and MIAP Process for A Computer Graphics and Animation Course" that performs at 84.89/82.15 and with the hypothesis appointed the web performance higher than standard at 80/80.

3. The learners' performance after receiving treatment ($\bar{x} = 26.73$, S.D. = 2.93) is higher than of before ($\bar{x} = 12.54$, S.D. = 3.83) with statistical significance level at .05. Thus, the result of performance attains the hypothesis established. This is because the researcher had analyzed the significant factors that affected the development of learning media for example learners' aptitude analysis, managed and developed the content to cope with established objectives, and analyzed the content of teaching media that yielded more efficient and suitable for learners. It is in line with the research of Siksen, Phumeechanya, and Laisema [9], "The Development of System and Collaborative Learning Activities in Ubiquitous Learning Environments Using Computer Tablet with QR Code", which the samples'

learning achievement through the developed system and activities was higher than the pretest at the .05 level of significance.”

4. The learners’ satisfaction after receiving treatment is at an excellent level ($\bar{x} = 4.52$, S.D. = 0.56), which is greater than the set hypothesis. Learners’ eagerness and satisfaction in the content and flow of content possess is average at 4.69. It is correlated with the research of Chawanapaisarn, Varasunun, & Arunyanart [10], “The Development of Mathematics Achievement in Pythagorean Theorem by integrated STEM education of students in Mathayomsukasa 2 of Banglane Wittaya School.”, which stated that students’ satisfaction with STEM learning management is at a high level.

8. Recommendations for Further Research

Recommendations for applying the research results were as follows:

1.1 Lecturers must survey and analyze learners’ dominant aptitude before conducting any lesson in class.

1.2 Lecturers must clearly explain the process of taking pre-, mid-, and post-test. So, the actual score will be gained from a certain learning environment.

1.3 According to this research, learners possessed better performance. However, partial of these lessons might have room to reexamine and validate learners’ potential based on learning by learners’ dominant aptitude result of VARK in of the Computer-based

Learning and Teaching Course for undergraduates of Nakhon Pathom Rajabhat University.

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A process of promoting the publication of research in academic journals among the Faculty of Nursing

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Abstract

This research and development were conducted to promote the publication of research in academic journals of the Faculty of Nursing in 2019. The research process was divided up into three parts: the current situation, the developmental process and promotion of the research publications of the Faculty of Nursing, and the responses to this research upon national publication. There were 50 key participants, including the administrator and faculty members from the Faculty of Nursing, educational and health experts, the head nurse, and registered nurses. The research was conducted with quantitative and qualitative methods. All quantitative results were reviewed by the educational and health experts for a consistency of 0.76. The reliability of the results was measured using Cronbach's alpha coefficient of 0.8. The qualitative method used was data analysis; the percentage frequency, mean, and standard deviation were observed and interpreted.

The results indicated that the research publications in academic journals from the Faculty of Nursing of Nakhon Pathom Rajabhat University exceeded the standard rates by 103.29%. During the process of promoting the research publications, the researchers have allowed to exchange ideas and discussions with registered nurses. It has also resulted in 13 total research publications of national and international caliber. These successes can be attributed to three main causes: using networking as a means to learn and implement nursing techniques, encouraging good budgetary management and efficiently delivering the research publications, and verifying information with experts in the field for accurate presentation of research findings upon publication.

Keywords: Process of promoting, publication of research, faculty of nursing

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1. Introduction

Since the nursing sciences is progressive in nature, the publication of new researches is required to reflect these constantly growing changes. Researchers in this field have a role in sharing their research findings with broader audiences, their fellow peers, and funding sources. The knowledge from these research publications can complement the field of nursing and develop the sciences even further. However, the problem is that there are limitations in the way that they are interpreted and understood. There have also been problems within the organization about the submission reviews for the research publications [1]. Also, research funding sources, appropriate environments for research conduct, convenient research facilities, and research members that are fit for the job are problems that the organization has still not been able to address [2].

Additionally, the research publications that are included in academic journals are important indicators of the quality of the education system [3]. This is reflective on a syllabus level to a degree level and all the way to an institutional level. Obtaining new understandings and applications to the field of nursing is crucial to have deeper knowledge in this area, and with this in mind, it is very important when thinking about the classroom setting [4]. Under the care of faculty instructors, students can familiarize themselves with the ways that clinical settings are run, such as in the ways they can be furthered, protected, and cared for [5]. Utilizing this method of practical learning can allow students to be better equipped when faced with real-world clinical situations in the future [6]. Significantly, the Faculty of Nursing at Nakhon Pathom Rajabhat University offers students the ability to practice their nursing skills at Nakhon Pathom Hospital and Ratchaburi Hospital. Both of these hospitals are very important places in which capable and promising graduating nursing students are produced and put forth

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towards their roles in the future.

Ever since the foundation of the nursing program 10 years ago, there have been continuing problems with the progression of academic work and research publications. Specifically, the amount of academic and research journals published on a national and international basis is decreasing. In part, this can be related to the small number of lecturers available in the faculty compared with a large amount of work that needs to be done in order to make greater development in the field of nursing. Additionally, many lecturers lack the experience and motivation to make advances in their lessons and research, which causes the university to extend the contracts of two of these individuals. Researchers, therefore, have concluded that promoting the publication of research in academic journals is an important process in addressing these problems. To begin the process, there has to be growth in the thought processes of the lecturers to be ready to commit to their work. Once they are ready, they must be equipped with the knowledge and methods that are important in research paper writing. These should all be done under the guidance of experts in writing research on the field of nursing. All in all, lecturers should take active measures in developing their research papers based on the feedback given and foster an environment that encourages one another in times of discouragement.

Nakhon Pathom Rajabhat University has a policy regarding research development to promote and support the lecturers in the university. This encourages more production of research publications and creates academic cooperation between the lecturers and the university. As a result, the university is more willing to endorse monetary funds into publishing research papers, leading to more efficacy of the research. This strengthens the outcome of high-quality published works at a faster rate at both national and international levels. Since the results of assessments of the university and Faculty of Nursing standards are still below the criterion, it is necessary to encourage more publication of research.

2. Research Objectives

2.1 To promote the publication of research in academic journals of the Faculty of Nursing.

2.2 To encourage lecturers to create research that can be published in academic journals and accepted by the public.

3. Research Methods

Research and development are ways to involve both the Faculty of Nursing and registered nurses in curriculum improvement. With the help of these health partners, the quality of the nursing curriculum can be enhanced by the knowledge and experience that they

can offer. In particular, the students can receive practice on the theoretical and practical aspects of the curriculum. With the experiences that each party brings to the table, they can help collaborate, plan, and evaluate the process of promoting the publication of research in academic journals together. This academic and research development plan can be credited to their collaboration, with the help of nursing experts in giving feedback and suggestions in the research production process.

3.1 Population and Study Samples

Informants: The informants is divided into three groups. The first group of informants consists of the administrator, heads of the program, lecturers from five main areas of study, and supporting staff members of the Faculty of Nursing. The second group of informants consists of the head of the nursing department, the head of the academic department, the head nurse, and registered nurses from the hospital. The final group is experts knowledgeable in the field of nursing.

3.2 Study Sample Selection

The method for selecting study samples began by going through information of faculty members and staff of the Faculty of Nursing. Their preparedness to engage in activities involving Nakhon Pathom Hospital and Ratchaburi Hospital were also noted. Another method for selecting research samples was through word of mouth, using the Snowball technique. This method involved the recommendations from the head of the nursing department at Nakhon Pathom Hospital and Ratchaburi Hospital to select hospital staff and specific sample groups. The criteria for the selection was pertaining to the time collected the information. Overall, 50 key informants, consisting of experts in the fields of nursing, research, and hospital care, were gathered.

3.3 Research Location

The research was conducted at Nakhon Pathom Rajabhat University's Faculty of Nursing, Nakhon Pathom Hospital, Ratchaburi Hospital, and a hotel conference in Petchaburi.

3.4 Research Tools

The research tools used were included quantitative and qualitative methods.

3.4.1 Quantitative Method: Evaluation of the Progression of the Activity or Project

This method applied a questionnaire that was divided into 2 parts. **The first part consisted of 8 personal questions** about age, gender, religion, occupation, marital status, income adequacy, and education. **The second part consisted of 10 questions on the**

evaluation of project activities. These included questions about the lecturer, the satisfaction of the activities, the application received relating to the research and the academic curriculum, as well as the level of self-development.

3.4.2 *Qualitative Method: Analytical Tools*

This method was used to observe and record the situation, experience, and competency of the lecturers in conducting research as a context to compare and analyze with the content. The attitude of the lecturers when participating in organizational activities was also observed and recorded using the matrix content table in relation to the goal of the research created by the researcher. The tools used were a focus group guideline, an interview guideline, a participation guideline, and an audio-tape recorder.

3.4.3 *Evaluating the Quality of the Tools Used*

The quantitative tools used in this research were reviewed for content validity by 3 research experts who are nursing lecturers. They also looked at the index of consistency (IOC) of the questionnaire, which was found to be 0.76. To make improvements, the language of the research was modified to make it easier to read. The reliability of the questionnaire was tested with 30 samples, which revealed a Cronbach's alpha coefficient of 0.8. Moreover, the qualitative tools were checked for credibility. For the information that was provided in the research, it was cross-checked using data triangulation of methodological triangulation. The conformability of the information gathered in the interviews was also determined by checking its accuracy and concordancy with one another.

3.5 *Research Procedures*

3.5.1 *Procedure 1: Studying the System and Layout of the Research*

This procedure was done in order to compare the results gathered from the research study with factual information. The competency of the lecturers was also determined. Likewise, this procedure served to involve the participants with problem-solving and making goals for the research. This activity was done at Nakhon Pathom Hospital and Ratchaburi Hospital. The participants were faculty members from the Nakhon Pathom University's Faculty of Nursing, the head nurse and head of the nursing department, and registered nurses with experience in these activities.

3.5.2 *Procedure 2: Determining the Process of Promoting Research Articles for Publication and the Outline for Completion*

This procedure served to present the results from the first procedure and to determine if they were accurate. This involved the gathering of ideas about the strengths and weaknesses that the research had and any further improvements that the research could

take. As a result, the faculty members and registered nurses could plan their research and determine the steps needed to publish their research papers.

3.5.3 *Procedure 3: Receiving Guidance from Experts in the Field of Research In Order to Produce Research of High Enough Quality to Be Considered for Publication*

A conference was organized to apply the information received from the second procedure, such as the research draft and outline, along with the research and academic articles for publications. The purpose of this procedure was to develop the quality of research and prepare it for publication. All this procedure was done under the guidance of research experts.

3.5.4 *Procedure 4: Developing and Improving Upon the Research Articles to Improve Its Quality for Publication*

This procedure was conducted to evaluate and prepare for the process of promoting the research publications in academic journals from the Faculty of Nursing.

3.5.5 *Procedure 5: Conclusions on the Promotion of Research Publications in Academic Journals*

Setting goals to evaluate how to promote the research publications in academic journals.

3.6 *The Ethics of Research and Safeguarding Sample Groups*

The ethical morals of researchers are very important, especially when it pertains to gathering data from human research. Therefore, in this research study, it was necessary to give clear and sufficient information to the participants on how the data was going to be gathered. These included the main aspects of the research, such as its purpose, gain, reasoning, and procedures chosen. Additionally, questionnaires remained anonymous and permission to record participants' voices was received. Those in the research voluntarily chose to participate and were made clear that they could leave at any stage in the research without causing any damage. The participant anonymity was kept at all times, and their personal information was never revealed.

3.7 *Data Collection*

The researchers prepared ethical certificates for the sample group throughout every procedure of the research. Letters of permission to conduct research were also sent to Nakhon Pathom Rajabhat University, and the directors of Nakhon Pathom Hospital and Ratchaburi Hospital. The data was collected from March 17, 2020, to March 6, 2021, with the observation of participant interviews. The process of gathering data was divided into 4 steps, each taking no longer than 2 hours. Discussions within study circles were collected throughout specific activities given.

3.8 Data Interpretation

The process of data interpretation involved analyzing the quantitative results of the questionnaires with the percent frequency, mean, and standard deviation. The qualitative results were also analyzed alongside. For both the quantitative and qualitative methods, data needed to be recorded throughout the scope of the research. In this particular research study, content analysis was done to explain the objectives and content of the research and how each data collected conveyed a distinctive message. This was done by analyzing the content of the recorded sample group interviews and organizing them based on patterns. It could then be interpreted and corroborated with each other.

4. Study Results

4.1 Part 1: General Information on the Participants

50 participants were asked to answer the provided questionnaires, with the majority being 41–55 years of age (22 individuals). 98% (49 individuals) of the participants were female. All (50 individuals) of the participants were Buddhist. 50% (25 individuals) of the participants were lecturers or assistant Professors. 66% (33 individuals) of the participants were married. 82% (41 individuals) of the participants said that they had sufficient incomes. 94% (47 individuals) of the participants held graduate degrees.

Results of the analysis of the nursing lecturers' experience and capability showed that all lecturers have their work published in one journal in a span of 5 years. 22 of the lecturers have had their work published in 6 national journals (96.66%). Lecturers that have completed or were about to complete their international doctoral degrees have had experience with publishing international research (8.34%). As a result, previous research work has affected on the development of future research work. All the lecturers have goals to publish at least one research paper per year, but many factors are hindering that process. Since many lecturers lack the time, do not have enough guidance, have too much workload, and lack reinforcement at work, workshops can be a way to help them become more motivated to work again. In their own words:

"...I want to write research but I have no time because our faculty doesn't have enough lecturers to teach. I also have shifts at the hospital, so I really don't have the time. Also, since COVID happened, I have even less time because I have to teach online... this has really made me lose motivation to work and find inspiration to write research... having a workshop could be helpful, I guess..." (FG005)

"...the dean has always told us to write at least one research paper per year, but I can't do it. My past experiences haven't been helpful for me. I want

someone to help guide me through it. Of course, I want to write research. The support system here is really good. However, I really don't have the time..." (FG 024)

"...when I was studying for my Ph.D., I had to write my thesis in English, so I kind of know the basic outline of what to do. I've also been doing it continuously. The university has appointed a clinic to help guide me through it, and they have given sufficient funds for it, which has given me the motivation to do research. It's just that my duty of teaching has been taking up much of my time. I barely have any days off... I need to find a time to relax first, which will be able to help me write research of higher quality..." (FG003)

4.2 Part 2: Evaluation of the Project Activities

After the project activities encouraging participants to create research that can be published in journals and accepted by the public, we found these factors include **the lecturer, the satisfactory rates of these activities, the helpfulness of these activities, the research and academic results, and the level of self-development**. The evaluation of the questionnaire results was done to assess the implementation of the activities and projects in Phase 3 of the research. The overall picture shows a very high level (mean of 4.40; standard deviation of 0.60). The participants were overall satisfied with how the activities were planned out (mean of 4.52; standard deviation of 0.60), and the application that they were able to get out of it (mean of 4.580; standard deviation of 0.70).

4.3 Part 3: Assessing a Small Number of the Research Results Based on a Survey of Academic and Research Publications in the Past 4 Years

The Faculty of Nursing at Nakhon Pathom Rajabhat University had a small number of research papers published in the past four years between 2016 and 2019. In 2016, the Faculty of Nursing had 28 lecturers. In 2017, 2018, and 2019, there were 28, 25, and 24 lecturers, accordingly. In those four years, the number of research papers published did not meet the standard for accreditation that the Nursing Committee had put in place. Only 30% met the criteria of the Office of Higher Education Commission. Nevertheless, in the last three years, it is estimated that there has been a 109.23% increase of research publications by the faculty from the standard amount.

Lesson learned from the situations mentioned, the researchers had decided to enact steps in developing and promoting the research publication of the Faculty of Nursing. The conclusion reached was made through the **"learning model to develop and further promote the research publication of the Faculty of Nursing"**. Development was made to help tackle the problem and needs of the Faculty of Nursing lecturers. Many have said that they wanted guidance from

Table 1. Shows the percentage of general information from the participants.

General Information	Number of Participants	Percentage
Age		
26 - 40	20	40.00
41 -55	22	44.00
56 years and above	6	16.00
Gender		
Female	49	98.00
Male	1	2.00
Religion		
Buddhist	50	100.00
Occupation		
Register Nurse	25	50.00
Lecturer, Assistant Professor	25	50.00
Marital Status		
Singer	17	34.00
Married	33	66.00
Income		
Sufficient	41	82.00
In sufficient	9	18.00
Education		
Graduate Degree	47	94.00
Bachelor's degree	3	6.00

Table 2. Evaluation of the questionnaire results to assess the development of the activities.

Evaluation of the Project Activities	Mean + SD	Meaning of the Results
1. The Lecturer	4.07+0.68	High
2. The Satisfactory Rates of These Activities	4.52+0.60	Highest
3. The Helpfulness of These Activities	4.58+0.70	Highest
4. The Research and Academic Results	4.38+0.51	High
5. The Level of Self-Development	4.48+0.51	High
Total	4.40+0.60	High

experts and help from fellow lecturers who had similar interests. This would enable them to develop more interest in their work and be able to further their research together. There have been suggestions to call in help from fellow lecturers at different institutions to give advice and help in the process of conducting research. 24 people participated in the workshop provided in the study (85.71%). The participants submitted the drafts of their research, which amounted to 12 papers (50.00%). From the questionnaires, it can be concluded that many lecturers did not have the time and expertise to conduct research. In order to write a research, there are needs of extensive planning and outlining. The ethics of research in humans is a very difficult ground to tread because many experts do not understand what participatory research stands for. For ethical purposes, quantitative methods should be used when submitting research outlines. This will allow the research process to be more easily transpired, and thus, discourage the process of producing academic or research work. Nevertheless, the clear development that has come out of this study is that the lecturers have gained more motivation to create research, along with the collaboration of registered nurses. A sense of pride and a development of a good relationship between the

lecturers and registered nurses can bring about a better environment for research production.

The research model for the development and promotion of research publications from the Faculty of Nursing is a process of taking the first draft of the research and making corrections to improve upon it. This is done through applying the knowledge received from the workshop and developing it through the efforts of the Faculty of Nursing. The funds of 50,000 Baht that were allocated for this project can also help to promote and develop the project further.

It has been shown that the desire for academic and research publications from registered nurses under the cooperation of Nakhon Pathom University and Ratchaburi Hospital is high. However, the number of lecturers and expert they have are not in line with the role that they need to take when participating in research. Since they are unable to operate within the faculty, they have to set up the activities at another place and within a specific time limit. This ensures that the activities can be completed in a smoothly manner. It can be concluded that the cooperation between nursing lecturers and registered nurses, and the activities organization outside of the faculty have helped in developing research.

Feedback from the Research Publications in National Journals: 13 research papers were published in total. 6 papers (5 research, 1 academic) have appeared in national conference journals. 2 papers (1 research, 1 academic) have appeared in the national TCI Base 1 journal. 8 papers (9 research, 1 academic) have appeared in the national TCI Base 2 journal. 2 papers (both research) have appeared in international ACI journals.

5. Discussion of the Results

From the research results, the researchers have compiled interesting conclusions. The research publications from the Faculty of Nursing in the year 2019 (funds from 2020) have seen quite an amount of success. This included the use of networking as a means to collaborate on academic work. Additionally, there was also the management of resources to promote and speed up the process of research publication [6]. The resources were also allocated for workshops outside of the faculty that helped to bring together nursing lecturers and nurses working in hospitals. Lastly, the management of resources by qualified research experts has created more trust in making research.

These management concepts were based on the theory of motivation [3, 6], which states that human motivation comes from motivating and supporting factors. Specifically, the motivation factor is a person's response to their internal need for success [7, 8]. To be able to obtain recognition in their work and accept responsibility in the work that they do are the greatest motivations⁹. Additionally, the supporting factor is an opportunity for a person to gain advancement in life. The policies and ways in which they do their jobs relate back [10, 11]. The process of developing research publications requires the improvement of promoting research and giving equal work to all involved [12]. Rujira Jeamamornrat and Oraachorn Intongpan (2014) stated that the way to improve the process of research production and publication requires 4 components [13]. These include policies and plans on how to promote the research [14], needs to measure how lecturers can create and publish research [15], a system to motivate people to start writing research, and research management that can facilitate more research. In Supaporn Pongpinyo-o-pas, Tuanthong Chaowakeeratiphong and Raykhar Aranyavong's research (2013), they have stated 3 key strategies to enhance the quality of research management. The first strategy is making sure that the information from the research is accurate and includes participation from all parties involved. Research experts should also be available to go over all the information. The second strategy is setting up platforms where the research can be looked over and evaluated for quality. The final strategy is ensuring the research is completed in time and up to date with the latest discoveries of the present

and potential future.

This process of research publications promotion has been approved on a national level in the academic year of 2019 at the Faculty of Nursing. This benefits the faculty by offering a learning model for promoting research publications in a variety of subjects in the nursing sciences. Additionally, it also helps to develop a more easily accessed system and improves the quality of nursing care. Nevertheless, in order to develop the field further, applications should be used to communicate with all groups of people, including nursing lecturers, students, and professional nurses. This concept is compliance with Ketkanok Urwongse's study (2017), which states that the strategy to promote the application of research should include improving the quality of the research to be more reliable [16]. Notably, the uses of the research should be highly emphasized. All in all, creating a network to develop the quality of the research, promoting a creative environment, and improving upon the ways that the research can be conveyed to general audiences are very important [14]

From the results of the research, there has been no research paper that has successfully gone through the process of research promotion before. Therefore, the researcher would like to summarize from the experience of creating research from other organizations to produce more academic works in the future.

5.1 Suggestions

1. The concept of preparing for nursing training workshops can help to expand the network of promoting the research publication of the Faculty of Nursing. Particularly, the development of a networking system collaboration of research work can help to promote the research in the future.

2. The lecturers at the Faculty of Nursing should get the opportunity to attend workshops that can promote their research.

3. The hospitals that serve as training centers for nursing students should seek cooperation with nursing institutions to develop and prepare curriculums to promote the research publication. This can enable nurses to move further up in their ranks at a faster rate.

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Development of sustainable consumption and production indicators for industrial sector according to circular economy principles in Thailand

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Abstract

This research aimed to: (1) investigate the sustainable consumption and production indicators for industries as well as difficulties and limitations in using the indicators for the Eco-Factory program under the Federation of Thai Industries; and (2) develop the sustainable consumption and production indicators for Thai industries based on the Sustainable Consumption and Production Roadmap 2017–2037 and circular economy principles which are part of Thailand's long-term strategic plan of the national industrial development goals based on the BCG Model (Bio–Circular–Green Economy Model). At present, there is none of academic study on the Sustainable Consumption and Production (SCP) indicators for sustainable development at the micro level for industry in Thailand. This research focused on stakeholder involvement in developing indicators through surveys, an in-depth interview, a focus group meeting, a seminar, and a workshop. The study achieved the final version of SCP indicators (26 sets of indicators, 60 sub-indicators) consisting of 4 dimensions including environmental, social, economic, and good governance dimensions. Recommendations for implementation of indicators are (1) initiating a pilot project to support practical implementation in the industrial sectors based on industrial types including upstream, midstream, and downstream industries; (2) conducting a periodic review of the indicators, such as every 3 years by entrepreneurs and other sectors, and there should be standards, evaluation, and certification based on the circular economy standards of Thai Industrial Standard Institute (TISI); and (3) supporting the information provision and workshop at the first step to promote the readiness for the industries interested in the implementation, as well as supporting the sustainability reporting of indicator implementation, and creating a network of collaboration between industries.

Keywords: Sustainable development, sustainable consumption and production, indicator, circular economy, Thai industry

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1. Introduction

Thailand has strongly emphasized sustainable consumption and production (SCP) due to the limitation of natural capital as well as the ecological footprint, which is lower than the existing ecosystem capital. For the industrial sector, manufacture has exploited resources and simultaneously created an environmental impact from its production activities. After participating in the United Nations Conference on Environment and Development in 1992, Thailand developed various plans and strategies, which progress beyond other countries in the ASEAN Community, especially the 11th National Economic and Social Development Plan (2012–2016) to the 12th National Economic and Social Development Plan (2017–2021) proposed by the Office of the National Economic and Social Development Council (NESDC) to pursue the green growth

or green economy [1, 2]. Additionally, in 2019, the government promoted the New Sustainable Growth Engine or BCG model that includes developing bio-economy, circular economy and green economy concurrently. The model aims to develop the economy of the country and correspond to the Sustainable Development Goals as well as sufficiency economy that create a base for SCP operations [3]. The Office of Natural Resources and Environmental Policy and Planning (ONEP) identified strategies, adjusted consumption and production bases to eco-friendliness, and developed the 20-year Sustainable Consumption and Production Roadmap 2017–2036. The consumption and production goals are specified based on 3 main strategies comprising of lifting Thai society to meet sustainable consumption strategy, sustainable production strategy and supported factors for sustainability strategy [4].

Therefore, the SCP Roadmap of the manufactur-

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ing strategy has proposed the goal that “Thai industry becomes intended to be sustainable manufacturing industry in a socially responsible and environmental-friendly way as well as emphasizes on manufacturing process development, Green Industry certification, and integrated industrial waste management” [4]. It has specific indicators, such as the number of the factory that obtain the certificate of the Green Industry within 2021 with 2,000 additional green factories each year, and the number of industrial estates that are certified as Eco Industrial Town with the annual increase of not less than 4 estates [4] pp 13. However, the SCP Roadmap was revised in 2019 in which goals and objectives for industry sectors are more specific and correspond to SDG12. There are 19 SCP indicators with targets required for industry sectors to achieve by 2037 [5].

Conforming to the Sustainable Industrial Development Policy 2015 presented by the government, the Federation of Thai Industries, the Industrial Estate Authority, and the private sector collaborate to develop Eco-Factory criteria for entrepreneurs in manufacturing sectors. The entrepreneurs who are certified can equate to achieving the Green Industry Level 4 [6]. There were 247 entrepreneurs in manufacturing sectors who achieved the certificate (in November 2020). The criteria of assessing Eco-Factory are based on sustainable industrial development principles which comprise of 14 aspects covering all dimensions (i.e., social, environmental, and economic dimensions), and they are also specified as indicators of sustainable industrial development [6].

Accordingly, the development of SCP indicators is important in following up the achievement of implementation objectives based on SCP policies. Since the policies are complicated, related to process in diverse dimensions, and associated with many organizations (i.e., public sector, private sector, and civil society organizations), the objectives and goals of the policy implementation cannot be achieved if the indicators are not suitable. Besides, “the data implementation of sustainability industrial indicators is in a limited group or limited area, which conduce the data of developing sustainable development guidelines.” [4].

As observed, in Thailand there is no study concerning the current sustainability indicators of the Thai manufacturing sector (micro level) whether they are practically suitable to the industrial development as well as the limitations of using these indicators in the contexts of national policies that support the economic growth under green economy and corresponding to the circular economy principles. Thus, the study on development of sustainable consumption and production indicators for industrial sector according to CE principles in Thailand will be very beneficial for relevant sectors as well as in assessing goals achievement stated in the SCP Roadmap of Thailand.

2. Research Questions

1. What are the obstacles and limitations in implementing the existing sustainable development indicators for industries in Thailand?
2. What sustainable consumption and production indicators for Thai industries based on the Sustainable Consumption and Production Roadmap 2017–2037 and circular economy principle should be?

3. Research Objectives

1. To investigate obstacles and limitations in implementing the existing sustainable development indicators for industries in Thailand under the Eco-Factory program initiated by the Industrial Estate Authority of Thailand and the Federation of Thai Industries.
2. To develop sustainable consumption and production indicators for Thai industries based on the Sustainable Consumption and Production Roadmap 2017–2037 and circular economy principles.

4. Research Methodology

This qualitative study was conducted using the grounded theory as well as top-down and bottom-up approaches in developing indicators. These approaches were accepted as a suitable process of the indicator development for practical implementation [7]. The target group of this study including 8 groups of industries certified as the Eco Factory, generating 64% of the GDP original from manufacturing at current market prices in 2017 [8]. There were 168 industries including industries of food products, coke and refined petroleum products, chemicals and chemical products, rubber and plastic products, computer, electronic and optical products, electrical equipment, motor vehicles, trailers, semi-trailers, and other transport equipment, which obtained 67% of the total number of 247 certified Eco Factory (in November, 2020).

4.1 Development of the First Draft of SCP Indicators

The research procedures began with reviewing the literature such as reports and researches related to the national policy on sustainable development and the sustainable indicator development at the industrial level in Thailand and other countries in order to develop the 1st draft of SCP indicators. The conceptual framework is shown in Figure 1.

4.2 Revision of the Developed SCP Indicators: The Second Draft of SCP Indicators

A survey (no. 1) and an in-depth interview with the representatives of target industries were then conducted to gather comments on the 1st draft, and the indicators were revised based on the comments as the 2nd draft of SCP indicators.

4.3 Finalization of SCP indicators.

The 2nd-draft indicators were considered through a focus group discussion and a survey (no. 2) of the Eco Factory working group comprising representatives of the public and private sectors. After that, the suggestions from the seminar were used to improve the indicators as the 3rd draft of SCP indicators. Finally, the 3rd-draft indicators was validated through a workshop and a survey (no. 3) by representatives of the target entrepreneurs and the Eco Factory working group to consider the implementation practicality as well as to investigate the difficulties and recommendations. Then the summarization of the research result was made.

5. Results and Discussions

The development of sustainable development indicators for Thai industries is corresponding to the international sustainable development indicators, Eco Factory criteria, and the SCP Roadmap based on the CE principle, which contains 4 dimensions considered as 4 pillars for SD. In addition, the indicators associated with the policy indicators as well as micro- and macro-level indicators. To make a theoretical conclusion of the sustainable development indicators for Thai industries, the drafts of developed SCP indicators were examined by the stakeholders who play a role in developing and implementing the sustainable development indicators for Thai industries and have been working on this issue for more than 5 years. The main findings are as follows:

5.1 Development of the First Draft of SCP Indicators.

As mentioned in 4.1, the 1st draft of SCP indicators was developed based on the framework. It consisted of 28 sets of indicators and 78 sub-indicators. The literatures reviewed for developing the 1st draft of SCP indicators are:

1. International academic studies conducted on the industrial indicators for sustainable development, sustainable production and sustainability. GRI and Sustainability Assessment of Food and Agriculture Systems (SAFA) [11]-[15].
2. Eco Factory criteria [6].
3. Thai SCP Roadmap specifying goals, targets, and indicators for Thai industries as the national plan [5].
4. Six principles under the circular economy concept are applied into drafting the indicators [10].

5.2 Revision of the Developed SCP Indicators: The Second Draft of SCP Indicators.

The 2nd draft of SCP indicators was developed after conducting the 1st survey (20 respondents, 76 representatives of the factories) and the in-depth interview (6 respondents) with target industry. The 1st draft

of SCP indicators was revised and improved based on suggestions of the survey and the in-depth interview as shown below.

1. Environmental indicators. Sub-indicators of materials resource efficiency, water and wastewater intensity, and greenhouse gas emission intensity were adjusted by measuring per product instead of the monetary and avoiding absolute value sub-indicators. Air emission management efficiency should be modified to the volume of air emission reduction to show the higher performance. The logistics indicators should be added as the number of accidental sub-indicator and complaints of product transportation process per year.

2. Social indicators. The proportion of permanent and temporary staff sub-indicator should be deleted from the employee indicators due to the impracticality of employment in the business.

3. Economic indicators. The ratio of standard entry level wage by gender compared to local minimum wage at significant locations of operation sub-indicator should be deleted from the cost/expense indicators as it was not practical for employment in some businesses and there were various types of industry.

4. Good governance indicators. The code of conduct for mission statement sub-indicator should be added in the corporate ethics indicators.

To sum up, 6 sub-indicators of the 1st draft were deleted. The 2nd draft of SCP indicators consisted of 28 sets of indicators and 72 sub-indicators.

5.3 Finalization of SCP Indicators.

The 3rd draft of SCP indicators was developed and verified by the 5 activities described in 4.3. From those activities the industries' opinions on obstacles of implementing the SD indicators complied with the experts, the Eco Factory working group, and public sectors. Regarding the obstacles of implementing the indicators based on the 14 Eco Factory criteria, the experts claimed that there were obstacles to 11 criteria for implementing the indicators (such as biodiversity, materials management and green supply chain, green landscape management), which was consistent to most stakeholders. The obstacles to the implementation based on the same criteria were mentioned by both the experts and the industry. The specified obstacles are significant as the industrial entrepreneurs who gave opinions towards the improvement are in the manufacturing companies in the large-scale upstream industries that utilize the intense and modern production technology with readiness of human resources and capitals. Moreover, some of them have conducted the report based on the GRI international sustainability reporting and they are in the DJSI List. Thus, the obstacles are mainly on Eco Factory criteria.

All comments and suggestions were taken into consideration to improve the indicators. In summary, the

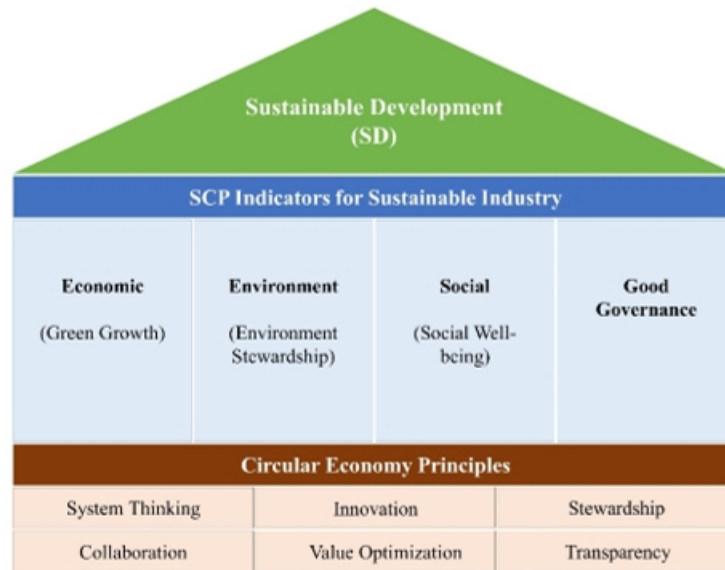


Figure 1: The conceptual framework of SCP indicator development for sustainable development for Thai industries [9–11].

final version of SCP indicators for sustainable development for Thai industries consisted of 4 dimensions (26 sets of indicators, 60 sub-indicators) as follows:

1. Environmental dimension (11 sets of indicators, 32 sub-indicators): These indicators corresponded to the indicators in the SCP Roadmap on 5 out of 8 goals for manufacturing sectors, CE principle, system thinking, innovation, value optimization, and stewardship in terms of indicator operation by covering life cycle thinking, impacts of product life cycle, efficiency of resource consumption, intensity renewable materials and renewable energy, hazardous material, % symbiosis, waste and wastewater, energy intensity, greenhouse gas management, logistics, technology, and supplier.

2. Social dimension (4 sets of indicators, 11 sub-indicators): These indicators expressed the social responsibility of the organization that reflected the sustainable responsibility to stakeholders in all dimensions as well as the creation of collaboration, stewardship and transparency for worker, customers, consumers, communities, and employees based on the CE principles.

3. Economic dimension (5 sets of indicators, 9 sub-indicators): These indicators could track the economic sustainability of the organization, which were revenues and profits, employment expense, environmental expense, investment on research and development, eco-innovation, technology transfer and machine usage efficiency, green procurement, and local procurement.

4. Good governance dimension (6 sets of indicators, 8 sub-indicators): These indicators strengthened sustainable development of the organization with the indicators of corporate ethics, ethical behavior, accountability, sustainable risk management action plan,

holistic management and participation. Furthermore, these indicators helped tracking whether the operation of the organization was sustainable and efficient. Figure 2 showed the final version of SCP indicators in 4 dimensions.

The number of set indicators was equal to other studies recommending for the industrial sustainable development [12]. The important perspectives of stakeholders towards the sustainable development framework emphasized on environmental issues and gave higher weight on economic indicators in eco-efficiency than other indicators, such as indicators of technology and production equipment investment efficiency, or social indicators. The sustainable development needed to create balance in all dimensions simultaneously; therefore, there should be sufficient indicators to monitor and evaluate the sustainable development progress in short term, medium term, and long term [16].

6. Conclusions

The research reviewed literature on the development of SD indicators for industrial sector and the accepted SD indicator standards, such as the international academic studies, Eco Factory criteria, the SCP Roadmap, and the CE principle. The indicators development in this research employed 3 surveys of stakeholders including target industries, Eco Factory working group, related government agencies and experts. In addition, the in-depth interview was conducted on industries, and the focus group meeting was conducted on the experts and governments officers who are responsible for Eco Industrial Town Promotion. The limitation of this research is that its target industries who participated in the study were mainly

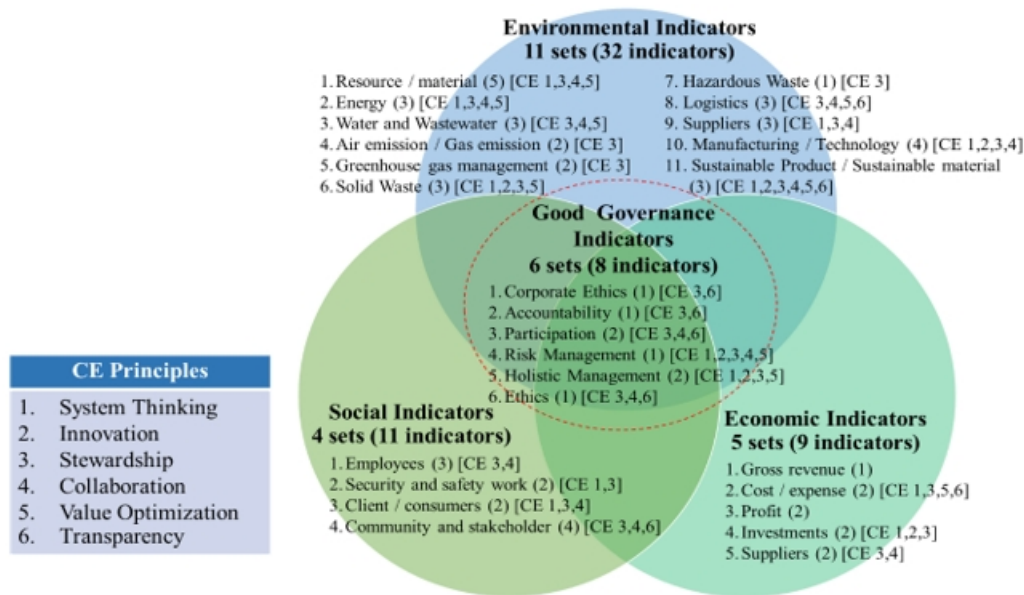


Figure 2: Sustainable consumption and production indicators for industrial sector according to circular economy principles in Thailand.

Table 1. The final sets of SCP indicators are consistent with CE and can be identified according to the 6 CE principles as follows.

CE Principles	Environ- mental	Social	Economic	Good Gov- ernance	Total
System Thinking	6	2	2	2	12
Innovation	3	n/a	1	2	6
Stewardship	11	4	3	6	24
Collaboration	7	3	1	4	15
Value optimization	6	n/a	1	2	9
Transparency	2	1	1	4	8

the large-scale group, while there was only one small and medium scale.

From this research, the 26 sets of indicators with 60 sub-indicators were developed, and these indicators could be categorized by dimension as follows:

1. Environmental dimension having 11 sets of indicators with 32 sub-indicators
2. Social dimension having 4 sets of indicators with 11 sub-indicators
3. Economic dimension having 5 sets of indicators with 9 sub-indicators
4. Good governance dimension having 6 sets of indicators with 8 sub-indicators

The benefits of the indicators are reduction of resource expense and promotion of positive image to communities and customers who could create more systematic development plans, and environmental resource, and emission management goals. The set of SCP indicators would be able to enhance Thai Industries to monitor and assess their sustainable level consistent to the SCP Roadmap and the BCG policy. This can also strengthen the transition of their future business models into the circular economy.

7. Recommendations for Implementation of the Indicators

7.1. There should be a pilot project to support practical implementation in the industrial sector based on the industrial types including upstream, middle-stream, and downstream industries or based on the industrial sizes including large-, medium-, and small-scale industries. This is due to the differences of readiness conditions in implementing the indicators, such as the environment of the upstream, middle-stream, and downstream industries, or technology utilization, resources, employees, market, and investment.

7.2. There should be periodic reviews of the indicators, such as every 3 years by entrepreneurs and other sectors. Moreover, there should be standards, evaluation, and certification based on the circular economy standard of Thai Industrial Standard Institute (TISI).

7.3. There should be a consideration on supporting the information provision and workshops at the first step to promote the readiness for the industries who are interested in implementing the indicators. In addition, there should be supports to the sustainability reporting of indicator implementation and creation of collaboration network between large-scale industries with the readiness in conducting the sustainable development and being a mentor in supporting the medium-

and small-scale industries who lack of readiness on the issue.

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An evaluation of a Lexiles–based reading management system

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Abstract

This study reports on a trial use, in independent extensive reading over a three–month period, of an online reading management system, with low proficiency non–native speakers of English (EFL/TESOL) at a Taiwanese university, in order to evaluate its effectiveness in increasing reading proficiency. The system used the controversial Lexile measure, of both text difficulty and reader ability level, to match readers to texts. Data was gathered with the software package’s objective measures of reading proficiency, text comprehension and number and type of texts read, to which the researchers added a reader attitude questionnaire. While student attitudes towards the visual aspects of the system and its wide range of reading topics were favorable, the system was found to lack support for non–native readers who attempt to read more challenging texts and would benefit if it improved how it explains and uses lexile scores. Over the trial period, comprehension on tests that immediately followed reading fell as text difficulty increased over time. Scores on the reading proficiency test provided by the system decreased slightly but significantly, throwing doubt on its validity over short periods of time. In addition to limitations of the system itself, reading improvement was found to be related to the level of texts which students chose to read, but not to how many or their length. The implication is that increased efforts must be made to convince students not to read at a level way below their personal lexile level when improving proficiency is the goal.

Keywords: Graded reading, lexiles, proficiency, fluency, extensive reading, EFL, TESOL

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1. Background

Reading is widely accepted as a crucial skill in foreign language learning [1], [12]; therefore, any resource, electronic or otherwise, that can promote it is to be welcomed. Furthermore, people learn to read, and improve other skills through reading, better if they independently read materials, typically out of class, that is graded to suit their current reading ability, either through selection or adaptation [1, 2]. Many studies have shown that this form of graded reading can improve reader comprehension [3, 4], as well as reading proficiency [5], writing skills [6], and vocabulary [3], [7, 8].

This study concerns the evaluation of a Lexiles–based online English reading management system, whose aim is to promote reading in just that way. It offers students a variety of graded texts to read, tracks which texts students read, and measures text comprehension and general proficiency.

1.1 Digital Reading Management and Lexiles

A complete system for achieving this, whether implemented by a publisher of graded readers as in the past [9] or by a digital reading management system

(DRMS) such as we consider here, requires three components, not all of which are fully understood or always successfully implemented [10]. It must measure (a) the difficulty of reading texts, and (b) the reading proficiency of readers, and it must (c) have an appropriate method of matching the two so that readers are offered texts at the most suitable level to help them improve. The widely advertised system of Lexiles promises exactly that [11].

Measuring text difficulty (a) has a long history of relying either on holistic expert intuition [12] or on selected objective indicators of difficulty as a whole, such as topic [13], vocabulary frequency [14–16], word and sentence length as used by ‘readability’ measures such as Flesch, Fog, and Coleman-Liau [17, 18], or more sophisticated measures such as the number of passives or clauses per sentence [19, 20], type–token ratio, and vocabulary frequency profile [21, 22]. Lexiles apparently rely just on word frequency and sentence length, omitting not only other linguistic measures but also relevant matters such as the topic, genre (e.g. linear narrative is usually easier), the number of pictures, etc. These measures then provide a useful but only approximate way of making or selecting progressively harder texts.

Reader proficiency (b) equally can be measured either by expert judgment, especially of a teacher rec-

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ommending a book to a pupil (e.g. [1]), or by objective tests [23]. The former has the advantage that factors like student knowledge of, and interest in, particular topics and genres can possibly be taken into account. It is still widely relied on, as evidenced for example by netTrekker d.i. [24]. A more objective approach to (b) involves actually testing reading proficiency of the student (whether an L1 or L2 speaker), e.g. by multiple choice reading comprehension questions after a short text is read, or from filling cloze gaps in a text. This side of the equation is less well developed [17], but a DRMS can only be effective and truly adaptive [25] if it incorporates regular reader proficiency testing, which a lexiles-based DRMS can.

The third and most controversial DRMS requirement (c) is automatising a connection between measures of reading proficiency and measures of text difficulty/readability. In the past, elaborate lists of claimed correspondences were used between the levels of text identified and scores on reading tests adopted by publishers [10]. A more recent approach exploits the increasing popularity worldwide of the Common European Framework of Reference (CEFR) as a reference scale with which language proficiency tests and exams of all types can be calibrated. It identifies and describes six levels, from beginner A1 through A2, B1, B2, C1 to C2 highly proficient. Websites such as *Text Analyser* [26] then use computerized text measures of word and sentence length, plus word frequency in the language, to assign reading texts also to CEFR levels. However, a system working with only six categories is not really refined enough to tell a learner precisely what text is just at their level for independent reading.

A lexile-based DRMS overcomes this by using a 0 to 2000 lexile scale both to assess reading text difficulty and to measure reader reading ability [27–29]. The precise system used to measure, and achieve parity between, lexiles as both a text and personal proficiency measure is in the hands of MetaMetrics Inc. The lexile system then comes with a recommendation for use thus. If a student takes a reading test score for example lexile 880L, then the system predicts that books with lexile scores from 100L below 880L to 50L above would be suitable. In that, it is claimed a reader should understand at least 75% of what they read. One such book, for example, is J K Rowling's *Harry Potter and the Sorcerer's Stone*.

This recommendation, however, must be seen as contentious. First, researchers suggest that comprehension scores of at least 92% [30], rather than 75%, are required to allow a text to be read without interruptions to look up unknown words and the like being so frequent as to destroy the reading process. In order to achieve that, a reader would in fact need to read a text with a lexile below their personal lexile by around 25%. For instance, a reader with lexile 880L would have to be matched with a book of 660L like *Arthur, for the Very First Time* by Patricia MacLachlan.

Second, the difficulty of the text relative to reader proficiency needs to be fine tuned in relation to the purpose of reading. Krashen [31] and Chiang [32] stated that acquisition occurs when the learner is exposed to comprehensible input, characterized as 'i+1', meaning input that is just a little beyond the learner's current proficiency level (i), so maybe +10L to +100L above learner calculated lexile level. This allows comprehension to occur but still offers some new language to be learned. For Krashen, input at i or i-1 (i.e. with a lexile below the reader's calculated lexile) will be comprehensible, but too easy and not enable learning to occur as a new language would not be introduced. On the other hand input at i+3 would not be understandable, so again not lead to acquisition. A similar concept is found in social theories of learning with the zone of proximal development, i.e., a zone just beyond the learner's current capability, in which social interaction may have a beneficial effect on acquisition,[33–35].

In contrast to the above, Nation [36], for example, makes the point that while input at i-1 or indeed i-3 may not help proficiency in the sense of language knowledge to develop, it can serve a useful separate role in developing fluency, here reading speed [37]. That is, material -100L or more below a reader's calculated lexile level, while not assisting language learning in the sense of increasing stored language knowledge, can be used to give students an easy read that allows them to become quicker at retrieval of what they know. There is additionally a third important kind of learner purpose, which is not to read for any language development purpose at all, but purely to enjoy or learn from the content of what is read. That is prominent for example in non-native students studying their major, such as medicine, nursing, or engineering, through the medium of English. Their ideal reading material would again be below their calculated lexile, but instead of increased fluency being the result, the desired outcome would be subject knowledge of their specialism.

Aside from those issues, limitations and shortcomings of lexiles have been voiced in several areas [38–41], [29]. These include criticism of the limited range of text indicator measures used, the cost of ascertaining the lexile of texts of teacher's choice, and the obscurity and predominantly L1 orientation of the personal lexile measurement. In a rare empirical study evaluating lexiles for non-native speakers, Holster et al. [40], for example, found that for Japanese learners, the Yomiyasusa system was a better predictor of English text difficulty than lexiles. However, that system seems to provide no systematic way of matching readers with texts-based on individual measures of texts and readers.

1.2 Objectives of the Study

In summary, lexiles are widely accessible, and ambitious claims are made for their usefulness. Criticisms have been made of them, but they are based largely on theory and argument: there is a paucity of evaluation of any lexiles-based DRMS through actual empirical trialling, especially with non-native speakers. For those reasons, the present study set out to evaluate a lexile-based DRMS as an aid to developing reading proficiency, through an empirical trial. The study, therefore, aims to answer two kinds of questions, concerning objective reading improvement and subjective perception of value by the students:

1. What patterns of development do we observe over the period of the study in terms of increased lexile of texts read, change in the amount of text read, and change in reading scores achieved?
2. What attitudes do the students have towards the lexile-based DRMS, especially in terms of its visual design, interface design, and usefulness for learning to read better?

These questions conform to a common view that the evaluation of teaching resources, including software, needs to consider both their objective and subjective merits.

2. Method

2.1 Participants

Forty-seven L1 Chinese sophomore English majors at Hungkuang university in central Taiwan agreed to participate in the reading intervention during the first half of a reading and discussion course; 44 completed the questionnaire. The group contained late beginners (CEFR A2), aged 19–23 (mean 19.7, SD 1.0), 70% female. Their mean lexile score was 716L (SD 171L) claimed as grade 3 reading ability in the US native speaker school system. They can be regarded as motivated students not least due to the fact that they have to pass the TOEIC test of English reading and listening proficiency at a 550 level in order to graduate.

2.2 The Reading Intervention Procedure

The DRMS vendor (Scholastic Taiwan) provided free use of its online system for three months. The students received a short orientation session in class from the vendor, explaining lexiles (both as text and personal scores). A teacher who had used the system also shared her students' experiences. Participants, next, took a pre-test of general reading proficiency in the DRMS to establish initial personal lexiles. That measured comprehension of short texts with multiple choice items in a progressively adaptive framework and calculated a personal lexile score. The class teacher then encouraged the students to make good use of the platform for reading their own choice of texts after class, either on or off-campus, to upgrade their reading proficiency. Neither the researchers nor the

DRMS limited the level of text offered in any way. Several classes were arranged in the lab with a TA to assist those who still had questions about the reading platform, but there was no researcher presence.

Shortly after the pre-test, it was found that most students were choosing a level of text to read that was well below their pre-test lexile. The instructor encouraged students to read books that matched their proficiency level or higher by giving extra credit. Furthermore, as an incentive, it was announced that the post-test at the end of the study intervention would replace the usual mid-term exam of the course.

Texts were presented by the DRMS as in hardcopy, without any associated activities that a teacher might supply in a reading class. While reading, the students sometimes had access to an audiobook version of the text to listen to but otherwise had no facilities on the site to support reading that presented linguistic or other challenges to comprehension.

The reading texts were authentic texts written initially for native speakers, including children, plus some "simplified" graded texts written for younger or elementary readers. Most of the texts students chose to read were expository/descriptive texts concerning culture-neutral universal general knowledge or interest topics such as *Galaxies*, often treated in a light way, e.g., *What am I?* and some with personal information value such as *Internet safety*. There were also a few fictional and biographic narrative texts. All texts were "general English", not academic English or English for specific purposes. This is, therefore, not the English of university subjects taught through the medium of English nor the English needed in specific jobs such as nursing which some students might later take up.

After reading each text, students were offered a quiz of up to seven multiple choice comprehension items. In order to assess progress in reading proficiency, a DRMS mid-test and post-test similar to the pre-test were given, respectively in the middle and at the end of the study intervention period. Shortly after the post-test (which was also the mid-term examination for the course) the questionnaire was administered to elicit an in-depth understanding of students' attitudes to the DRMS reading experience.

2.3 Measures

Aside from providing the post-text quizzes and the proficiency tests (validated by Metametrics), the DRMS also recorded the number of words read by each student. The software however credits a reader who reads even a small part of a text with having read it all. It also logs the number of texts read where the student completed the follow-up quiz, which can be seen as an indication of motivational intensity or interest, and the lexile levels of all texts (partially) read, from which we derived, mean lexile of texts read by an individual, and the difference between the lexile of

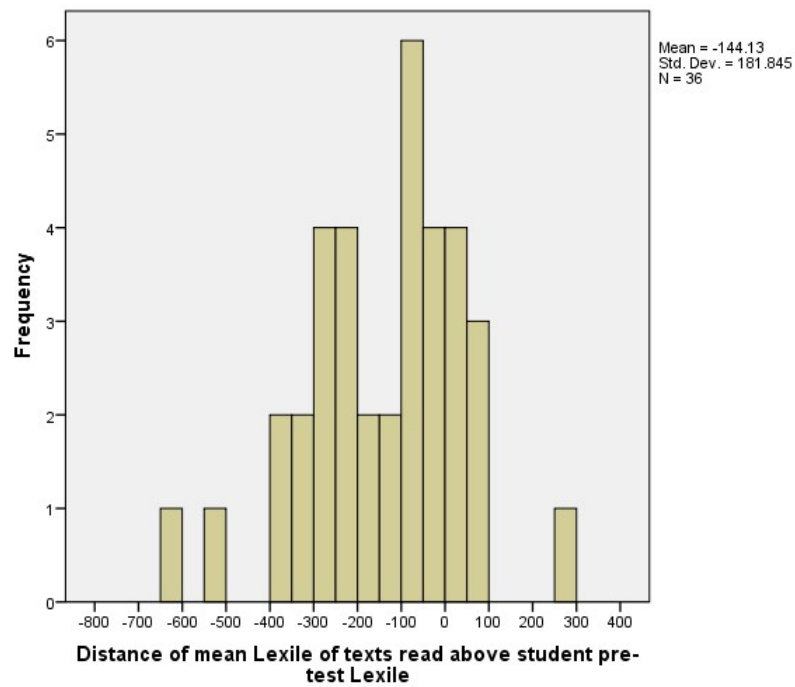


Figure 1: Histogram of differences between initial personal lexile scores and mean text lexiles.

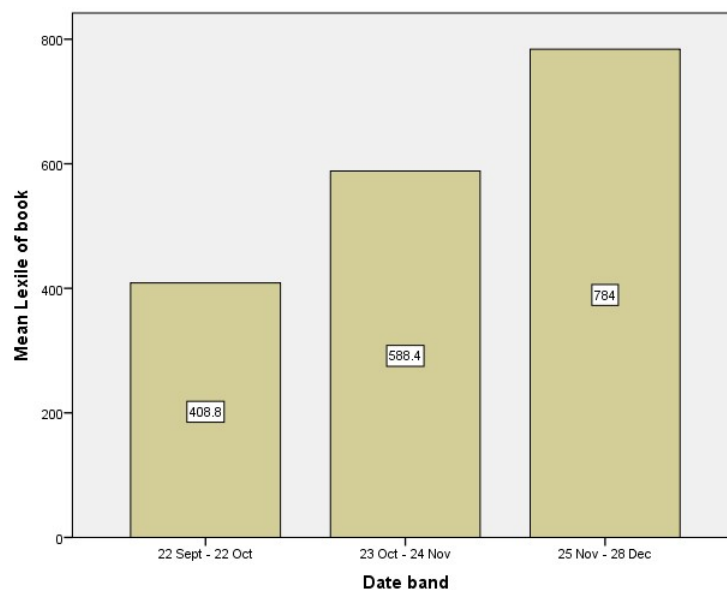


Figure 2: Lexile of book read over time.

a text read by a participant and their personal lexile level.

2.4 The Questionnaire

The questionnaire (modified from [42]), administered in Chinese, elicited demographic information and attitudes to features of the DRMS website, mostly in closed response mode with a five-point Likert scale. Those covered visual features of the DRMS website (QV, 15 items), website interface and organization (QI, 11 items), and learning benefits of the site (QL, 25

items). Closed items are listed in appendix 1. There were also three open response attitude items at the end.

2.5 Data Analysis

Since the data was not normally distributed, Spearman rho was calculated where correlations were needed.

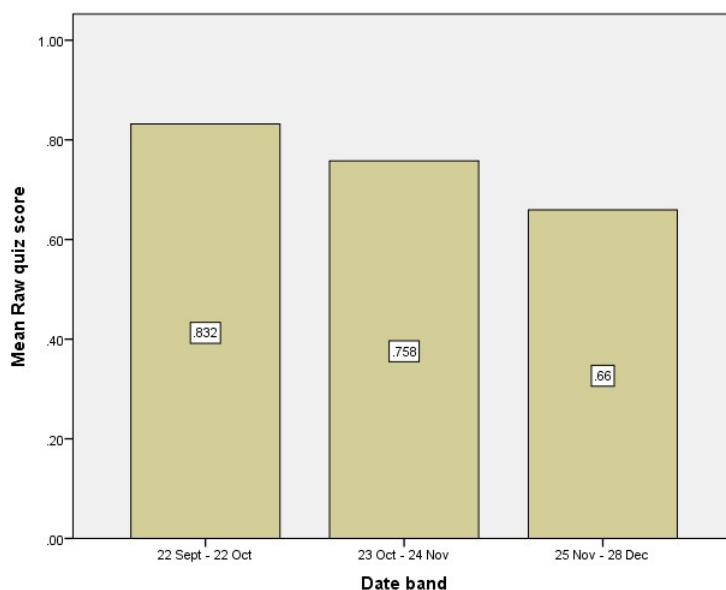


Figure 3: Raw quiz scores over time.

3. Results

3.1 General.

299 different texts were read by one or more participants. The most popular one was *I've Lost my Hat* (17 reads). However, less than half of the different texts (110) were read by more than one reader. This range testifies to the variety of choices offered, and used by students using the system. The 47 students read, on average, 12 texts each over the period of the study, ranging from 1 to 44 (SD 8.8).

The number of words in a text read by participants, as recorded by the software, ranged from 21 to over 85000, with a median of 700 words per text. As we have already mentioned, however, this may not be the number of words actually read. Lexile levels of texts read ranged from 10L (*Learn about Weather: Snow*) to 1170L (*Are we Alone?*), median 620L.

3.2 RQ1 Reading Development.

This can be revealed from changes in reading proficiency scores (personal lexiles), changes in immediate post-reading comprehension quiz scores, and from progression to reading more difficult texts.

3.2.1 Test scores of general English reading proficiency.

These scores, intended to measure learning, fell slightly over the period of the study, with means respectively pre-test 716L (SD 171L), mid-test 659L (SD 194L), and post-test 654L (SD 159L). This decline follows a significant downward trend ($F= 5.65$, $p= .022$), though with quite a small effect size (partial eta squared .127). It contrasts with the student perception in the questionnaire, which was that their reading had improved.

While this result was unexpected, there could be several reasons for it. One is that the time period of the study (three months) is quite short for one to expect a measurable improvement to occur: by contrast Vlangas [43] gathered data over two years to record an increase. Second, in the absence of reliability statistics for the DRMS test used, possibly the range of scores over time falls within the within-subject measurement error of the test. Third, in the absence to our knowledge of full publication by companies like MetaMetrics of how they determine lexile equivalences from proficiency tests such as those used by the DRMS, we cannot be certain of the validity of the personal lexiles given to the participants. Fourth, a lack of increase in reading proficiency, if not a fall, could be explicable if participants were reading texts below their personal lexile, possibly due to a wish to read for pleasure or fluency development rather than to push their boundaries and read to increase language knowledge. In a context where the DRMS did not constrain the texts offered to the reader, it emerged that this was happening to a great extent.

Figure 1 shows that students were reading texts considerably below their personal lexile level (mean=144L). Only four were reading on average in the official recommended area just above their calculated personal lexile, while the remainder were reading below, or in one case way above. We must, however, be aware that these figures are based on average lexiles for the texts read, so this does not mean that those reading on average at a lexile below their personal lexile did not, in fact, read some texts at an appropriate level along with others at a much lower level.

In the light of our discussion earlier, we may alternatively take the view that reading just above 75% of calculated personal lexile is appropriate for learning.

Table 1. The results for items in the section entitled Visual Design (QV).

	Mean	SD	t	p
1. The design and content of learning website are clear.	3.82	.815	6.66	<.001
2. The visual design of the learning website can help me to find the books that I want to read.	3.73	.899	5.37	<.001
3. The visual design of the learning website allows me to set my reading level.	3.95	.861	7.35	<.001
4. The visual design of the learning website offers different ways to find the books I want to read.	3.82	.922	5.89	<.001
5. The font size of the learning website is well suited to reading.	3.86	.979	5.86	<.001
6. The color of the learning website's background is subdued; it won't hinder and affect learning.	4.09	.802	9.03	<.001
7. The page setup of the learning website is consistent and unified.	4.00	.863	7.69	<.001
8. I think the overall visual color of the learning website is consistent with the design style.	3.95	.834	7.59	<.001
9. The visual design of the learning website is clearly visible.	4.02	.792	8.57	<.001
10. I like it that the learning website provides a playback function.	3.89	.813	7.23	<.001
11. The pictures in the learning website are related to the theme of the book.	3.84	.861	6.48	<.001
12. The visual effect of the learning website layout guides me in navigating the interface.	3.73	.845	5.71	<.001
13. The design of the learning website is too complex; I don't know how to use.	2.61	1.10	-2.32	.025
14. I like it that the learning website provides full screen function.	3.82	.870	6.24	<.001

Appendix 1. The questionnaire items and statistics

Scale 1= Strongly disagree to 5= Strongly agree. Significances are of difference between the observed mean and 3

On average that would be in a band such as -170 to -80L in Figure 1, where only 10 readers fall. In fact whatever band one chooses as the Goldilocks band for acquisition, at least two-thirds of our participants fall outside it reading too high or too low.

In order to see what was occurring at a more detailed level, we conducted a more detailed study of individual cases, of which we report two here which are particularly illuminating.

U104A128 obtained 529L (75% = 396L) on the pretest, but then read books in order with lexiles: 300, 490, 60, 270, 30, 110, 50, 10, 450, 540. Except for the very last, they were all below this student's lexile and many also below their 75% lexile so predicted to be easy reads, in some cases very easy, and indeed this student obtained 80–100% on most of the comprehension quizzes. This student dropped 46L points between the pre-test and post-test.

By contrast one of the bigger rises came from U104A143, who initially scored a lexile of 689L (75%= 517L), which rose by 87L in the post-test. This student read many texts (15), some of which were way below even 75% personal lexile. However, it is notable that six were close to or above the pre-test lexile (ranging 690–920L). Thus, the student received an appropriate challenge in the area where learning from input can occur, which maybe accounts for the satisfactory rise in personal lexile score.

Thus overall, the message seems to be that, for proficiency to increase (or in our study decrease less), the student needs to be challenged by texts at an appropriate lexile level close to and just above their lexile score

(or maybe their 75% lexile score), so as to achieve a learning benefit, consistent, for example, with the tenets of Mason and Krashen [5].

3.2.2 Text difficulty and Quiz scores measuring understanding of a text just read.

Figure 2 indicates that the lexile (i.e., difficulty) of the books being read goes up over time, as would be expected, even though student choices often remained below their initial calculated lexile. The average lexile of the books read in the second month was 180L higher than that of books read in the first month. In the third month, the average was 196L higher than in the second month, suggesting an increasing differential. Certainly, we would want any reading program to enable the students to read progressively more demanding texts over time.

The mean score for immediate post-reading quizzes (Figure 3, where 1 = 100% correct) was initially 83% (not far off the ideal 92%) but went down over time to a far less satisfactory 66%. This may be explained by the fact that the texts became harder. However, if reading ability was improving we would expect the comprehension scores for individual texts to remain the same or even improve. Therefore, this again indicates that underlying reading proficiency was not improving, so reading harder texts simply resulted in lower comprehension.

All these results are significant (taking as cases each text read by each person: the number ranges 477–552, depending on missing data). Correlation of lexile of

Table 2. The results for items in the section entitled Website Interface Usability (QI).

	Mean	SD	t	p
1. The learning site guide is well designed, allowing me to quickly find the function I want to use.	3.66	.914	4.79	<.001
2. The overall interface of the the learning website is well designed, so I don't have to spend a lot of time learning how to use the function.	3.57	.950	3.97	<.001
3. The functions of the learning site are very clear to see where I can click, and I can indicate the hyperlink.	3.75	.781	6.37	<.001
4. The learning website's menus, buttons and icons are easy to understand.	3.77	.859	5.97	<.001
5. After using the learning website, I don't have to explore how to use it.	3.82	.815	6.66	<.001
6. There are some functions of the learning website that I don't know.	3.02	1.11	.136	.893
7. The function icons in the learning website are unclear, and I often press the wrong link.	2.91	1.14	-.530	.599
8. The instructions on the the learning website are clear.	3.70	.954	4.90	<.001
9. The difficulty of the books provided by the learning website is clearly arranged.	3.73	.788	6.12	<.001
10. I think the various test modes on the learning website are easy to use.	3.91	.802	7.52	<.001
11. I think the function of the learning website is easy to understand.	3.66	.861	5.08	<.001

book with date was $\rho = .457$, $p < .001$. Correlation of quiz score with date was $\rho = -.209$, $p < .001$.

3.2.3 Correlations among reading-related measures.

Change in students' lexile between pre- and post-test was most strongly correlated with their initial lexile score ($\rho = -.366$, $p = .028$). This shows that students who entered the study with lower lexile scores (i.e. individual reading proficiency) improved their lexile more (or decreased it less) over the period of the study, compared with those who entered with relatively higher personal lexile (greater reading proficiency). This is heartening, although one would hope that a reading program would help readers of all degrees of proficiency to improve.

There was also a significant negative correlation between mean lexile of texts read and pre-post change in lexile score of a student ($\rho = -.332$, $p = .034$), showing that students who read easier texts also improved their lexile level more over the period of the study than those who read (on average) harder texts. This finding is related to the preceding one since initial student lexile scores were positively correlated with lexile of texts read, as one would hope ($\rho = .492$, $p = .002$). Those who started with lower reading ability read easier texts, on average, and those who started higher read harder texts, even if, as we saw earlier, the texts were still often below the calculated lexile levels of students at all levels (Table 4).

Change in student lexile between pre- and post-test was not significantly related to the number or length of texts read. This indicates that amount of reading is not crucial to proficiency improvement, but rather the lexile level of the texts read. Since, in the current study, the latter decision was left to the students, this may have contributed to the lack of strong positive per-

sonal lexile improvement scores over the period of the study.

3.3 RQ2 Student Attitudes.

Due to space limitations, only the key findings are considered here: for full results see appendix 1. All 15 attitude items in the section labelled Visual Design (QV) were significantly endorsed above the midpoint of the scale (3) (using the one-sample t-test). Particularly items 7 and 10 were rated above 4 (on the 1-5 scale), concerning the use of color and clarity of pictures, which accompany book covers and texts. In the set of 13 positively worded items about the interface design (QI) no items reached a mean rating of 4, but all were significantly positively endorsed above the midpoint. The two negatively worded items, concerning whether users got confused by the DRMS and whether the site lacks clear signposts, were not significantly agreed or disagreed with.

In the third main attitude section of the questionnaire, concerning pedagogical usefulness (QL), all 25 items were positively worded and significantly agreed with, though only one topped a mean of 4. This was item 24 which stated that the site allows students to read books on many different topics as much as they like. This testifies again to the range of choices offered.

Overall, the answers to the closed questionnaire items favor the website. However, students were not asked about crucial specific aspects such as the lexiles: whether they understood them, how they used them, and whether they saw them as useful. Nor were they asked about their experience moving from easy to harder texts: whether there was enough support to help them understand. Some of these issues were, however, raised in answers to the open questions.

Table 3. The results for items in the section entitled Learning Satisfaction (QL).

	Mean	SD	t	p
1. The learning website is helpful for me to learn English.	3.86	.765	7.49	<.001
2. The functions of the learning website meet my needs for learning English.	3.77	.859	5.97	<.001
3. Using the learning website, you can improve your English learning ability and use it more handily in the future workplace.	3.79	.833	6.23	<.001
4. I can strengthen my English learning through the learning website and get reasonable scores in the course-related assessment.	3.74	.848	5.76	<.001
5. I think using the learning website to study is helpful for me to study cross-culturally.	3.67	.892	4.96	<.001
6. I will share with others the content of the courses I have followed on the learning website.	3.67	.969	4.56	<.001
7. Learning through the website has made me more interested in English learning, and feel satisfied and a sense of accomplishment.	3.70	.887	5.16	<.001
8. If I need to improve my "reading" ability in the future, I will use the learning website as a practice tool.	3.81	.880	6.07	<.001
9. If I need to improve my "vocabulary" skills in the future, I will use the learning website as a practice tool.	3.65	.897	4.76	<.001
10. If I need to improve my "listening" ability in the future, I will use the learning website as a practice tool.	3.42	1.03	2.67	.011
11. The audio file in the learning website is helpful for my oral training.	3.47	.855	3.57	.001
12. The audio file in the learning website is helpful for my listening.	3.67	.892	4.96	<.001
13. The audio file in the learning website is helpful for my reading comprehension.	3.77	.868	5.80	<.001
14. The learning website provides a platform for me to take the initiative to learn English. It is an indispensable supplementary textbook after class.	3.67	.837	5.28	<.001
15. Through the learning website, I can enhance my learning ability.	3.84	.814	6.74	<.001
16. Through the learning website, I can enhance my reading comprehension skills.	3.93	.799	7.64	<.001
17. Through the learning website, the course learning method can enhance my motivation for active learning.	3.63	.952	4.33	<.001
18. Through the learning website, I can apply the professional knowledge I have learned to develop my potential in the course learning method.	3.74	.848	5.76	<.001
19. Through the learning website, I am learning English and I can integrate English into my life more.	3.84	.898	6.11	<.001
20. I am rich in the reading materials provided on the learning website.	3.79	.833	6.23	<.001
21. I am interested in the reading materials provided on the learning website.	3.81	.880	6.07	<.001
22. I am satisfied with the reading materials provided on the learning website.	3.84	.861	6.48	<.001
23. I think the advantages of the learning website outweigh the disadvantages.	3.86	.852	6.73	<.001
24. The learning website allows me to read books on different topics unlimited times.	4.02	.792	8.57	<.001
25. The learning website allows me to choose suitable texts according to my reading ability.	3.95	.806	7.86	<.001

Asked what improvements they would recommend, 45% said nothing needed improvement, with praise for the wide choice of reading, the value of the tests and quizzes, and clarity of the site. The remainder offered a wide range of suggestions. Some students called for more mainstream, interesting, or funny books to be included. Others targeted the text lexiles. In particular, there was a call for the lexile score to appear in the book list so it would be easier to pick the right level book. Similarly, another stated that the search engine did not make it easy to search books by lexile score.

Another useful and straightforward feature requested was a function allowing unfinished books to be saved in the library since at present it took a long time to locate any unfinished books.

While reading, some wanted more help with words, such as an English dictionary or words that were clickable to obtain help, maybe in Chinese. One wanted an increase in oral training. Concerning the tests, one person called for the lexile level test of the student to be available for them to take whenever they wanted. There was also a call for the quizzes to have the cor-

Table 4. Correlations among reading related measures.

		Pre-Post student lexile change	Mean lexile of texts read	Number of texts read	Mean words in texts read	Mean lexile of texts read- initial student lexile
Initial student lexile	rho	-.366*	.492**	.300	.052	-.546**
	p	.028	.002	.076	.762	.001
	n	36	36	36	36	36
Pre-Post student lexile change	rho		-.332*	-.264	.089	.039
	p		.034	.095	.582	.823
	n		41	41	41	36
Mean lexile of texts read	rho			.195	.533**	.404*
	p			.221	.000	.015
	n			41	41	36
Number of texts read	rho				-.175	-.243
	p				.275	.153
	n				41	36
Mean words in texts read	rho					.380*
	p					.022
	n					36

rect answers and explanations given.

4. Discussion and Conclusion

The aim of the study was to evaluate the lexile-based DRMS in an EFL context. Taking the students' subjective perspective first, overall, the DRMS was favoured, especially for its ease of use, color, and pictures, and the wide choice of reading offered. Possibly, however, the positive response was in part because they were mainly using the resource in a way that did not fully challenge them, by often reading below their personal lexile level, i.e., apparently reading for pleasure rather than for proficiency improvement. Nevertheless, the general clarity of signposting of links and functions could be improved and fuller listening resources provided. For our focus on learning to improve reading, however, the following two key issues emerged which, as far as we know, have not been reported before from any empirical EFL study of lexiles.

First, insufficient support is offered when a lack of comprehension occurs. Given that this DRMS is primarily used to provide educational resources for the native speaker market, this must not be overlooked when extending the learner audience to an EFL/EIL market, especially if the aim is to boost learner proficiency, which, according to the literature, means students must read texts a little above their personal lexile or comfort level (Krashen [31]). In support of independent reading, a computer resource has to supply the scaffolding and other support that otherwise a teacher would supply [44]. Relevant to the present case, the system should incorporate clickable words and phrases to offer help on word meaning, complex grammar, or unfamiliar names, terms, and concepts. Also, the system vendors should provide links that would allow students to access suitable reference

sources without leaving the reading page, such as a sidebar of dictionaries, including dictionaries of language and culture, and good quality bilingual dictionaries, rather than to Google Translate, which some students were observed accessing independently of the website during the trial. Arguably this lack of support as readers moved to harder texts may have contributed to the lack of proficiency development.

A second key area mentioned concerns the lexiles, which need to be more prominent at all points where lists of books are displayed or searched. It seems that in fact, some information on text lexiles is available that the students in this study did not manage to access due to unfamiliarity with some function keys, and this needs to be made more transparent. Furthermore, the student's personal lexile level should not only be displayed when they take a proficiency test, but the user should be reminded of this regularly and of the need to use their own lexile to guide what they read. This is critical if readers are to make better choices of what to read concerning their own personal lexile scores, which there was considerable evidence was not occurring properly in the study.

The objective measures of reading development using the DRMS did not yield unambiguous evidence that progress was really being made. Reading proficiency scores provided by the system tended to fall slightly, which puts some doubt on the validity of the tests used by the site to measure small changes in reading proficiency/personal lexile level, at least in the short term. Indeed, other studies that record an increase in personal lexile score over time generally took place over a far longer period (e.g. two years in Vlangas [43]). This is in fact consistent with findings of other studies of extensive reading that show that proficiency gain is slow [36]. A relevant factor also seemed to be the extent to which readers made good choices of

what to read in order to improve proficiency, i.e., texts just a little above their personal lexile level (or 75% of it). That is to say that they seem to have often chosen texts that were relatively easy for them, more perhaps for the pure enjoyment of the content without undue effort than to improve reading proficiency. This policy might, in fact, have coincidentally helped them boost reading speed/fluency, but that was not something we measured.

One conclusion from the above is that there are some clear limitations of the lexile-based DRMS, in the area of user support for example, which really need addressing if it is to be used successfully by non-native learners. However, the last mentioned issue that is so important in a way falls between the responsibility of students, teachers, and software such as the DRMS. This is the fundamental question about the real role of independent reading assisted by a DRMS. Arguably the students quite reasonably saw the purpose as different from that which the teacher had in mind: they saw it as a chance to use what English they knew to read for pleasure, without undue linguistic demands, with focus on content, while the teachers, mindful of the student low proficiency level, saw it as an activity aimed to increase student reading proficiency, so with some focus on language, rather like intensive classroom reading: for this reason paradoxically student subjective ratings were favourable although objective reading proficiency scores did not increase. However, the researchers agree with Krashen [31] and Nation [36] that these are not entirely compatible goals.

One way to deal with this is for the teachers to be more directive in guiding the students in these matters, as they tried to be in our study. However, ideally it is the learner who would make an informed decision autonomously about which kind of reading it is best for them to do at any given time. In that case, the teacher would assume the role of a trainer or advisor of the student rather than a dictator of what they do. In any event, the DRMS can then help by making sure that the choice of text does fit the aim of the student. As Bower [25] remarks, computer systems should be designed to support development at the level of the learner's abilities (their "zone of proximal development" or ZPD). Our study was not refined enough to say for certain whether that ZPD (or $i+1$ in Krashen's [31] terms) starts at the threshold of their personal lexile level or at something closer to 75% of their lexile level. That requires further research. However, once that is decided, we suggest a way forward, in either case, is for the site to configure what it offers more clearly into different distinct options where the software automatically constrains what texts can be accessed by the reader, relative to whatever is decided as the threshold personal lexile. From the reading research perspective, one might suggest three user-chosen modes.

Content mode would offer the reader an unconstrained choice of texts, and no time pressure, from a lexile range that they should be able to cope with (relative to their threshold personal lexile) and so allow focus on the content, whether read for pleasure or a necessary topic of their subject course. An attractive feature would be a chance for the reader to rate each text for interest (or "Like") after reading it, which could be used by the system to suggest what to read next. Fluency mode by contrast would have the goal of increasing reading speed (Nation [36]). It would offer texts in a range 100L+ below the student's threshold personal lexile score. However, when the student reads a text, some form of time pressure would be applied to prompt the reader to read a little bit faster than their initial speed. Thirdly, proficiency mode would only offer text choices a little above the reader's threshold lexile level, from 10L up to 50L above. There would be no time pressure, but the reader would meet unknown words and maybe longer sentences than they were used to and need to work to understand. In this mode, support features to combat a lack of comprehension would be important. There are in fact signs that the promoters of lexiles are moving somewhat in this direction with respect to L1 reading instruction. As reported by Vlangas [43], the lexile bands identified as corresponding to Common Core State Standards for reading at each grade in US schools have recently been extended upwards in what is called "stretch bands". Effectively this means more children will have to read texts that are above their personal lexile level, so reading proficiency should increase (Mason and Krashen [5]).

As indicated at the start, the whole system of lexiles itself raises many issues and has been attacked by influential critics (Krashen [38]; Hiebert [29]; Holster, et al. [40]; Cunningham, et al. [41]). In particular, the lack of consistent correspondence between lexiles and CEFR levels is worrying [45]. Our study has shown some specific further limitations of an existing lexile-based DRMS in relation to potential use by non-native speakers. However, we cannot condemn the whole system as useless. As we discussed, it can be improved and there is a need for teachers to play a role in training students in making good decisions about what kinds of texts to read, so that their reading meets their current needs. A good DRMS can then supply them with choices of texts that match their requirements. Finally, there is also a need for more studies in this area, conducted over a longer period than ours, and ideally with more participants.

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The contribution of emotional intelligence to academic engagement of undergraduate students in Thailand: the mediating role of self-efficacy

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Abstract

This paper explores the personal qualities of university students that influence their academic engagement in class. Class participation is evidently crucial, through which students' abilities can be assessed. This examined the roles of emotional intelligence (EQ) and self-efficacy on the academic engagement of undergraduate students in Thailand. The university students' self-efficacy is proposed to act as the mediator of the direct linkage concerning EQ and academic engagement. A self-administered survey questionnaire was utilized and the respondents were college students from a private university in Thailand (N= 395). Data were analyzed by the Partial Least Squares Structural Equation Modeling. The study findings supported that EQ has a positive influence on self-efficacy and academic engagement. Furthermore, the study showed that university students' self-efficacy is contributed to academic engagement. Self-efficacy of undergraduate students in the university mediated the positive association between EQ and academic engagement. Given that there were mixed findings on the influence of EQ on academic engagement, this research provides evidence that EQ is a significant factor contributing to the academic engagement of undergraduate students.

Keywords: Emotional intelligence, academic engagement, self-efficacy

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1. Introduction

The goal of each university is to improve their students' experience during their stay in their premises. One way to help students increase their university experiences is their academic engagement. Additionally, one of the main criteria to assess the effectiveness of the educational establishments is the level of students' engagement and is considered to be one of the main purposes for every educational institution [1]. Scholars refer to academic engagement as engaging students in various academic and non-academic activities such as class presence, assignment submission, interaction with other students and lecturers, and involvement in extra-curricular activities [2, 3]. Scholars suggest that student disengagement can be a huge challenge for institutions because it leads to behavior problems and potential dropouts [4]. Because academic engagement is a vital aspect that contributes to the overall success

of students, understanding the antecedents associated with academic engagement remains significant.

Academic engagement denotes the connection of the students throughout the learning process. Thus, lack of academic engagement in the classroom needs to be addressed as students in the class are described to be low achievers, experienced boredom, and eventually dropped in their respective classes. Given the harmful consequences of lower academic engagement among university students in Thailand, it is important to recognize some personal qualities of students that might prevent them from experiencing these consequences in the university setting. This study proposed that emotional intelligence (EQ) is one characteristic of a student that has been regularly being studied that helps students manage their academic stress in class.

EQ is associated with students' academic achievement improvement, social behaviors, lesser distress, and good evaluations. In addition, students with high emotional competency had greater academic goals, a higher level of motivation, self-discipline, and stress

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control. They learn more, hence get high grades [5]. Another factor that may help students enhance academic engagement is self-efficacy. It is important that students know how to evaluate their capacities and meet certain requirements in the academic setting [6]. Previous research claimed that self-efficacy influences students' performance and participation in activities. Furthermore, since self-efficacy also offers more personal resources, good academic performance will be achieved [7].

2. Research Objectives and Contribution

Thus, the primary goal of this study is to explore the personal qualities of students which influence their academic engagement. In this paper, the roles of EQ and self-efficacy on academic engagement of undergraduate students in Thailand were examined. It is proposed that the direct linkage between EQ and academic engagement might be mediated by the students' self-efficacy.

This research contributes further data to EQ studies on academic engagement. Even though research showed that academic engagement can be influenced by students' EQ, there is no consensus on the finding whether the level of students' EQ can lead to better engagement [19]. This study can add more evidences to this area. Furthermore, given that prior research exploring the role of self-efficacy as a mediator on the association between EQ and academic engagement is still scant, this research will fill this gap.

3. Literature and Hypotheses

3.1 Academic Engagement

Academic engagement is a concept that had been studied extensively which refers to the level to which students devote their resources such as time and energy in academic activities and the level of their willingness to study during their university life [2], [8]. [9] suggest that academic engagement has three aspects: vigor, dedication, and absorption. Firstly, vigor is the level of individual energy, psychological flexibility, and determination to put the effort into his/her studies. Secondly, dedication refers to the feeling of importance, eagerness, motivation, satisfaction, and confrontation. Lastly, absorption refers to the situation when an individual is completely focused and contentedly engaged in his/her study without realizing that time has gone by [10]. In total, students involved in learning activities are motivated to put effort and dedication into their tasks with full concentration. On the other hand, some scholars posit academic engagement as comprising the following dimensions: behavioral engagement, emotional engagement, and cognitive engagement [2], [11]. Firstly, behavioral engagement denotes the level to which students participate in their learning [12]. Secondly, emotional engagement

is described as the feeling of students toward teachers, friends, studying, and institutions.

Previous literatures support that academic engagement enhances academic success [4], [13]. For example, [14] reported that academic engagement is the predictor of academic achievement of students in the Dominican Republic. Researches support that academic engagement is influenced by various contextual elements such as the lecturer's teaching style, classroom setting, and interaction with friends [15]. This study proposes that the individual factor may also influence the students' academic engagement.

3.2 Emotional Intelligence

Emotional intelligence (EQ) was defined as the capability to recognize, observe and understand one's feelings and emotions and that of others [20]. This ability also incorporates utilizing this emotional understanding to make decisions, solve problems, and communicate with other people. A person who possesses a higher level of EQ recognizes themselves extremely well and can readily sense others' emotions. They have the characteristics of being sociable, resilient, and optimistic [21]. A growing body of research has found EQ tended to be a decent predictor of work performance ranging from interns to managers, psychological well-being, and academic performance [16–19]. Consequently, these notable contributions in different fields highlighted EQ as one of the integral factors to help people in different walks of life deal with matters effectively with several life- and job-related stressors.

EQ has four branches. These are perceiving emotion, use of emotion to facilitate thought, understanding emotion, and managing emotion [20]. Perceiving emotions is the capability to distinguish and recognize sentiments in oneself and others. People who are versed in this area are often delighted to discover their emotional conditions and will progress through it in dealing with situations. Second, the use of emotion to facilitate thought or the thought facilitation branch is concerned with one's ability to engender emotion, then use this feeling to reason out [20]. Third, understanding emotions refers to the person's ability to understand intricate emotions and emotional chains. Fourth, managing emotions is an individual's capability to manage and control feelings towards oneself and others [20]. Managing emotions refers to the ability of an individual to observe, classify, and label his feelings in an accurate manner, and know what to do to enhance or adjust these moods.

3.3 EQ and Academic Engagement

EQ helps in prioritizing intellectual thinking and enables one to manage emotions in anxiety-provoking circumstances, for instance taking any kind of tests in the academic field [21]. It has been shown that students who are more emotionally intelligent performed

better, both in continuous assessments and in the final professional examination. Hence, it is probable that developing emotional skills may enhance the academic engagement of students [22]. How students' EQ can help him/her learn better and perform academically is an interest of many researchers. One research claimed the importance of EQ in the personal health and college success of students. Students with higher EQ are able to cope better with complex and demanding college life.

Students who can focus on their learning and perform in their academics are able to succeed in the academe [23]. However, research findings related to the role of EQ in academic settings were mixed. Some previous researches showed a positive association [21, 22], [24–26], while others show that EQ has no direct relationship at all to academic engagement [27–30]. For instance, it was found that the overall EQ scores and academic engagement of first-year community students in the US have no apparent relationship [29]. Emotionally intelligent students have healthier interpersonal and intrapersonal skills, they are more malleable, good at stress management, and most likely to perform academically. Moreover, a student with self-awareness particularly being confident in engaging inside and outside the classroom activities is most likely succeeded in school [26].

H 1: The EQ of undergraduate students is positively associated with academic engagement.

3.4 EQ and Self-efficacy

Self-efficacy is defined as a belief that one is capable to succeed in facing different challenges in life with full motivation, acquired intelligence, experience, and actions [31]. Over the years, self-efficacy got a positive perception and association with individual performance improvement in various areas such as sales, retail industry, job performance, and academic performance [32, 33]. For instance, self-efficacy was considered a factor in university students' academic performance. The research posited that academic self-efficacy had a direct relationship with academic performance [34]. This means that students who get into university and they are fully prepared and generally confident of their abilities will perform academically well than their weaker counterparts. They have the drive and motivation to achieve better as they are intrinsically self-sufficient. Furthermore, students demonstrating a high level of self-efficacy are motivated to feel confident to know and learn information and do well in the exam [35].

Social cognitive theory characterized self-efficacy as self-regulation of capability. The social cognitive theory proposes that a person holds principles about their ability to accomplish things by their own actions [36]. Self-efficacy can be developed through observation with colleagues who were good models on how to achieve goals including a range of previous successful

endeavors to achieve challenging goals [37]. The research found that there is a high correlation between initial levels of emotional stability and self-efficacy beliefs [38]. An optimistic type of individual tended to have strong control of their emotions, therefore, not affected by negative feelings and self-efficacy tended to be higher. Self-awareness and self-regulation were critical factors of EQ. Therefore, EQ was an important component that contributed to the formation of self-efficacy through self-awareness and self-regulation of emotion. Previous researches found that a person with a higher level of EQ tended to boost his/her self-efficacy by possessing profound awareness of his/her emotional state and by controlling it directly [39, 40]. From the above premise, the following hypothesis is proposed.

H2: The EQ of undergraduate students has a positive association with self-efficacy.

3.5 Self-efficacy and Academic Engagement

According to [6], self-efficacy influences persons' choice of actions, determination, and perseverance. Consistently, there is research that supports the association between student self-efficacy and academic-related tasks [41]. Hence, self-efficacy may be one of the predictors in motivating students to put the effort into their learning activities. Because the high self-efficacy students have high self-confidence and believe in their capability, they tend to be encouraged to put their effort and concentration into their studies [42]. Consistently, [43] state that when students got a higher level of self-efficacy, they also put more effort and have higher participation in the classroom, thus; they can perform better in exams. Moreover, research also supported the role of self-efficacy as the antecedent of academic engagement [42], [44]. Given the aforementioned reasons, the following hypothesis is presented:

H3: The self-efficacy of undergraduate students has a positive relation to academic engagement.

3.6 Mediating Role of self-efficacy

Although EQ is reasonably linked to academic engagement, this association can be indirectly described by the students' level of self-efficacy, who have higher EQ. This research suggests that the linkage between EQ and academic engagement can be mediated by the students' level of self-efficacy. Because students with high EQ tend to be more successful in overcoming fear and failure about their academic intentions, then EQ might as well be a predictor of self-efficacy which in turn leads to better academic engagement. As self-efficacious students tend to believe what they are capable of achieving their academic goals, it could then be argued that students who got a higher level of EQ would be able to control negative emotions such as fear and anxiety in dealing with their classroom tasks. Hence, as a result, it is predicted that academic engagement is strengthened. Taken together, this study proposes the following hypothesis:

H4: The self-efficacy of undergraduate students mediates the positive association between EQ and academic engagement.

4. Methods

4.1 Sample and Data Collection Procedure

This study collected data from the international university in Thailand as there are many foreign students from different countries, therefore the degree of students' engagement in the classroom is different due to mixed cultures in the classroom. In particular, students may not be comfortable engaging in the class as their culture is demure, in contrast, they may highly engage in class as their normal practice in their home country where they belong. Therefore, the teachers are interested to find out how EQ and self-efficacy could help students interact and participate in the class. University students who are enrolled in the international university served as a sampling frame for data collection. Approximately, there were five thousand students who were currently enrolled in the university. Students were asked for voluntary participation in the research survey, whenever students did not want to participate then they were free to do so.

Data collection employed an online survey questionnaire allowing 600 students to answer the survey via a link and a QR code at their convenience. But they were informed beforehand on the research goals, along with the assurance of the confidentiality and anonymity of the data collected. After one month of data collection, 395 usable responses were gathered, accounting for 65.8% percent response rate. Table 1 presents the respondents' demographic profiles.

5. Measures

A brief version 10-item self-reported EQ scale adapted from [56] was used to measure EQ. A 5-point Likert scale was employed with 1 (Strongly disagree) to 5 (Strongly agree). Furthermore, measurement of academic engagement adapted the scale from [45] consisting of seventeen questions. All items were measured using a 5-point Likert scale ranging from 1 (Strongly disagree) to 5 (Strongly agree).

Six demographic control variables were used, which were age, sex, GPA, faculty, language, and educational level. These factors tend to determine the level of outcome variables used specifically in self-efficacy and academic engagement. Age was measured in years, while sex was measured as a dummy variable with codes 0 and 1 for female and male; respectively. Faculty and language were measured by nominal, and educational level was measured ordinally.

5.1 Control Variables

This paper considered some of the demographic factors and academic characteristics of the students as control variables, namely age, gender, GPA, faculty, language, and educational level. Age was measured as actual age in the years; gender was measured as a categorical variable (Female= 0, Male= 1); GPA was measured with the actual grade, language was measured as a ranked variable (1–Thai, 16- Dutch in sequence as shown in Table 1); and educational level was measured as a categorical variable (First year = 1; Second year = 2; Third year= 3; Fourth year= 4).

5.2 Data Analysis Method

For data analysis, the statistical tool used was the Partial Least Squares Structural Equation Modeling (PLS-SEM). PLS-SEM is the method that combines principal component analysis, a series of regression analysis, and path analysis [46]. PLS-SEM is more suitable as it allows small sample sizes and is more effective whenever the data is in non-normal distribution [47]. WarpPLS version 7.0. was utilized in the PLS estimation.

6. Results

Tests for the reliability and validity were conducted prior to performing the PLS model because the main constructs were measured as reflective latent variables. The conduct of the test for convergence validity to evaluate the factor loadings was done first. As advised by [48], a factor loading of more than the minimum requirement of 0.5 was given for every construct. This was followed by the test for discriminant validity through a comparison of the results of the square root of the AVE and the square of the correlation coefficient. The analysis demonstrated that the square root of the AVE was greater than that of other correlations, indicating that the level of discriminant validity was acceptable [49]. Table 2 shows the correlations among all of the variables in the model and the square root of the AVEs of all latent variables. Thereafter, the reliability test was performed using Cronbach's alpha and composite reliability coefficients. As Table 2 depicts, the reliability indicators of all latent variables surpassed the minimum requirement of 0.7 [50].

Lastly, in order to assess the multicollinearity problem, a full collinearity variance inflation factor (VIF) test was performed. [51] suggests that a full collinearity VIF test is more powerful than the traditional VIF test because it can evaluate simultaneously both the vertical and lateral collinearity. In addition, according to [52], the possibility of CMB in the PLS model can be measured from the full collinearity VIF test. The result of the full collinearity VIF for all constructs ranged from 1.090 to 1.976, which was lower than the critical value of 3.3 as suggested by [53].

Table 1. Descriptive statistics of the sample.

Demographic factor	Descriptive statistics
Sex	Male: 237 (60%) Female: 158 (40%)
Age	Mean: 22.52 S.D.: 2.495
Education Level	First year college: 80 (20.3%) Second year college: 156 (39.5%) Third year college: 62 (15.7%) Fourth year college: 97 (24.6%)
Cumulative GPA	: 1.55 Max: 4 Mean: 2.35 S.D.: 1.051
Language	Thai: 273 (69.01%) Chinese: 69 (17.5%) Korean: 13 (3.3%) Burmese: 13 (3.3%) Cambodian: 2 (.5%) Indian: 2 (.5%) Nepalese: 2 (.5%) Taiwanese: 6 (1.5%) Vietnamese: 5(1.3%) Filipino: 2 (.5%) Japanese: 2 (.5%) Cantonese: 1 (.3%) Pakistani: 1 (.3%) Laos: 2 (.5%) American: 1 (.3%) Dutch: 1 (.3%)

Table 2. Correlation among variables and square root of AVE.

time	Cronbach's alpha coefficient	Composite reliability coefficient	EQ	SE	AE	AGE	GEN	GPA	FAC	LANG	EDU
EQ	.858	.887	(.663)	.508**	.414**	-.006	-.077	-.017	-.090	-.006**	-.055
SE	.921	.935		(.803)	.624**	.011	-.012	.071	-.022*	-.006	-.020
AE	.942	.948			(.721)	.071	-.012	-.128**	-.149*	.122**	.040
AGE	-	-				(1)	-.105*	-.229**	-.140	-.074*	.595**
GEN	-	-					(1)	.212	-.063	.122	.022
GPA	-	-						(1)	.067	-.147	-.212
FAC	-	-							(1)	.062	-.286**
LANG	-	-								(1)	-.028**
EDU	-	-									(1)

Notes: *p-value <.05, ** p-value <.01;

The square root of AVE is displayed in the parentheses. EQ= emotional intelligence, AE= academic engagement, SE= self-efficacy, AGE= age, GEN= gender, GPA= grade point average, FAC= faculty, EDU= education.

Results of the PLS analysis are presented in Figure 1. Hypothesis 1 predicted that the EQ of undergraduate students is positively associated with academic engagement. The research finding demonstrated this positive relationship and was statistically significant ($\beta = 0.12$, $p < .001$), hence hypothesis 1 was supported. Furthermore, it was projected in hypothesis 2 that the EQ of undergraduate students is positively linked with self-efficacy. The results revealed a positive linkage between the EQ of undergraduate students and their self-efficacy, and it was also established to be statistically significant ($\beta = 0.50$, $p < .001$). Consequently,

hypothesis 2 was also supported. Hypothesis 3 likewise predicted that the self-efficacy of undergraduate students is positively related to academic engagement. The findings demonstrated a positive linkage between these two constructs, and it was also statistically significant ($\beta = 0.55$, $p < .001$). Therefore hypothesis 3 was also supported.

Then, hypothesis 4 projected that the self-efficacy of undergraduate students mediates the positive linkage between EQ and academic engagement. The examination of mediating effect was measured by utilizing the estimation of the indirect effect as proposed

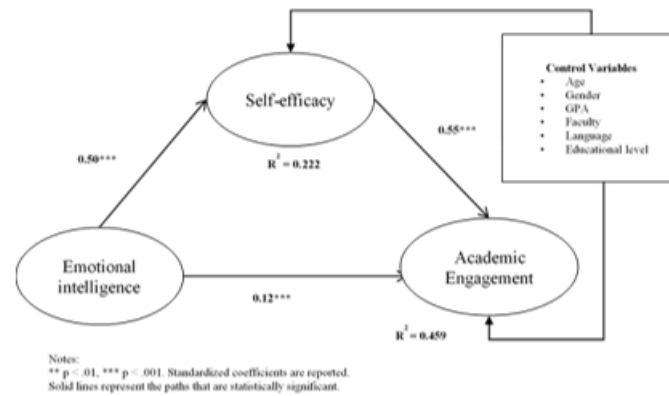


Figure 1: Results from hypotheses testing.

by Preacher and Hayes (54). The investigation was conducted using a bootstrapping method. The result supported the positive mediation of self-efficacy; this result showed that it was statistically significant ($\beta = 0.034$, $p < .001$). Hence, hypothesis 4 was supported.

According to the model, EQ has a direct effect on AE with a value of 0.12. Additionally, it was found that SE mediated the linkage between EQ and AE with a total value of 0.275. Despite all values being strongly significant, it can be concluded that the indirect effect is more powerful than the direct effect. Students with high EQ are able to regulate their emotions and focus more on engaging themselves in class. In addition, high EQ students who also have high SE tend to be more motivated to engage in class.

Regarding the control variables, age, and GPA were depicted to have a positive linkage with self-efficacy, while faculty, language, and education have a negative linkage with self-efficacy. Furthermore, age, language, and education positively linked with academic engagement while gender, GPA, and faculty were found negatively associated with academic engagement. In addition, language proficiency and GPA were reported to have a positive relationship with academic engagement and these were statistically supported. It implied that (1) students with high English proficiency tend to engage themselves more in class conducted in English language and [55] students with high GPA tend to be more motivated to engage more with their studies.

7. Discussion

General Discussion

This research examined the role of EQ and self-efficacy in predicting the academic engagement of undergraduate students in one international university in Thailand. Generally, the outcomes from the PLS supported all hypotheses. First, the results reported that students who possess high EQ tend to have engagement with their studies and are consistent with aforementioned findings that also supported the role of EQ

[22]. Second, the analysis demonstrated a positive relationship between EQ and self-efficacy. This finding indicated that students who exhibit high EQ tend to have strong self-efficacy. This is also consistent with previous studies, stating that students having a higher level of self-efficacy are found emotionally intelligent and therefore confident to do well in terms of the academe [35]. Third, this research supported a positive association concerning self-efficacy and academic engagement, which implied that students who possess high self-efficacy tend to have strong academic engagement. This is also parallel with previous research where self-efficacy was reported to influence academic engagement [42]. In addition to the direct linkage between EQ and academic engagement, this study also found the association with these two constructs was mediated by the level of students' self-efficacy. This finding provided evidence supporting the notion that high EQ students who also possess strong self-efficacy are more likely to demonstrate strong academic engagement which is consistent with the previous study that EQ is positively associated with self-efficacy [38]. Furthermore, it claimed that self-efficacious students tend to engage themselves well in class and outside class activities [34].

Research Contribution This study provides a contribution to EQ studies. Given that there was a mixed finding on the influence of EQ on academic engagement, this research provides evidence that EQ is an important factor contributing to academic engagement of undergraduate students. The mediating role of self-efficacy also offered further understanding into some personal characteristics in which EQ's role can have more impact on student engagement in their studies.

Managerial Implications These research findings also provide a practical contribution to the university's authorities, lecturers, as well as students. The results of the study suggested a direct relationship between self-efficacy and academic engagement, that is; students with higher self-efficacy demonstrate better academic engagement. The academic staff should support students to build their self-efficacy by giving them

constructive feedback and encouragement. Moreover, the findings provide a significant contribution to previous EQ researches specifically on the mediating role of self-efficacy which was not explored extensively in prior researches.

Limitations and Future Research The first limitation of this research is that this study is only based on one international university in Thailand and does not represent the entire undergraduate students' population; hence the generalizability of the findings may be limited. Second, this research is the subjective bias on the respondents' part which can imperil the analysis of data collected through the survey questionnaire. Third, the study is conducted on a cross-sectional basis, therefore, the causality between the variables cannot be established.

It is suggested that further study should consider using a bigger sample size from more institutions in order to draw a significant contribution. It is also interesting to introduce some cultural variables to see if the culture has an impact on the students' EQ and academic engagement.

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Electrospun *Centella asiatica* leaf extract–loaded poly (vinyl alcohol)/ gelatin fiber mats as potential wound dressings

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Abstract

The electrospun poly(vinyl alcohol) (PVA)/gelatin (GEL) fibers containing *Centella asiatica* leaf extract (CA) with different ratios of PVA/GEL and different contents of CA were fabricated. The ratios of PVA/GEL/CA affected the kinematic viscosities of solution and thereby affected the morphology and size of fibers. Only the electrospun fiber mats at PVA/GEL ratios of 9/1 and 8/2 containing 5% CA (PVA/GEL/CA 9/1/5 and 8/2/5) were selected to investigate their potential for use as wound dressings. The release behaviors of CA from these fiber mats were investigated at 37°C in phosphate buffer (pH 7.4) solution using the total immersion and the diffusion using modified Franz cell methods. For both release methods, the burst release of CA at the initial time followed by a gradual release until reaching a plateau was noticed. The PVA/GEL/CA 8/2/5 provided a greater release of CA than the PVA/GEL/CA 9/1/5 fiber mats. The slower rate and smaller amounts of CA released from the diffusion method than those from the total immersion method were observed. The degree of water swelling of the fiber mats was evaluated. Lastly, the PVA/GEL/CA 9/1/5 and 8/2/5 fiber mats exhibited antioxidant activity as determined by 1,1-diphenyl-2-picrylhydrazyl (DPPH) assay and antibacterial activity against *Staphylococcus aureus* and *Escherichia coli*, which revealed the potential for use as wound dressing materials.

Keywords: *Centella Asiatica*, poly(vinyl alcohol), gelatin, wound dressing, electrospinning

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1. Introduction

Electrospinning is the process to produce ultrafine fibers in a range of micrometers down to nanometers from either polymer solutions or polymer melt. An emitting electrode of the high power supply charges the polymer solution or melts until the electrostatic field strength reaches a critical value, in which the pendant drop destabilizes into a conical shape (i.e., the Taylor cone) [1]. Beyond a critical value, a charged polymer jet is ejected from the cone and travelled to the collector by the electrostatic force. The thinning down of the charged jet during its flight to the collector is due to the Coulombic repulsion force.

Electrospun fibers have been proposed for use in a number of applications, for example, air and water filtration, sensors, catalysis, optical devices, tissue engineering, carriers for drug delivery systems, and wound dressings. The outstanding aspects of the ultrafine electrospun fibers for use as wound dressings are their interconnected porous structure with a high surface-to-volume ratio that provides the drug molecules to diffuse out continuously. The sustained release of drugs can be achieved using the electrospun fibers as carriers [2–4].

Among various types of materials used as the carriers in wound dressings, hydrogels are of the most interesting according to their ability in absorbing water or fluid but not dissolving. Poly(vinyl alcohol) (PVA) incorporated with drugs or bioactive molecules is widely used as promising wound dressings [5–7]. Crosslinking of PVA could be performed by using boric acid [8], diisocyanate [9], glyoxal [10], and glutaraldehyde [11] to improve the physical stability during usage and to control the degree of weight loss and swelling.

Several proteins or partially hydrolyzed proteins, for example, silk fibroin, elastin, and gelatin were integrated into wound dressings to improve cell attachment, cell proliferation, and the biocompatibility of the materials. Among these polypeptide substances, gelatin was chosen to incorporate into the electrospun PVA nanofibers in the present work. Gelatin is widely utilized in biomedical applications, for example, tissue engineering, targeted drug delivery, and wound dressings according to its non-toxicity, biocompatibility, biodegradability, and resemblant structure to collagen, an extracellular matrix of tissues [12, 13]. The biodegradability, viability, and proliferation of cells cultured on the alginate/gelatin scaffolds increased with an increase in the gelatin content [14].

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Electrospun gelatin/polyurethane nanofibers for use in wound healing applications exhibited higher cell proliferation when the gelatin content was increased [15].

Centella asiatica (CA) plant is widely found in moist and warm regions including Asia, Africa, Australia, Central America, and South America [16]. It is used as a local medicine for the treatment of many diseases or symptoms, for example, skin diseases, renal stones, asthma, and gastrointestinal diseases [17]. The major compounds in CA plant are triterpenes, asiatic acid, madecassic acid, and their derived triterpene ester glycosides including asiaticoside, and madecassoside [17]. CA extracts possess several pharmacological properties such as anti-ulcer, anti-inflammatory, antioxidant, and anti-microbial [17–19]. Many reports revealed that CA facilitates the wound healing process by stimulating collagen synthesis, enhancing cell proliferation, and reducing oxidation in the wound [18]. Wang L. et al. fabricated CA loaded-gelatin/chitosan hydrogel for use as wound dressings which exhibited antibacterial properties and good biocompatibility [19]. Yao C.H. et al. demonstrated that the electrospun gelatin nanofibers containing CA extract enhanced the recovery rate of wound healing in rats compared with gauze and neat gelatin membrane [20].

In the present work, the electrospun CA leaf extract-loaded PVA/gelatin fiber mats with different ratios of PVA and gelatin and different contents of CA were fabricated. The morphology and size of fibers were examined. The potential for use of the electrospun PVA/gelatin/CA fiber mats as materials for topical and transdermal delivery of CA was investigated. The release behaviors of CA therefrom were studied using the total immersion and the diffusion methods in the phosphate buffer (pH 7.4) solution at 37°C. The degree of water swelling of the fiber mats was evaluated. Lastly, the antioxidant activity and the antibacterial activity of these fiber mats were determined.

2. Experiment

2.1 Materials

Centella asiatica (CA) leaves were brought from the local market in Pathumthani, Thailand. Poly(vinyl alcohol) (PVA; degree of hydrolysis: 86.0–89.0%, MW: 85,000–124,000 g/mol) and gelatin (GEL) powder were purchased from SD Fine Chemicals (India). Glutaraldehyde (25% aqueous solution) was purchased from Acros Organics (USA). Ethanol, disodium hydrogen phosphate (Na_2HPO_4), and sodium dihydrogen phosphate (NaH_2PO_4) were purchased from Carlo Erba (Italy). 1,1-diphenyl-2-picrylhydrazyl (DPPH) was purchased from Sigma Aldrich (USA).

2.2 Extraction of *Centella Asiatica* Leaf

CA leaves were collected, washed with water, and dried at room temperature for 5 h. They were cut into

small pieces and immersed in ethanol at a solid:liquid ratio of 10 g:20 mL. The mixture was shaken in a closed container at room temperature for 24 h. The filtrate was collected from vacuum filtration. The liquid extract of CA was placed in a rotary evaporator to remove the solvent at 40°C for 30 min. The obtained slurry was further freeze-dried. Lastly, the CA extract was obtained in a solid form and kept in a desiccator.

2.3 Electrospinning of CA Extract-loaded PVA/GEL Fiber Mats

Aqueous solutions of PVA and GEL were prepared at 12% and 8% w/v at 80°C and 45°C, respectively. PVA and GEL solutions were mixed at the ratios of 9/1, 8/2, 7/3, and 6/4 w/w and stirred until the homogeneous solutions were obtained. The obtained solutions were designated as the PVA/GEL 9/1, the PVA/GEL 8/2, the PVA/GEL 7/3, and the PVA/GEL 6/4, respectively. For each of the PVA/GEL solutions, the CA extract was subsequently added at different concentrations of 5, 10, and 20% w/w. The pristine PVA/GEL 9/1 solution without the addition of CA and the CA extract-loaded PVA/GEL solutions were designated as the PVA/GEL/CA 9/1/0, the PVA/GEL/CA 9/1/5, the PVA/GEL/CA 9/1/10, and the PVA/GEL/CA 9/1/20, respectively. The other solutions were named in a similar manner. Kinematic viscosities of the solutions were measured using a Cannon-Fenske Routine viscometer (a constant kinematic viscosity of 2.351 cSt/s at 40°C).

Each of the PVA/GEL/CA solutions was electrospun into a non-woven nanofiber mat. The solution was placed in a plastic syringe connected with a stainless-steel needle used as a nozzle. The diameter of the nozzle was 0.91 mm. A high voltage of either 15 kV was applied to the solution using a Gamma High Voltage Research ES30P-5W power supply. The rotating collector which was covered with aluminum foil was used to collect the electrospun fibers at 100 rpm. The distance between the collector and the nozzle was 15 cm. The flow rate of the solution was kept constant at 0.5 mL/h using a syringe pump (SP-8800 AMPall, Korea). The electrospun PVA/GEL/CA fiber mat with the thickness of about $60 \pm 10 \mu\text{m}$ was obtained after 10h of electrospinning. The selected PVA/GEL/CA fiber mats were chosen to investigate in the further study including the release behavior of CA therefrom, the degree of water swelling, the antioxidant activity, and the antibacterial activity. The PVA/GEL/CA fiber mats were crosslinked by a glutaraldehyde vapor treatment. The fiber mats were placed in a closed container saturated with the vapor of glutaraldehyde, and were kept in an oven at 40°C for 10h. Later, the fiber mats were left in a ventilated area for 24h at room temperature to allow complete evaporation of glutaraldehyde.

The morphology of the electrospun fibers before and after crosslinking was investigated using a JSM-5410LV JEOL scanning electron microscope (SEM).

The samples were coated with a thin layer of gold using a Polaron SC7640 coater prior to observing under the SEM.

2.4 Release of CA from the PVA/GEL/CA Fiber Mats

2.4.1 Preparation of the phosphate buffer (pH 7.4)

For the proposed application of the PVA/GEL/CA fiber mats as wound dressings, the phosphate buffer solution (pH 7.4) was used as a releasing medium in order to simulate the physiological condition of the wound. For the preparation of 1 L of the phosphate buffer (pH 7.4), 20.2 g of $\text{Na}_2\text{HPO}_4 \cdot 7\text{H}_2\text{O}$ and 3.4 g of $\text{NaH}_2\text{PO}_4 \cdot \text{H}_2\text{O}$ were dissolved in distilled water. The final volume of the solution was adjusted to 1 L. Few drops of sodium hydroxide solution or hydrochloric acid could be added to adjust the pH to 7.4. The release characteristics of CA from the PVA/GEL/CA fiber mats were investigated by the total immersion method and the diffusion method at 37°C using the phosphate buffer solution as a releasing medium.

2.4.2 Release assay by the total immersion method

The PVA/GEL/CA fiber mat was cut into a square shape of 2x2 cm² and immersed in 40 mL of the phosphate buffer solution at 37°C. The solution was slowly stirred using a magnetic stirrer during the releasing time ranging from 0 - 8h. At each specified time point, 1.0 mL of the releasing medium was withdrawn and diluted with the buffer solution before measuring for the absorbance by the UV-vis spectrophotometer at 208 nm. The same amount (i.e. 1.0 mL) of fresh phosphate buffer solution was refilled into the release bottles in order to keep the constant volume. The amounts of CA released were quantified from the absorbance of the releasing solution against the pre-determined standard curve of the CA solution in the phosphate buffer solution. The cumulative percentage of the CA released was calculated according to the equation (1):

$$\text{Cumulative CA release (\%)} = \frac{C_t}{C_{total}} \times 100 \quad (1)$$

where C_t is the cumulative weight of CA released at time t and C_{total} is the initial weight of the CA loaded in the PVA/GEL/CA fiber mats. The experiments were carried out in triplicate. In order to determine C_{total} , the actual drug content (i.e., the actual amount of CA extract presented in the fiber mats) was quantified. The fiber mat was cut into a square piece of 2x2 cm² and was completely dissolved by continuously stirred in 20 mL of distilled water at 80°C for 3 h. The actual amount of CA extract was quantified from its absorbance at 208 nm using the UV-vis spectrophotometer.

2.4.3 Release assay by the diffusion method

The PVA/GEL/CA fiber mat was placed on top of the modified Franz diffusion cell which was fully filled

with the phosphate buffer (pH 7.4) solution. The diameter of the Franz diffusion cell which exposed to the tested fiber mat was 13 mm. The total volume of solution in the Franz cell was 9.0 mL. The experiments were performed at 37°C and the solutions were slowly stirred using a magnetic stirrer during the releasing time ranging from 0 - 8h. At each specified time point, 0.3 mL of the releasing medium was withdrawn and diluted with the buffer solution before measuring for the absorbance by the UV-vis spectrophotometer at 208 nm. The same amount (i.e. 0.3 mL) of fresh phosphate buffer solution was refilled into the Franz diffusion cell. Similar to the total immersion method, the cumulative percentage of the CA released was calculated according to equation (1). The experiments were carried out in triplicate.

2.5 Water swelling of the PVA/GEL/CA fiber mats

The degree of water swelling of the PVA/GEL/CA fiber mats was determined after immersion in the phosphate buffer (pH 7.4) solution at 37°C for 2 and 4h. The tested fiber mat was cut into a square shape of 2x2 cm² and immersed in 40 mL of the phosphate buffer solution. The percentage of water swelling was calculated according to the equation (2):

$$\text{Water swelling (\%)} = \left(\frac{M - M_i}{M_i} \right) \times 100 \quad (2)$$

where M_i is the initial dry weight of the fiber mat and M is the weight of the fiber mat after immersion in the phosphate buffer solution at a specified time point.

2.6 Antioxidant activity of the PVA/GEL/CA fiber mats

The antioxidant activity of the PVA/GEL/CA fiber mats was evaluated by the radical scavenging DPPH assay. The PVA/GEL/CA fiber mat was cut into a square shape of 2x2 cm² and immersed in 40 mL of the phosphate buffer solution at 37°C. At 30, 60, and 120 min of immersion time, 1.0 mL of the releasing media were withdrawn and mixed with 3.0 mL of 0.5 mM DPPH solution in methanol. The mixture was kept in darkness for 30 min and was measured for absorbance at 517 nm by the UV-vis spectrophotometer. The pristine 0.5 mM DPPH solution was also stored in the same condition for being as a control. The antioxidant activity was calculated according to the equation (3):

$$\text{Antioxidant activity (\%)} = \left(\frac{A_{control} - A_{sample}}{A_{control}} \right) \times 100 \quad (3)$$

where $A_{control}$ and A_{sample} are the absorbances at 517 nm of the DPPH solution without and with the presence of the as-released CA solution, respectively. The experiments were carried out in triplicate

2.7 Antibacterial activity of the PVA/GEL/CA fiber mats

The antibacterial activity of the PVA/GEL/CA fiber mats against *Staphylococcus aureus* (*S. aureus*: ATCC 25923) and *Escherichia coli* (*E. coli*: ATCC 25922) bacteria was evaluated by the agar disc diffusion method. The circular filter papers saturated with either deionized water or ethanol were used as the negative and positive control, respectively. The tested fiber mat was cut into a circular disc of 6 mm diameter. The agar disc was incubated at 37°C for 24 h. Lastly, the diameter of inhibition zone, included the diameter of the disc, was measured.

3. Results and Discussions

3.1 Electrospinning of the PVA/GEL/CA fiber mats

Prior to electrospinning, the as-prepared solutions of the CA extract-loaded PVA/GEL at various ratios were measured for their kinematic viscosities. The values of kinematic viscosities are presented in Table 1. The morphology of the electrospun PVA/GEL/CA fibers was observed by using the SEM. The selected SEM images and the average diameters of the electrospun PVA/GEL/CA fibers which were measured using ImageJ software [21] are shown in Table 1. For the PVA/GEL solutions at a ratio of 9/1, the viscosities of solutions increased with increasing the CA content. Consequently, the average fiber diameters were increased. The viscosity of the solution is one of the important properties that governed the morphology and the size of electrospun fibers. The higher viscosity of the solution leads to the higher viscoelastic force which resists the stretching of the fiber jets from the electrostatic attraction and the Coulombic repulsion forces [22]. Therefore, the size of the fiber is generally increased when the viscosity of the polymer solution increased. The smooth surface with the round cross-sectional shape of fibers was evidenced in the case of the PVA/GEL/CA 9/1/0 and 9/1/5. However, the fibers of PVA/GEL/CA 9/1/10 were fused together. More fused fibers which revealed the film-like morphology was observed in the case of the PVA/GEL/CA 9/1/20. It is known that the fusion of the electrospun fibers is mainly caused by the inefficient evaporation rate of solvent from the fiber jets or the too slow solidification rate of the fiber jets. Too high amounts of CA extract in the as-prepared solutions (i.e., PVA/GEL/CA 9/1/10 and 9/1/20) led to the presence of fused fibers. The possible reason could be that some excess amounts of CA extract could not mix well with PVA and GEL and therefore existed on the surface of the as-spun fibers which hindered the evaporation of the solvent (i.e., water) or solidification of fibers.

For the PVA/GEL solutions at a ratio of 8/2, the viscosities of solutions increased with increasing the CA content. Therefore, the higher average fiber diameters were observed as a similar trend as those in the case

of the PVA/GEL of 9/1 ratio. Also, the PVA/GEL/CA 8/2/20 fibers were fused together in some areas and wide distribution of the fiber diameters was observed.

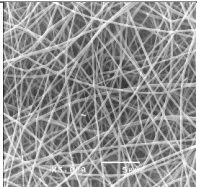
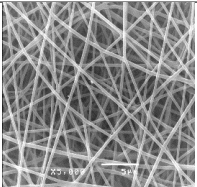
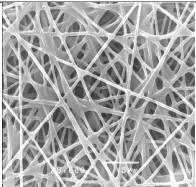
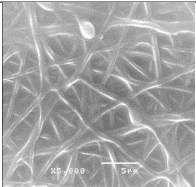
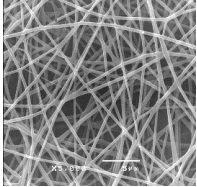
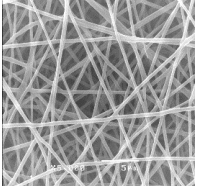
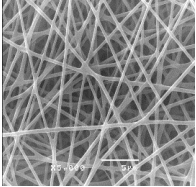
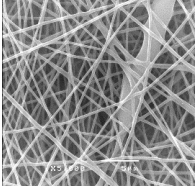
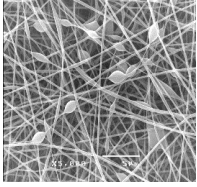
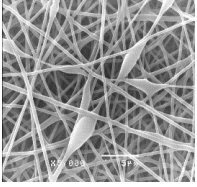
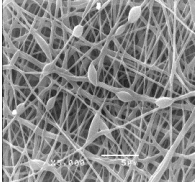
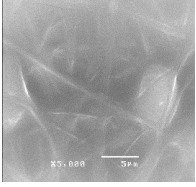
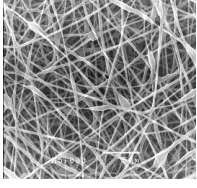
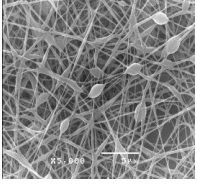
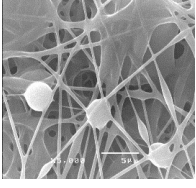
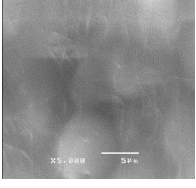
For both ratios of the PVA/GEL solutions at 9/1 and 8/2, the fibers without beads were produced. However, the beaded fibers were obtained from the PVA/GEL solutions at the ratios of 7/3 and 6/4 for all conditions with various CA contents. The presence of beads was mainly caused by the substantial low viscosities of the solutions (i.e., about 55–82 cSt for the ratio 7/3 and about 17–29 cSt for the ratio of 6/4) in which the viscoelastic force was not sufficient to withstand the electrostatic and the Coulombic forces [22]. Again, some parts of fibers were fused together when the CA content was at 10% for both the PVA/GEL ratios of 7/3 and 6/4. Eventually, the fibers were completely fused until the film-like morphology was obtained when the CA content was up to 20%. Based on these results, the PVA/GEL solutions at ratios of 7/3 and 6/4 were not suitable to fabricate into the fibers for use in the further studies because the obtained fibers were not uniformed. In addition, for the PVA/GEL solutions at ratios of 9/1 and 8/2, the CA contents at 10 and 20% were considerably too high in which the fused fibers were obtained. Therefore, only the PVA/GEL/CA 9/1/5 and 8/2/5 were used in the further studies including the release of CA, the antioxidant, and the antibacterial activities of the fiber mats for the proposed application in wound healing.

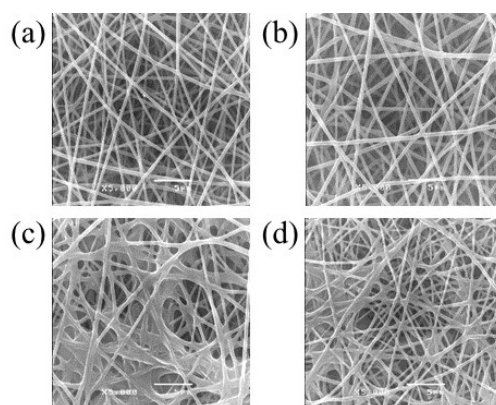
Furthermore, crosslinking of the PVA chains is necessary in order to improve the stability or physical properties of the fiber mats. Figure 1 shows the SEM images of the PVA/GEL/CA 9/1/5 and 8/2/5 before and after treatment with glutaraldehyde vapor at 40°C for 10 h. Crosslinking of PVA involves the formation of acetal groups between two hydroxyl groups of PVA. After crosslinking, most of the fibers fused together. However, the fiber-like morphology still remained.

3.2 Electrospinning of the PVA/GEL/CA fiber mats

The water swelling behaviors of the PVA/GEL/CA 9/1/5 and 8/2/5 fiber mats were investigated after submersion in the phosphate buffer solution (pH 7.4) at 37°C for 2h and 4h (see Figure 2). The percentages of water swelling of the PVA/GEL/CA 9/1/5 and 8/2/5 at 2h of submersion were about 375% and 569%, respectively. At 4h of submersion, these values were about 516% and 633%, respectively. It was found that the degree of water swelling increased with increasing time of submersion. Additionally, at either 2h or 4h, the PVA/GEL/CA 8/2/5 exhibited a higher degree of water swelling than the PVA/GEL/CA 9/1/5. Similar observations were also reported that the hybrid hydrogels fabricated from PVA and GEL for use in osteoarthritis surgery had a higher swelling ability when the amount of GEL increased since the molecules of GEL are more extendable and can hold more water compared to the PVA chains [23].

Table 1. The SEM images of the electrospun PVA/GEL/CA fibers, the average fiber diameters (FD), and the viscosities of the as-prepared solutions (μ).

Samples	PVA/GEL/CA 9/1/0	PVA/GEL/CA 9/1/5	PVA/GEL/CA 9/1/10	PVA/GEL/CA 9/1/20
SEM images				
FD (nm)	218.94 \pm 28.12	305.62 \pm 30.46	326.60 \pm 41.81	N/A
μ (cSt)	153.44 \pm 1.29	189.98 \pm 1.43	220.06 \pm 1.06	228.01 \pm 3.81
Samples	PVA/GEL/CA 8/2/0	PVA/GEL/CA 8/2/5	PVA/GEL/CA 8/2/10	PVA/GEL/CA 8/2/20
SEM images				
FD (nm)	301.67 \pm 55.61	334.52 \pm 51.24	335.20 \pm 47.82	336.00 \pm 61.05
μ (cSt)	120.92 \pm 1.03	153.07 \pm 1.35	162.07 \pm 1.83	166.80 \pm 1.51
Samples	PVA/GEL/CA 7/3/0	PVA/GEL/CA 7/3/5	PVA/GEL/CA 7/3/10	PVA/GEL/CA 7/3/20
SEM images				
FD (nm)	185.42 \pm 30.76	319.71 \pm 57.26	301.72 \pm 53.87	N/A
μ (cSt)	55.19 \pm 1.52	61.24 \pm 1.12	69.06 \pm 1.02	81.60 \pm 1.64
Samples	PVA/GEL/CA 6/4/0	PVA/GEL/CA 6/4/5	PVA/GEL/CA 6/4/10	PVA/GEL/CA 6/4/20
SEM images				
FD (nm)	226.30 \pm 55.41	202.05 \pm 71.32	N/A	N/A
μ (cSt)	17.04 \pm 1.22	17.19 \pm 0.50	18.13 \pm 0.68	29.43 \pm 0.47

**Figure 1:** SEM images of the electrospun PVA/GEL/CA fibers before crosslinking at ratios of (a) 9/1/5, (b) 8/2/5 and after crosslinking with glutaraldehyde vapor at ratios of (c) 9/1/5, and (d) 8/2/5.

3.3 Release of CA from the PVA/GEL/CA fiber mats

The release behaviors of CA from the PVA/GEL/CA 9/1/5 and 8/2/5 fiber mats were

investigated by the total immersion method and the diffusion method at 37°C during 0–8h using the phosphate buffer solution (pH 7.4) as the releasing

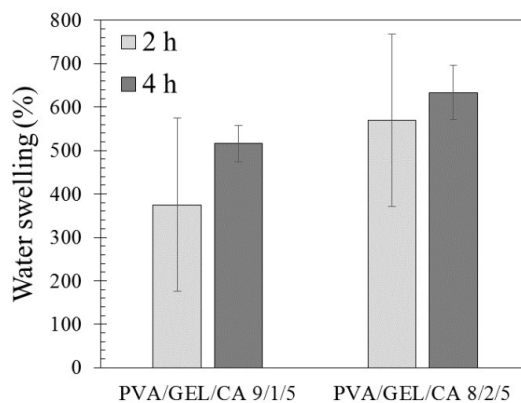


Figure 2: Water swelling of the PVA/GEL/CA 9/1/5 and 8/2/5 at 2 and 4h of immersion in phosphate buffer (pH 7.4).

medium.

3.3.1 Total immersion method

Figure 3(a) shows the percentages of the cumulative release of CA therefrom by the total immersion method at 37°C in the phosphate buffer solution (pH 7.4). The burst release was observed at the initial 10 min of release. Later, the gradual release until reaching the plateau amounts was noticed. The maximum amounts of CA released from the PVA/GEL/CA 9/1/5 and 8/2/5 at 480 min (8 h) were about 84.4% and 90.0%, respectively. The higher amounts of CA released from the PVA/GEL/CA 8/2/5 than those from the PVA/GEL/CA 9/1/5 were evidenced. A number of factors affect the rate and the amount of a substance released into media, for example, the temperature [24], the solubility of substance in media (i.e., hydrophilicity and lipophilicity), the degree of weight loss of the matrix, the degree of swelling of the matrix [25] and pH of releasing media [26]. It was found that the release behaviors correlated with the degree of water swelling in Figure 2 in which the PVA/GEL/CA 8/2/5 had a higher swelling ratio than the PVA/GEL/CA 9/1/5. The greater swelling ability of the matrix indicates that it can hold more water or be highly solvated by water and therefore allowing the drug molecules to diffuse out conveniently [26]. Isoglu et al. investigated the release of CA from the electrospun poly(D, L-lactide-co-glycolide) (PLGA)/poly(3-hydroxybutyrate-co-3-hydroxy valerate) (PHBV) fibers [27]. CA was rapidly released from the electrospun PLGA/PCL membrane in the first 5h, followed by a slow release. In this work, the release of CA from the PVA/GEL/CA fiber mats showed the burst release in the first hour which was faster than that observed from their work. The higher hydrophilicity of PVA and GEL than those of PLGA and PHBV could be one of the factors affecting the greater degree of water swelling, and therefore faster release of CA. However, the release of CA from the PLGA/PCL fibers reached a plateau at about 10h which was close to this work (i.e., 8h).

3.3.2 Diffusion method

The attempt to investigate the release characteristics of CA from the fiber mats in the most similar conditions as in the applications of wound dressings was performed by the diffusion method. Figure 3(b) shows the percentage of the cumulative release of CA from the PVA/GEL/CA 9/1/5 and 8/2/5 fiber mats by the diffusion method at 37°C in the phosphate buffer solution (pH 7.4). Similar to the results observed in the total immersion method, the burst release of CA at the initial time of release was presented. However, the slower and smaller amounts of CA released were noticed from the diffusion method. The amounts of CA released in the region of the burst release were only about 35–40%, whereas those from the total immersion method were about 67–70%. Later, the gradual release until reaching the plateau amounts was revealed. The maximum amounts of CA released from the PVA/GEL/CA 9/1/5 and 8/2/5 at 480 min (8 h) were about 74.3% and 80.4%, respectively. Also, the maximum amounts of CA released in the diffusion method were lower than those in the total immersion method.

Consistently, it can be noticed that the PVA/GEL/CA 8/2/5 fiber mats exhibited more amounts of CA released than the PVA/GEL/CA 9/1/5 which were similar to the results of the total immersion method. The greater swelling ability of the PVA/GEL/CA 8/2/5 fiber mats could be the reason that they can provide the greater amounts of CA released as discussed earlier.

3.4 Antioxidant activity of the PVA/GEL/CA fiber mats

Wound healing is the complex biological process to restore the structure and functional integrities of injured skin tissues. Antioxidants are the substances that can prevent or delay the production of free radical species. Antioxidants are asserted to help control wound oxidative stress and thereby accelerate wound healing [28]. The antioxidant activities of the

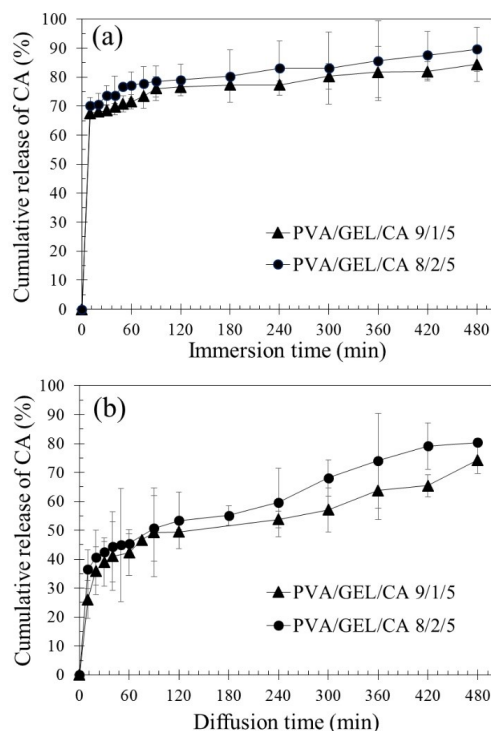


Figure 3: Cumulative release amounts of CA from the PVA/GEL/CA in phosphate buffer (pH 7.4) as determined by (a) total immersion method and (b) diffusion method.

PVA/GEL/CA 9/1/5 and 8/2/5 fiber mats were evaluated by the DPPH assay. The DPPH radical (DPPH·) is a stable free radical that can accept electron or hydrogen radical to become a non-radical molecule (DPPH-H). The transformation of the DPPH radicals into the non-radical molecules induced by CA was measured by the reduction in its absorbance at 517 nm according to Equation (3). Figure 4 presents the antioxidant activities of these fiber mats after immersion in the phosphate buffer solution (pH 7.4) for 30, 60, and 120 min. For both types of fiber mats, the antioxidant activity increased with increasing time of immersion according to the higher amounts of CA released as time increased. Interestingly, the antioxidant activities of the PVA/GEL/CA 8/2/5 were greater than those of the PVA/GEL/CA 9/1/5 fiber mat. The values at 120 min of the PVA/GEL/CA 9/1/5 and 8/2/5 fiber mats were 12.01 ± 1.05 and $13.66 \pm 1.12\%$, respectively. Once more, the results of the antioxidant activity corresponded to the trends observed in the water swelling and the release amounts of CA that the PVA/GEL/CA 8/2/5 fiber mats possessed the greater values.

3.5 Antibacterial activity of the PVA/GEL/CA fiber mats

The antibacterial property is one of the important properties of wound dressings. The antibacterial activities of the PVA/GEL/CA 9/1/5 and 8/2/5 fiber mats were investigated against *S. aureus* and *E. coli* by agar disc diffusion method. Table 2 shows the average diameter of inhibition zone observed from the

bacterial culture disc. No inhibition zone was observed for a negative control (i.e., deionized water) for both types of bacteria. Ethanol as a positive control showed the average diameter of inhibition zone of 10.66 ± 0.58 and 10.34 ± 0.58 mm for *S. aureus* and *E. coli*. Interestingly, both types of the PVA/GEL/CA fiber mats exhibited the larger diameters of inhibition zone than that of a positive control for both bacteria. Contrary to the release behaviors, the PVA/GEL/CA 8/2/5 showed a smaller inhibition zone compared to the PVA/GEL/CA 9/1/5 fiber mats. However, its inhibition zone is still greater than a positive control. The higher contents of GEL in the electrospun ciprofloxacin-loaded alginate/PVA/GEL fibers [4] and in the tetracycline hydrochloride-encapsulated poly(lactic acid)/GEL hydrogel [29] also caused a smaller antibacterial properties against *S. aureus* and *E. coli*. The outstanding antibacterial property of the PVA/GEL/CA fiber mats is affirmed by this study which indicate the potential for use as the carriers for transdermal drug delivery and for wound healing applications. Mouro *et al.* fabricated the double-layered composite membranes composing of a layer of the electrospun chitosan-sodium tripolyphosphate and poly(vinyl alcohol) containing CA on top of a polycaprolactone layer [30]. These membranes exhibited the outstanding antibacterial activities against *S. aureus* (99.96%) and *Pseudomonas aeruginosa* (*P. aeruginosa*) (99.94%) as tested by ASTM E2180-07 standard. The antibacterial activities of the

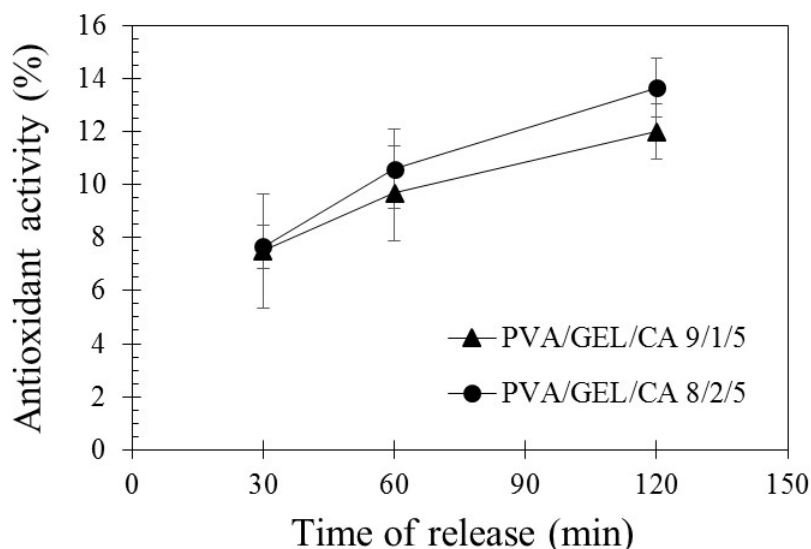


Figure 4: Antioxidant activities of the PVA/GEL/CA fiber mats at different immersion times.

Table 2. Antibacterial activities of the PVA/GEL/CA against *S. aureus* and *E. coli* as determined by the agar disc diffusion method. The diameter of the circular disc was 6 mm.

Samples	Average diameter of inhibition zone (mm)	
	<i>S. aureus</i>	<i>E. coli</i>
Negative control: deionized water	0.00 ± 0.00	0.00 ± 0.00
Positive control: ethanol	10.66 ± 0.58	10.34 ± 0.58
PVA/GEL/CA 9/1/5	14.34 ± 0.58	13.26 ± 0.22
PVA/GEL/CA 8/2/5	11.34 ± 0.58	12.00 ± 0.44

PVA/GEL/CA fiber mats herein are consistent well with the previous study.

4. Conclusions

In the present contribution, CA leaf extract which is widely known for its anti-inflammatory, antioxidant, and antibacterial was encapsulated in the electrospun PVA/GEL fiber mats. The as-prepared solutions with various ratios of PVA/GEL and various contents of CA were used in the electrospinning. The ratios of PVA/GEL/CA affected the kinematic viscosities of the solution and thereby affected the morphology and size of fibers. The potential for use of the selected electrospun PVA/GEL/CA fiber mats (i.e., 9/1/5 and 8/2/5) as wound dressing patches was explored. The release behaviors of CA therefrom were investigated at 37°C in phosphate buffer (pH 7.4) solution using the total immersion and the diffusion using modified Franz cell methods. For both release methods, the PVA/GEL/CA 8/2/5 provided the greater release of CA than the PVA/GEL/CA 9/1/5 fiber mats which corresponded with the values of water swelling. The burst release of CA at the initial time followed by a gradual release until reaching a plateau was observed for both types of release methods. However, the more sustained release was noticed in the case of the diffusion method. The antioxidant activity of the

PVA/GEL/CA 8/2/5 was slightly higher than that of the PVA/GEL/CA 9/1/5 fiber mats which correlated with the release amounts of CA. Both types of fiber mats exhibited antibacterial activities against *S. aureus* and *E. coli* which revealed the potential for use as wound dressing materials.

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Human resource management and development of government officer 4.0: A case study of the department of disaster prevention and mitigation

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Abstract

This research article is a part of the research project “the guidelines for organizational development and human resource development to become DDPM 4.0”. The objective of this article was to study and formulate the HR DDPM 4.0 Plan and the HR DDPM 4.0 Action Plan in alignment with the context of human resource management and development to drive the Department of Disaster Prevention and Mitigation towards Government 4.0 or DDPM 4.0. The qualitative research was employed by exploring, collecting, and analyzing related documents, official correspondence, related researches, etc. Data were also collected and analyzed from interviews, focus groups, seminars, workshops of government officials, and staff members in the operational sections of the Department of Disaster Prevention and Mitigation, as well as survey research by distributing questionnaires to the Provincial Disaster Prevention and Mitigation Offices to acknowledge opinions of agencies operating at the local level. The findings led to the preparation of the HR DDPM 4.0 Development Plan and the HR DDPM 4.0 Action Plan. The developed plan consists of 3 strategic issues, namely Strategic Issue 1: Recruitment and Selection of Government Officer 4.0; Strategic Issue 2: Human resource enhancement to the capability to drive DDPM 4.0; and Strategy Issue 3: Improvement of the quality of life in DDPM 4.0. It is a guideline for organizational development and human resource development to become DDPM 4.0 that is consistent with the context of the organization, the framework of the 20-year National Strategy, Thailand 4.0, and Government 4.0 and consistent with the principles of strategic human resource management which connects people to their organizations.

Keywords: Government officer 4.0, human resource management, human resource development

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1. Introduction

The government push for the Thailand 4.0 policy by Prime Minister General Prayut Chan-o-cha requires all relevant sectors to understand and create a goal of becoming Thailand 4.0, Organization 4.0, including the Department of Disaster Prevention and Mitigation. The departmental agency under the Ministry of Interior has a mission to carry out the country’s disaster prevention and mitigation. Now that natural disasters are becoming more serious and frequent, coupled with changes and twists in the digital disruptive world, organizations need to adapt to changes and make full use of technology and create the effectiveness of the organization’s mission.

However, when the administrative contexts change over time, the organization can no longer be in a position to control the environment, as well as the adoption of the Thailand 4.0 policy. All agencies in the

bureaucratic system, therefore, must make the proper adjustments to drive Thailand 4.0 successfully. The Department of Disaster Prevention and Mitigation is one agency that cannot escape adaptation in such environments, especially human resource management, which is the main mechanism for driving the organization to achieve its goals. It is consequently necessary to make adjustments by moving toward Organization 4.0 or Government 4.0.

This research article is a part of the research project “the guidelines for organizational development and human resource development to become DDPM 4.0”. One of the objectives of the research is to study and formulate the HR DDPM 4.0 Plan and the HR DDPM 4.0 Action Plan in alignment with the context of human resource management and development to drive the Department of Disaster Prevention and Mitigation towards Government 4.0 or DDPM 4.0.

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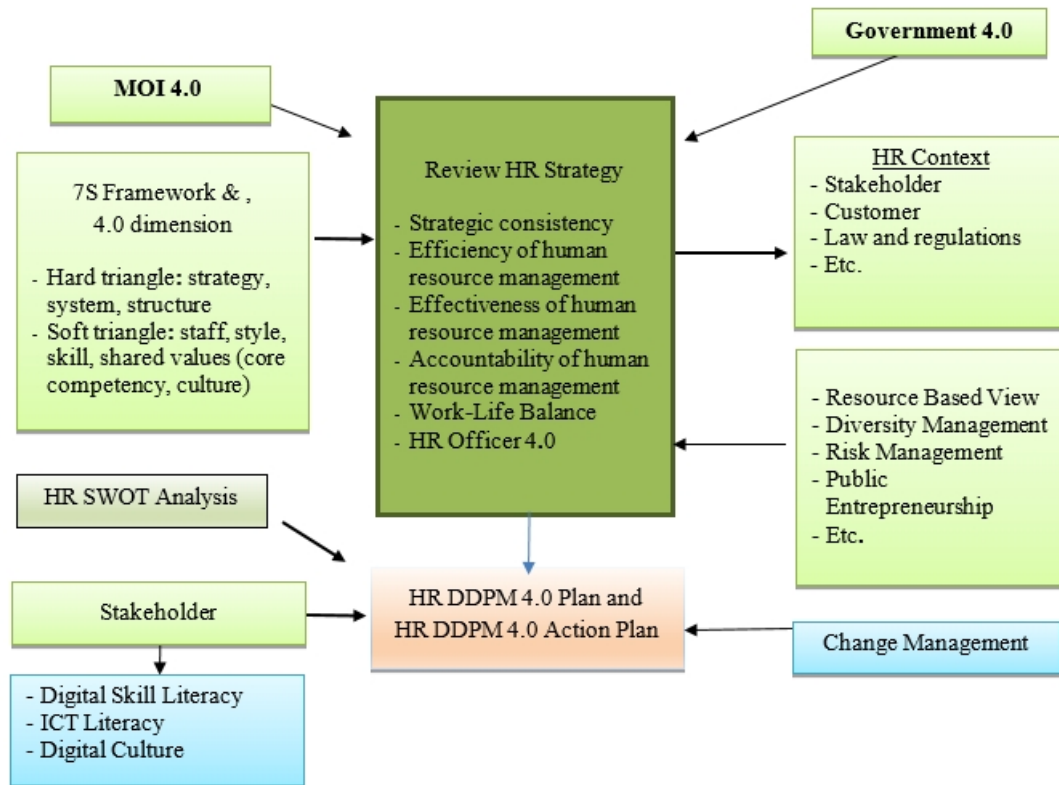


Figure 1: Conceptual Framework.

2. Research Objectives

To study and formulate the HR DDPM 4.0 Plan and the HR DDPM 4.0 Action Plan in alignment with the context of human resource management and development to drive the Department of Disaster Prevention and Mitigation towards Government 4.0 or DDPM 4.0.

3. Conceptual Framework

The conceptual framework is formed by studying, collecting, and analyzing based on strategy and policy at various levels, such as the 20-year National Strategy, Government Policy, MOI Strategy 4.0, Thailand 4.0, Government 4.0, related academic knowledge, etc. and the analysis of the DDPM Positioning until leading to the formulation of the HR DDPM 4.0 Plan and the HR DDPM 4.0 Action Plan, a guideline for the development to HR DDPM 4.0 as shown in figure 1.

4. Research Methods

4.1 Scope of Research: The qualitative research was employed by exploring information related to the establishment of the HR DDPM 4.0 Plan and the HR DDPM 4.0 Action Plan, and the scope of the research is as follows:

1. Scope of content: Various documents related to the HR DDPM 4.0 Plan and the HR DDPM 4.0 Action Plan based on strategic reviews at various levels, such as the 20-year National Strategy, Government Policy, MOI Strategy 4.0, Thailand 4.0, Government 4.0, and SWOT Analysis, were studied, collected, and analyzed. Then, the information was combined with the interview, workshop, and brainstorm data from all sectors prepared as the HR DDPM 4.0 Plan and the HR DDPM 4.0 Action Plan.

2. The scope of population: The population is divided into three groups: Group 1—personnel involved in the formulation of HR DDPM 4.0 plans and implementation of DDPM 4.0; Group 2—personnel working in area-level operations agencies and not participating in Group 1; and Group 3—groups of representatives from various organizations related to driving DDPM 4.0, both from the public sector, the private sector, civil society, etc.

3. The scope of areas and time: The operational areas consisted of Bangkok, the Chonburi Province and the Surat Thani Province. In terms of

Table 1. The details of HR DDPM 4.0 plan and the HR DDPM 4.0 action plan.

Strategic Issue	Strategic	Indicator	Project
<p>Strategic Issue 1: Recruitment and Selection of Government Officer 4.0 The goal is HR DDPM 4.0 develops human resources and network partners to be DDPM 4.0 to increase organizational efficiency, effectiveness and achievement.</p>	<p>Strategic 1.1 Recruitment and Selection of Government Officer 4.0 Development guidelines 1) Review of the criteria for determining the manpower rate framework to be consistent with the mission to prevent / reduce / various disasters 2) Preparation of recruitment and selection guidelines to acquire personnel with knowledge, skills and attitudes in accordance with disaster management operations on the basis of the job competency</p>	<p>1. Number of newly accepted personnel who are qualified as required Government Officer 4.0 2. Number of new personnel trained</p>	<p>1. Young Smart DDPM 4.0 project 2. Join Team DDPM 4.0 project</p>
<p>Strategic Issue 2: Human resource enhancement to the capability to drive DDPM 4.0 The goals are • There is a 4.0 human resource management system capable of recruiting, developing and maintaining personnel to have knowledge, skills, and ability to drive DDPM 4.0. • Personnel have high knowledge, skills, and expertise in being a leader in disaster management.</p>	<p>Strategic 2.1 Raise the level of personnel to high capabilities, DDPM 4.0 Development Guidelines 1) Developing a system for enhancing knowledge, skills, and expertise of personnel to become DDPM 4.0 people, including job position competency system, knowledge management system, and learning organization 2) Review and development of training courses for personnel to have high capabilities and in line with the direction of driving towards DDPM 4.0</p> <p>Strategic 2.2 Developing innovators DDPM 4.0 <i>Development Guidelines</i> 1) Development of special training courses to create innovators, DDPM 4.0 2) Promoting, supporting and motivating people's innovative thinking, DDPM 4.0</p>	<p>1.A review is carried out and able to design 7 groups of personnel training 4.0 courses within 1 year after the end of the research. 2. Project 2–Project 7 Indicators from the number of training sessions in each group and how much the indicators from the assessment after training have been converted to Digital Culture. 3. Able to complete the training according to the specified course within two years, at least one model per group 4. For vocational training, normal (original) does not offer indicators</p> <p>1. Number of innovators, DDPM 4.0 2. Human resource development plan to raise the level to be an innovator, DDPM 4.0</p>	<p>1. Project to push the Institute for Personnel Development in Disaster Prevention and Mitigation to be a Human Resource Development Center 4.0 2. Project for review and development of the DDPM 4.0 curriculum 3. DDPM 4.0 executive project 4. Project Director 4.0 5. Policy and Academic Workers Project 4.0 6. Service Worker 4.0 Project 7. Worker Project 4.0 8. Technology 4.0 worker project 9. Network 4.0 development project 10. Project to develop the competency system of the position in accordance with the DDPM 4.0 11. 4.0 Performance Appraisal Guideline Development Project</p> <p>1. Project for developing innovators DDPM 4.0 (Innovator 4.0)</p>

the scope of time, the research had been conducted for eight months.

4.2 Methods and Tools of Research

This research was collected, studied, and analyzed data, related documents, official correspondence, re-

lated researches and websites to be used as a framework for research studies to develop guidelines for organizational and human resource development towards becoming DDPM 4.0. Data were also collected and analyzed from interviews, focus groups, seminars, workshops of government officials, and staff mem-

Table 1. The details of HR DDPM 4.0 plan and the HR DDPM 4.0 action plan.

Strategic Issue	Strategic	Indicator	Project
<p>Strategy Issue 3: Improvement of the quality of life in DDPM 4.0</p> <p>The goal are • DDPM personnel have a balance between the quality of work-life and the DDPM family • Fair compensation and incentives for performance for the DDPM personnel</p>	<p>Strategic 3.1 Build DDPM team Thailand 4.0 to sustainable team</p> <p>Development Guidelines 1) Strengthening fair compensation for DDPM personnel, especially those directly responsible for disaster management 2) Reducing gaps and fostering a good working atmosphere between supervisors and subordinates by meeting talk roaming to different regions and nationwide coverage 3) Balancing the quality of work-life and family DDPM</p>	<p>1. Percentage of the rate of resignation/ transfer to other agencies (outside the department) compared to the previous year 2. Availability of communication application where DDPM officers can share stories, talk, and communicate with each other. 3. Availability of meetings, exchanges, discussions, and storytelling spread across all 18 centers or spread to different provinces 4. Availability of projects that empower more horizontal groups (replaceable)</p>	<p>1. A review project for fair compensation for job positions 2. The project telling the story of the DDPM family 3. Roaming HR project to build a strong DDPM officer 4.0 4. Work–Life Balance DDPM officer project</p>

bers in the operational sections of the Department of Disaster Prevention and Mitigation, as well as survey research by distributing questionnaires to the Provincial Disaster Prevention and Mitigation Offices to acknowledge opinions of agencies operating at the local level.

5. Research Results

From the study of documents and data collection according to the research methodology, the researcher discovered the SWOT Analysis of the Department of Disaster Prevention and Mitigation affecting the human resource management of the Department of Disaster Prevention and Mitigation as preliminary information on the preparation of the HR DDPM 4.0 plan. However, strengths, weaknesses, opportunities, and threats can be summarized as follows:

Strengths

- The department's management system is based on the Public Disaster Prevention and Mitigation Act, B.E. 2550, the main law in disaster management, and the Civil Service Act B.E. 2551 and the Additional Amendment in human resource management.
- There is a human resource development institute to provide knowledge and training on disaster prevention and mitigation including creating a body of knowledge on disaster prevention and mitigation.
- There are tools and equipment that are ready to use in disaster management and prevention.
- There is a systematic collection of information about disasters.
- There are distributed agencies covering all regions.
- There are strategies and action plans in the organization's human resource management.

- There are staffs distributed in all regions ready for operation.

- There are staffs who are capable and have potential to perform their duties.

- There is a clear chain of command and there is teamwork that is ready to work in every situation, and clear shared values are established

Weaknesses

- There is a lot of patronage.
- The organizational structure lacks connection at the local level (district level), affecting the mission of cooperation/coordination between network agencies in the operation, as well as in the integration of information from related agencies, networks, and the public sector.
- The career path is unclear, and the implementation of the department's human resource development plan is not as planned.
- Staff are insufficient for disaster management operations.
- There is an inappropriate relocation of manpower.
- Staff lack reinforcement of motivation, persuasion, and encouragement, and lack of building engagement in the organization and in operation.
- Staff also have inconsistent competency and skills to DDPM 4.0. In other words, they have relatively little knowledge, understanding, and skills as follows: mutual policy acceptance, disaster management knowledge, analytical technology skills, inadequate communication and coordination skills, attitude towards technology, sacrificing dedication to aggregation, teamwork, and integration together.
- Organizational culture and work systems are too attached to the traditional bureaucratic model, not flexible to emergency operations.

Opportunities

- The government's Thailand 4.0 policy supports the drive towards becoming the DDPM 4.0, and the government's policy focuses on disaster management.
- There are foreign cooperation frameworks such as the Sendai framework, various laws conducive to operation including international cooperation, as well as USAR, and international joint training.
- There are network partners and those integrated working with agencies involved in disaster prevention and mitigation, such as Mr. Warning, Civil Defence Volunteer, and local government organizations.
- They create disaster prevention and mitigation work with strong support from partners.
- Awareness, alertness and participation of the people in the face of various disasters, as well as being able to prevent and mitigate disasters with the government and networks, affecting the department's work has been successful in operating in the area.
- Reduce the risk of disaster more.

Threats

- Global and regional climate change affects disaster management which is diverse, increasingly violent and proliferating. Increased public expectations for disaster prevention and mitigation.
- As well as various compensations that have not sufficiently mitigated losses in the lives and property of the people.
- Disruptive Technology has occurred, affecting the adaptation and development of the Department's organization and human resources.

Based on the data on the environmental analysis of the Department of Disaster Prevention and Mitigation (SWOT Analysis) that affects the operations of the Department of Disaster Prevention and Mitigation in stepping into the DDPM 4.0, the researcher has led to the synthesis and presentation of the HR DDPM 4.0 Plan and the HR DDPM 4.0 Action Plan. The important things are as follows:

Vision of HR DDPM 4.0 Plan : Department of Disaster Prevention and Mitigation personnel aim to upgrade the department to DDPM 4.0

Objectives of HR DDPM 4.0 Plan: Develop human resources and partnerships to be DDPM 4.0 to increase organizational efficiency, effectiveness, and achievement.

HR DDPM 4.0 Plan consists of 3 strategic issues, namely

- Strategic Issue 1: Recruitment and Selection of Government Officer 4.0
- Strategic Issue 2: Human resource enhancement to the capability to drive DDPM 4.0
- Strategic Issue 3: Improvement of the quality of life in DDPM 4.0

The details of HR DDPM 4.0 Plan and the HR DDPM 4.0 Action Plan are shown in Table 1.

6. Research Discussion

The government's push for the Thailand 4.0 policy by Prime Minister General Prayut Chan-o-cha requires all relevant sectors to understand and create a goal of becoming Thailand 4.0. The Thailand 4.0 policy is an economic model to lead Thailand out of three traps, namely, middle-income traps. The wealth inequality trap and the development imbalance trap will turn Thailand into a developed country that is Stability, Prosperity and Sustainability according to the 20-year National Strategy 2018–2038 [1]. However, the modification of effective government mechanisms is considered to be of paramount importance in driving Thailand. 4.0. Mechanism modifications include the creation of a credible state, a source of public policy, transforming roles, missions, authority, and mode of action, building partnerships between governments and various sectors, enhancing capacity to respond to change, managing finances and resources. and the creation of seamless bureaucracy [2], [3].

In which human resources are the key factor in driving the transformation of the organization's operations including the Department of Disaster Prevention and Mitigation. The formulation of the HR DDPM 4.0 Plan and the HR DDPM 4.0 Action Plan is consistent with the vision of the DDPM 4.0 development plan and the DDPM 4.0 action plans in alignment with the context of the organization, the framework of the 20-year National Strategy, Thailand 4.0 and Government 4.0 which mentioned that the DDPM is the main organization in disaster management using technology and innovation towards the safety of Thailand. The principles of strategic human resource management Schuler (1992) [4] proposed that strategic human resource management is a system that connects people to organizations. HRM strategies are integrated with corporate strategies. SHRM requires plans and projects that define and resolve strategic issues related to human resource management in the organization. Therefore, the HR DDPM 4.0 Plan and the HR DDPM 4.0 Action Plan start from human resource planning suitable for the mission of the job, recruitment, and selection process for potential personnel suitable in disaster management tasks. There are three strategic issued formulated Strategic Issue 1 focuses on developing human resources to have knowledge and skills that are proficient in their duties including the attitude of devotion to the public in disaster management and attitudes towards accepting new innovative technologies to pushing to invent technologies and innovations. Strategic Issue 2 includes the development of employee retention system and enhancing the morale in the performance. Strategic Issue 3 focuses on changing the compensation management system in accordance with the risk-taking group, enhancing morale in terms of welfare and rewards, as well as creating new effective human resource systems such as strengthening work commitments. These strategies are in line

with the revision guidelines and recommendations for the adjustment of Thai civil servants to push for the Thailand 4.0 policy, as proposed by Khwanta Benchakan [5].

7. Research Suggestions

7.1 *Suggestions for applying the research results*

The researcher would like to present recommendations on 2 issues:

Firstly, policy recommendation: the research results should be communicated to the public either via digital telecommunication or online. It is necessary to let everyone in the organization and network know where the Department of Disaster Prevention and Mitigation is currently located and where it will move forward, to create a common goal and participation of personnel and network partners.

Secondly, practical recommendation: implementation of the study results of the DDPM 4.0 Development Plan and Action Plan depends on building awareness, understanding, and training in the necessary skills. Digital culture is not instantaneous but it is a continuous process that needs to be reviewed and designed in order to apply an Action Plan appropriately for the job, area, and relevant departments as well.

7.2 *Suggestions for the further research*

This research study is a study that has drawn up a development plan and an action plan for DDPM 4.0; therefore, the researcher proposes a recommendation for the next research to study more in detail, for example, a research study on the construction of Thailand's only disaster database system, study and research on legal improvements, rules and regulations of Public Disasters.

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Community-based teaching and learning management as the foster family in Thailand: PLESS + OSCE Model

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Abstract

The application of pragmatist epistemologies helps to develop community-based teaching and learning management. The multitude of benefits was foreseen from the intensive implementation of the concept of community participation which had positive outcomes for nursing students. A community-based learning management process for nursing students was developed. Students were immersed in the community by staying with host or foster families for a certain time period based on the designed curriculum.

The integration of community participation with the Community Nursing Practicum II drew an expectation at a very high level of learning outcomes and satisfaction, as the nursing students were able to identify factors needed before becoming graduate nurses.

Therefore, community involvement enabled nursing students to get along with the community as residents as well became participative in almost all of the community activities. The nursing students developed the skills to think critically and creatively as the main goal of comprehensive learning.

Keywords: community-based teaching, community nursing, foster family, Nakhon Pathom Rajabhat University, pragmatism

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1. Introduction

The community-based teaching and learning management as the foster family by planning, living, and learning, learning evaluation, showing and sharing + Objective Structured Clinical Examination activity, called PLESS + OSCE Model, was developed from to the accumulation of experiences in the implementation of various projects and activities in both the Community Nursing Practicum I and II courses for the first and third-year students, as well as the intention from the faculty in which they foresaw the multitude of benefits resulted from the intensive implementation of the concept of community participation that had positive outcomes for students [1–2].

The PLESS + OSCE model of teaching, which looks into pragmatist epistemologies, is understood as the theory of inquiry for its structure [3]. Pragmatist epistemologies help to explore how we can carry out inquiries in a self-controlled and fruitful way of students. So, pragmatists adopted facilitate to improve the nursing inquiry well.

In other words, the application of pragmatist epistemologies into the PLESS + OSCE model of teaching improved the skills of nursing students which re-

sulted in empowering people in the community, identifying the health problems, systematically analyzing the causes of problems, prioritizing, and finding solutions based on community capital development, mobilizing resources and coordinating all the network, collaborating and evaluating the actions taken, as well as being able to continue building the existing works and initiating new tasks until it is considered a strength community. All of this was due to the integration of the Community Nursing Practicum process with the concept of community participation as a foster family in Khlong Yong Sub-district and Nong Ngu Leum Sub-district for many years [4–7]. The lessons can be analyzed and interpreted into good regulations which can be extended to other fields of practiced courses.

Community Nursing Practicum II

The scope of this course includes the practice of caring family health, groups of people health, environmental health, and occupational health using digital technology and community health innovations to solve problems with community participation, integration of local wisdom and culture, as well as issues and trends of human rights, laws, ethics and codes of practice. Based on the meeting of instructors for the Community Nursing Practicum II Course, an off-site training at sub-district health promotion hospitals, it was found that students had problems applying nurs-

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ing theory into practice and could not create health promotion and solutions to the community problems in order to fully achieve the course goals.

According to the learning problem analysis, it was found that students did not understand their tasks as community nurses and could not manage the pre- and post- work system. They were also not good at teamwork, fail to manage time according to the schedule, and were unable to create an innovation to properly solve community problems.

Nakhon Pathom Rajabhat University has a teaching and learning policy by focusing on the development of practitioner graduates, to develop local communities. “Practitioner graduate” refers to a person who has extensive knowledge, competence, and professional skills leading to the application and creation of work that meets the demands of the community and society. The nursing faculty adopted the Pragmatist epistemologies into practicum teaching. Therefore, the learning management process for the Community Nursing Practicum II must be reviewed in order for students to gain field experiences according to professional standards. The teaching of Community Nursing Practicum II was organized by building community participation as a foster family, to develop nursing students to have desirable graduate characteristics and meet the university expected criteria. Therefore, the learning management process for the Community Nursing Practicum II had been focused on building community and student participation in the preparation phase—before, during, and after practice—to develop skills that are linked to real practice with the emphasis on thinking out of the box in terms of time, place, and learning [4–7].

The teaching and learning process of Community Nursing Practicum II for the 3rd year nursing students conducted in Nong Ngu Leum Sub-district of Nakhon Pathom Province. Community representatives and students were able to express opinions, take action, and evaluate results, including working together to find suitable ways to develop projects and activities. In every step, nursing students had developed all six (6) learning skills, as well as built the desirable characteristics of graduates according to the 21st-century learning skills, which consist of 1) being good and virtuous person, 2) being diligent, patient and responsible person, 3) knowing how to think critically, 4) knowing self-learning and self-improvement, 5) having interpersonal skills adaptable and be able to work as a team, and 6) having an identity in volunteering and local development. The participation concept was empowered by involving people in community health problem assessment, problem analysis, problem identification, problem prioritization, and self-determination. Through thinking creatively in planning projects to solve community health problems, the participatory actions between stakeholders of the community and students were focused, in which the in-

structor was a facilitator, coach, or supporter of the project under the objectives and learning outcomes according to the standards of the nursing profession.

Community involvement in teaching processes enable students to think critically and creatively, which is the ultimate goal of learning [6–7]. The created projects and innovations that can be used to solve community health problems are suitable for the community contexts according to the Principles of Sufficiency Economy [6–7]. In addition, the satisfaction score of teaching and learning was very high ($= 4.79$, $SD = 0.46$) as the community has developed health in a better way and there have been more groups of people doing health activities.

2. Objectives of Applying the PLESS + OSCE Model

According to pragmatism values to the lives of learners, the objectives of applying the PLESS + OSCE Model in the Community Nursing Practicum II Course are as follows:

1. Instructors, students, and relevant communities have truly involved in the management of the Community Nursing Practicum II Course in all processes of plan, do, check, and act cycle for carrying out change.
2. The effectiveness and efficiency of learning through community participation and inclusion in the community have been enhanced, leading to the development of skills that are linked to actual community practice.
3. The learning management for the Community Nursing Practicum II is developed and improved in all processes of plan, do, check, and act cycle. The results of the course evaluation can be adapted and planned for the implementation of the learning management next year.
4. Both inventions and innovations in the context of the training community can be used to fix or reduce health problems.

3. The Process of Teaching and Learning by the Community as a Foster Family

The ultimate goal of this course is to prepare nursing students to be good practicing nurses by using the participation of the community as a foster family. The model has a development process as follows:

3.1 Planning

In planning, the first step includes two (2) aspects in preparation which comprised of community and student preparation.

3.2 *Community Preparation*

The course administrator and the instructor had assessed the readiness of the community which is considered as the practical setting, in which the meetings were held with the health team staff in the district, community leaders, and local representatives [6–7]. The course administrator and the instructor had clarified the course objectives, operational procedures, and assessments. The community team had discussed the community's readiness to accept students in the foster homes in the targeted community accommodation. The advantages and limitations were identified and included in the consideration to select the practical area based on the availability and willingness of the community.

3.3 *Student Preparation*

The course administrator or the instructor who were responsible for the courses performed as follows:

1. The course orientation by describing course concepts, objectives, and grading criteria according to Thai Quality Framework 4 (TQF 4) [8] were conducted.
2. Basic knowledge and skills in community health nursing were tested before the actual practice through a written examination regarding to scenarios questions such as community diagnosis, project planning and evaluation, as well as home visits.
3. Rules for living with the host and the host guardian were clarified.

3.4 *Living and Learning*

Learners have to study the beliefs and principles of the people in the community paralleled to the specific goals of Community Nursing Practicum II Course.

Regarding to the concept of Pragmatism to identify actual problems and solutions in a community, coexistence could be promoted by living or existing together in the same place at the same time. This relates to how the practicing students living with their host families in the community throughout the actual workshops to learn the community lifestyle. In this step, the instructor allows students to stay in the community with their host families and engage in activities together. There is an orientation for nursing students which includes the introduction of health team staff, job characteristics of the healthcare staff, health volunteers, as well as community leaders. Community leaders consist of village headmen, assistant village headmen, chief executives of the Sub-district Administrative Organization (SAO), members of the SAO, chief administrators of the Sub-district health promoting hospital, nursing mentors, and host family members. Students had learned the community way of life 24 hours a day for one (1) month based on the required practicum hours

of the course. These methods helped to enhance students' ability to become independent learners, collaborative persons, and problem-solvers effectively working with communities in the real world as proposed in the study of Villanueva [2].

3.5 *Facilitating, Coaching, and Supporting Role*

In this step, the instructor played the role of student advisor throughout the practicum which includes performance facilitation, coaching, and support in order to ensure professional standards requirement using small group teaching [6–7]. In case students were unable to apply theoretical knowledge in real-life situations, the instructor would reinforce, motivate, and support the learner's according to individual needs. Students took action in community nursing practice that focused on health promotion, disease prevention, primary medical care, continuing care and rehabilitation, as well as managing environmental and health risk factors.

3.6 *Learning Evaluation*

In this process, there were three (3) assessments that included students' reflections, formative assessment, and progressive assessment. The participatory reflection of students was used to assess learners' performance. It comprised of three different parts: reflection on course learning outcomes, reflection on community nurse skills, and reflection on comprehensive learning experiences while residing with a host family. In addition, students were asked to assess at what points they and the course should improve. There were opportunities for students to give formative assessments twice which were the periods during the practicum and at the end of the practice session. The progressive assessment was performed daily in the evening. Instructors, health teams, community representatives, and host guardians jointly assessed the performance of practicing students and review the ratings from the course responsible team. This process can attain community nursing competencies of students by comparing to the National standard [8]. Also students reported high degrees of satisfaction and valuable living and learning experiences, increased students' ability in addressing real community problems, and commitment to work in the community. These results complied with the previous study stating about learning by doing, which increased ability in addressing real world problems and commitment to collaborate in the community [2], [9].

3.7 *Showing and Sharing*

In this step, knowledge was exchanged and exhibited by emphasizing participation between students and the community at the end of learning process to present the practicing results and discussions of case studies. Case studies were then reviewed by the hospital staffs. The exchange of knowledge among the

groups after the practicum was organized with the participation of the health staffs involved in the community facility. The results of the community nursing practice presentation comprised: 1) results of participatory community health development at every stage, 2) home visiting, 3) health innovations, and 4) suggestions of ongoing care. The participants in knowledge sharing and suggestions consisted of students, instructors, community leaders, public health volunteers, health personnel in sub-district health promotion hospitals. According to theory of pragmatism in education, this involved learners to value living and learning at the same time. By showing and sharing, students become proud of themselves through appreciating successful performance they have accomplished.

3.8 Objective Structured Clinical Examination (OSCE)

OSCE was designed to assess the Community Nursing Practicum II Course including data assessment, problem identification, project planning, implementation, and evaluation after the practice for a specific period of time. The instructor organized the knowledge and skills examination after the practice as one way to guarantee the quality of education.

4. Summary of PLESS + OSCE Model

The diagram below summarizes the PLESS + OSCE model as follows: P= planning; L= living and learning; E= learning evaluation; S= showing and sharing + O= objective; S= structured; C= clinical; E= examination (figure 1)

5. Successful Factors

The factors enhancing the succession of practice in this course comprise readiness of community, vision and mission of community leaders, and good preparation for community and students.

5.1 Readiness of community

The community chosen as the base of model implementation was a community that was close to the university. The village headmen and community leaders or the descendants of the community leaders had graduated from Nakhon Pathom Rajabhat University, as well as the university had continuously strengthened the community learning and development. In addition, the instructor was ready and got along well with the community.

5.2 Vision and mission of community leaders

The community that was a practice facility wanted to change for the better. Community leaders had the visions of participative development, commitment, determination, cooperation, and assistance. Students had perceived the affection and tendency from their host families in the communities where they lived. They were, therefore, more willing to practice and had a desire to make people having good health and be able to take care of themselves despite problems and obstacles, such as extreme heat, distance to hospitals. Students could perform their work well and receive admiration from all parties, including asking the instructor to send students to practice in the community every year.

5.3 Good preparation for community and students

The community and students had been prepared before the actual practice. Besides, students were assigned to think of innovations to solve health problems and community problems, allowing people and staff from the training facility to develop themselves simultaneously. The partnership developed between the university and the facility that supported both students and facilitator/preceptors led the PLESS + OSCE Model to become sustainable. This is the same as shown in the previous study which found that providing rural and remote student practicum experiences enhances the students' learning outcomes and health outcomes of the community [9].

5.4 The Innovation Created for Problem Solving

In semi-rural community, the directions to patients' houses were complicated and difficult to reach by nursing students. The students who are proficient in computers and technology made QR (code), an application to extend people's houses and geographic information systems (GIS), which are considered a useful innovation in the community.

There is a high prevalence of hypertensive patients who cannot control blood pressure in this setting. The students with language proficient developed a method to make the community gain health literacy about hypertension by composing the song "Quit salty food, Quit greasy food, Control the blood pressure of the whole district". This was considered an innovation for community music. The elderly, health volunteers, students, and the community members were taught to sing the song until they can master the lyrics. The song lyric was truly useful and accessible to the people in terms of common language and rhythm in daily life.

6. Problems and Solutions

There were some problems raised during the implementation including:

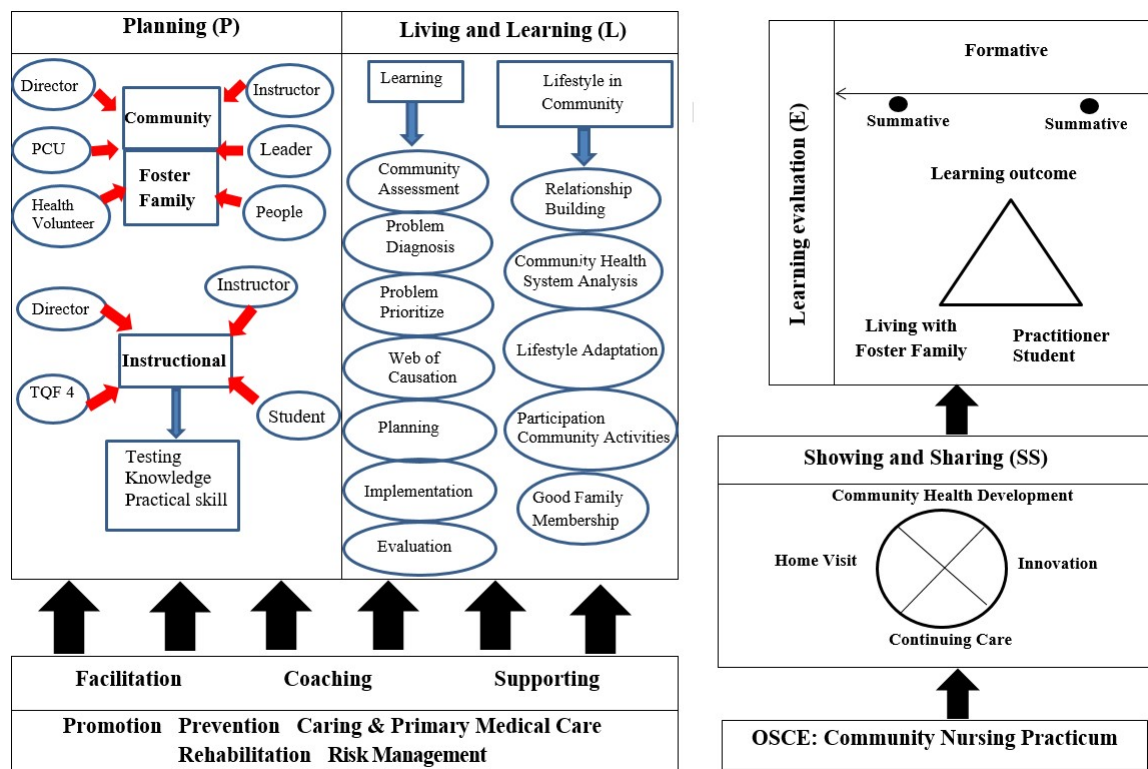


Figure 1: The diagram below summarizes the PLESS + OSCE model

1. There is hot weather during the summer period. So that changing practice activities from daytime to early morning and evening period were applied. Home visiting time was set in the evening, while thinking, analyzing, planning, and organizing services that can be performed within the office, host family houses, and health promoting hospitals were changed to daytime.

2. Physical environment and transportation going to the community are inconvenient because there are no buses or any public transportation so bicycles were very useful.

3. The workload are not associated with the practical time. That is to say, the workload is high, but the training time is less. Students felt exhausted from community practice as they work both day and night; therefore, the instructor should consider for revision the tasks assignment and practicum period.

7. Model Benefits

In viewpoint of the host family, there are some benefits of this model as follows:

1. Student coexistence in the community is a real learning process and is regarded as performing in real situations through joint actions among students, teachers, health teams, volunteer community leaders, and local people. It is the practice of creating academic learning and the ability to build comprehensive professional competencies and skills.

2. Teaching in the ways of facilitating, coaching, and supporting are considered family care with mentors and helpers as friends, teachers, and parents, which contribute to the development of objective learning and sustainable development of the community.

3. In integrated community development, community-based nursing practices are used with the development of academic work. Academic services for the community are conducted in accordance with the mission of the university for the real locals.

8. Summary

Therefore, the application of pragmatism theory on PLESS + OSCE Model involves planning in community and student preparations; living and learning through community coexistence together with instructors' facilitation, coaching, and support; learning evaluation by students' reflections, formative and progressive assessments; and showing and sharing the outcome of learning through innovation and successful implementation of the project in both community setting, as well as in the university. In so doing, this as well designed to evaluate the community nursing skills by OSCE examination. The PLESS + OSCE Model can improve the learning outcomes and satisfaction of nursing students and serves as a guideline for teaching and learning management that guarantees quality nursing education.

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