การประเมินความต้องการจำเป็นของการพัฒนาผลงานสร้างสรรค์และการยื่นคำขอรับสิทธิบัตร สำหรับนิสิตนักศึกษาครุศาสตร์/ศึกษาศาสตร์ ระดับปริญญาบัณฑิต

A Needs Assessment for Creative Product Development and Filing a Patent Application for Undergraduate Pre-service Teachers

ธิดารัตน์ ตันนิรัตร์* เนาวนิตย์ สงคราม และใจทิพย์ ณ สงขลา
คณะครุศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย
Thidarat Tannirat*, Noawanit Songkram and Jaitip Nasongkhla
Faculty of Education Chulalongkorn University

บทคัดย่อ

งานวิจัยนี้มีวัตถุประสงค์ เพื่อประเมินความต้องการจำเป็นของการพัฒนาผลงานสร้างสรรค์และการยื่นคำขอรับสิทธิบัตร ของนิสิต นักศึกษาครุศาสตร์/ศึกษาศาสตร์ ระดับปริญญาบัณฑิต ตัวอย่างในการวิจัยได้จากการสุ่มตัวอย่างแบบหลายขั้นตอน คือ นิสิต นักศึกษาครุศาสตร์/ศึกษาศาสตร์ ระดับปริญญาบัณฑิต จำนวน 543 คน จาก 8 มหาวิทยาลัยในประเทศไทย เครื่องมือที่ใช้ในการเก็บรวบรวมข้อมูล คือแบบสอบถาม วิเคราะห์ข้อมูล โดยใช้สถิติบรรยาย ด้วยค่าเฉลี่ย ส่วนเบี่ยงเบนมาตรฐาน ร้อยละ และใช้เทคนิค Modified Priority Needs Index ($PNI_{Modified}$) พบว่า มีความต้องการจำเป็นในการทำความเข้าใจขั้นตอนการขอรับความคุ้มครองสิทธิบัตร ในลำดับความต้องการมากที่สุด ($PNI_{Modified}$=0.495) รองลงมาคือ มีความต้องการจำเป็นในการเขียนอธิบายผลงานที่สร้างขึ้น เพื่อร่างคำขอรับสิทธิบัตรได้ ($PNI_{Modified}$=0.476) และมีความต้องการจำเป็นในการพัฒนาผลงานสร้างสรรค์และขอความคุ้มครองสิทธิบัตร ($PNI_{Modified}$=0.459) และสิ่งที่มีความต้องการจำเป็นน้อยที่สุด คือ การค้นหาข้อมูลของสิ่งที่ได้รับมอบหมายให้เข้าใจก่อนทำงาน ($PNI_{Modified}$=0.168)

คำสำคัญ: การประเมินความต้องการจำเป็น ผลงานสร้างสรรค์ การยื่นคำขอรับสิทธิบัตร

Abstract

The purpose of this research is to assess the needs for creative product development and filing a patent application for students in the Bachelor of Education program. The data was gathered Multi-stage sampling: 547 undergraduates in educational program of 8 universities in Thailand by using questionnaires. The data were analyzed by descriptive statistics using mean, standard deviation, percentage and Modified Priority Needs Index ($PNI_{Modified}$). The results of the study shows that a need of understanding in the process of filing a patent application is in the top of the ranking based on all of the needs ($PNI_{Modified}$=0.495). Second in the ranking is the necessity of describing products that are created to fill in the patent application form ($PNI_{Modified}$=0.476). Ranking third is the need of Creative Product Development and receiving patent licenses ($PNI_{Modified}$=0.459). And lastly is the need of information searching due to understanding the assignment before the project started. ($PNI_{Modified}$=0.168).

Keywords: A Needs Assessment, Creative Product, Filing a Patent

* ผู้ประสานงาน (Corresponding Author)
e-mail: noo_darat@hotmail.com

Introduction

The Secretariat of the Cabinet (2017) announced that the Thailand 4.0 policy of the government aims to reduce inequality and will create chances for Thai people for 20 years in the future in order so that Thailand can unlock the low income trap to higher incomes with innovation whereas. An innovation means the things that are new or changed from the original and the other similar word is the creative work means the work from invention, research, design, create artifact or industrial related products which are registered the patents if they met the legal qualification such as new model and commercial use. Furthermore, the inventors can produce, sell, import such products or permit the other persons to take the patent rights. The higher education institutes aim to develop all level of graduators to receive the certificates which are accepted in the international level, efficiency, and capacity which meets with the requirement and expectations of the various entrepreneurs. Therefore, every universities must manage the curriculums and prepare their students to jobs such as assigning the learners to practice and create the innovation following their own interest leading to the creative product development.

The creative thinking is important which must be standardized in 21st Century to entering the era of data and new knowledge". Wendler et al. (2010) said that the creative problem solving was the way of finding the innovation to respond to the complex problem challenge in the future. Walton (2003) found the 3 factors that influenced the creative thinking which are motivation, data access and attitude. According Torrance (1969; 1972) everyone can be practiced to be higher creative thinking. The training must use a continuous and regular method of problem solving and activity which corresponded with Miyasari et al. (2016) whose their research found that the creative thinking was not occurred accidentally, the learning of creative development must be design carefully and developed the creative thinking level of learners and also integrated 4 subjects or STEM; Science, Technology, Engineering and Mathematics. The factors of creative thinking (Selvi, 2007; 2011) had 4 factors; motivation, interaction, physical environment and evaluation. According Songkram (2011; 2012; 2013; 2014), the combined learning supported the new knowledge or innovation building. Zhou (2015) researched about the important factors of problem-based learning which developed the creative thinking and found the 5 factors of motivation which were 1) group learning 2) problem solving 3) interdisciplinary 4) project management and 5) the facilities of group learning.

From the above, it found that the creative product development and filing a patent application were necessary, so a needs assessment for Creative Product development and filing a patent application were evaluated and the results were the current situation, expectation and the needs of undergraduate pre-service teachers in the field of creative development products and a patent application which were the necessary information fulfilled the missing during studying the Bachelor degree and were ready to working after graduation.

Research Objective

The main purpose of this research was to a needs assessment for creative product development and filing a patent application for undergraduate pre-service teachers.

Research Methods

1. Populations and Sample

The research population was undergraduate pre-service teachers totaling 94,099 persons in the Year 2017.

Samples were undergraduate pre-service teachers who were studying from 3rd year to 5th year, then definition and multi-stage sampling. The researcher used rule of clarity to specify the samples which were appropriate size and reliable data. The number of samples were 450 persons and the rate of questionnaires respondents who were the students of Master degree were the average 61.85%. The researcher mailed the request letters and attached the questionnaires to Faculty of Education in 8 universities by cluster sampling in 4 regions; Central region, Northern region, North Eastern region and Southern region. Each region had 180 samples by stratified random sampling. The samples divided into 2 groups; 1) the non-Rajabhat Universities and 2) Rajabhat Universities. Each group drew lots and got 90 samples from each group which were the undergraduate pre-service teachers studying from 3rd year to 5th year and each year consisted 30 students.

2. Tools and tool development

The questionnaires of undergraduate pre-service teachers purposed to ask the comments about the studying and learning of the creative products development and filing a patent. The researcher asked the new questions and adjusted the questions from the local and international questions by using the steps and test. The results are as follows:

2.1 Variable specification and specific measurement samples and number of questionnaires.

The 1st section of questionnaires was the general information which were sex, education status and studying year etc. The 2nd sector was the evaluation of the needs 3 issues; Information Problem-Solving, the creative product development and the draft of patent filing application including draw the table defining the behavior measurement from studying variables which were the creative product development and the draft of patent filing application, the qualification of inventors of the creative products, the number of questionnaires, then built and developed the questions from research tools. The criteria of answers are as follows:

Lowest means do/agree to the statement from 0 to 20%, equals to 1 score.

Low means do/agree to the statement from 21-40%, equals to 2 scores.

Fair means do/ agree to the statement from 41-60% , equals to 3 scores.

High means do/ agree to the statement from 61-80%,equals to 4 scores.

Highest means do/ agree to the statement from 81-100%, equal to 5 scores.

And the score start from 1-5 scores and the criteria of the score has 5 levels; score 1.00-1.80 means lowest/low level, score 1.81-2.60 means at least/low, score 2.61-3.40 means middle level/fair, score 3.41-4.20 means the most/high/good and score 4.21-5.00 means the most/highest.

2.2 Drafting questionnaires and content validity. The research submits the draft of questionnaires, research detail, objective and research framework, definition of variable and number of questions to 5 experts to inspect the content validity about the questions covering, the accuracy, the validity of each questions and whether the questions match with the topic, including the suggestions of the experts. The experts gave score to every questions more than 0.5.

(Kanjanawasee, 2009) and also they recommended the adjustment of the wording to be more consistent.

2.3 Try out and inspect the reliability of questionnaires. The researcher adjusted the questionnaires, then tried out with 60 students who had the same characters as samples. The research distributed the questionnaires and inspected the tools and internal consistency of reliability of tools by finding the Cronbach's Alfa coefficient (α – coefficient) which equals to 0.876 showing the reliability, then adjusted and distributed to undergraduate pre-service teachers.

3. Data collection. The research submitted the requesting letters to Dean of Faculty of Education including the questionnaires and explanation to 8 universities, 90 letters each university totaling 720 letters and the questionnaires were respond completely at 75.42%.

4. Data analysis frequency (f), mean (X), standard deviation (SD), percentage (%) and Priority Needs Index (PNI). The research found the $PNI_{modified}$ = (I-D)/D to control the size of the needs to stay within not too wide range and comparative meaning (Wongwanich, 2007).

I means the score range of expectation to practice

D means the average scores of actual practice

Result

The basic data of people who answered the questionnaires were Undergraduate Pre-Services Teachers. The core has a total of 543 respondents from Rajabhat University. The questionnaires with the highest collected data were from females (77.89%). Divided in each school year, the data which was collected the most were from the 4^{th} year students (39.78%) proceeded by the 5^{th} year students (34.63%).

Table 1 Percentage of respondents who created creative products

Works created were artworks, inventions, educational materials, creation of original story telling covers.	**Yes**	**No**	**Total**
University in the Central Region	10.68	2.21	12.89
University in the Northern Region	7.18	4.79	11.97
University in the Northeastern Region	6.63	4.05	10.68
University in the Southern Region	7.18	5.90	13.08
Rajabhat University in the Central Region	12.34	3.68	16.02
Rajabhat University in the Northern Region	6.81	5.90	12.71
Rajabhat University in the Northeastern Region	6.45	4.97	11.42
Rajabhat University in the Southern Region	8.47	2.76	11.23
Total	**65.74**	**34.26**	**100.00**

Table 1 presents the undergraduate students in an educational program. The respondents indulged in works such as artworks, invention, educational materials, creating original story telling covers which comprises (65.74%). If categorized into each school, we found that the students from Rajabhat University in the Central Region of Thailand scored the highest in percentile ranking (12.34%). Second in rank were respondents from other Universities outside Rajabhat University in

the Central Region of Thailand (10.68%) the lowest percentile score came from Rajabhat University in the Northeastern campus of Thailand (6.45%)

Table 2 Percentage of respondents who acknowledged the organization that provided information of patents in their university.

University offices that provided patent information	Have	Not Have	Uncertain	Total
University in the Central Region	2.76	1.84	8.29	12.89
University in the Northern Region	2.76	4.24	4.97	11.97
University in the Northeastern Region	1.84	0.92	7.92	10.68
University in the Southern Region	3.30	1.10	8.66	13.06
Rajabhat University in the Central Region	3.50	2.95	9.58	16.03
Rajabhat University in the Norther Region	6.08	4.05	2.58	12.71
Rajabhat University in the Northeastern Region	2.03	2.03	7.37	11.43
Rajabhat University in the Southern Region	1.29	3.68	6.26	11.23
Total	**23.56**	**20.81**	**55.63**	**100.00**

Table 2 shows that in general, respondents weren't sure if their university has an office that provided information about patents (55.63%). Moreover, there are respondents who confirmed that they were aware that their school has the office (23.56%) and students who weren't aware of the office (20.81%). However, when the researcher investigated the schools where the data was collected from, found out that all universities has the office that provided information about the patent.

Table 3 Percentage of respondents who acknowledge the patent application processes

Respondents that acknowledge the patent application process	Know	Not know	Total
University in the Central Region	3.50	9.39	12.89
University in the Northern Region	2.58	9.39	11.97
University in the Northeastern Region	1.66	9.02	10.68
University in the Southern Region	3.68	9.39	13.07
Rajabhat University in the Central Region	3.32	12.72	16.04
Rajabhat University in the Northern Region	5.16	7.55	12.71
Rajabhat University in the Northeastern Region	3.68	7.73	11.41
Rajabhat University in the Southern Region	1.84	9.39	11.23
Total	**25.42**	**74.58**	**100.00**

Table 3 presents that in general, the respondents doesn't know the details of the patent application process (74.58%). Nevertheless, if dividing the universities by region, we found that students who study in Rajabhat University in the Northern Region knew the information about patent application processes and outweighed the other regions (5.16%). And the students in Rajabhat University in the Central Region doesn't know the information about patent application process with a percentile rate of (12.72%)

Table 4 Percentage of respondents who registered for patent application

Registration for Patent Application	Ever	Never	Total
University in the Central Region	2.40	10.50	12.90
University in the Northern Region	1.30	10.68	11.98
University in the Northeastern Region	1.47	9.21	10.68
University in the Southern Region	2.76	10.31	13.07
Rajabhat University in the Central Region	2.21	13.81	16.02
Rajabhat University in the Northern Region	3.31	9.39	12.70
Rajabhat University in the Northeastern Region	0.18	11.23	11.41
Rajabhat University in the Southern Region	1.30	9.94	11.24
Total	14.93	85.07	100.00

Table 4 shows students who never registered for patent application were (85.07%) By categorizing universities, the study found that students in Rajabhat University in the Central Region never registered in any patent application and is on top of the percentile ranking with (13.81%). The second is Rajabhat University in the Northern Region with (11.23%) and lastly the University in the

Northeastern Region with a percentage of (9.21%). On the other hand, the rank of students who registered for patent application that were on top is Rajabhat University in the Northern Region (3.31%).Second in the rank is the University in the Southern Region with (2.76%). Coming in last is Rajabhat University in the Northeastern Region (0.18%)

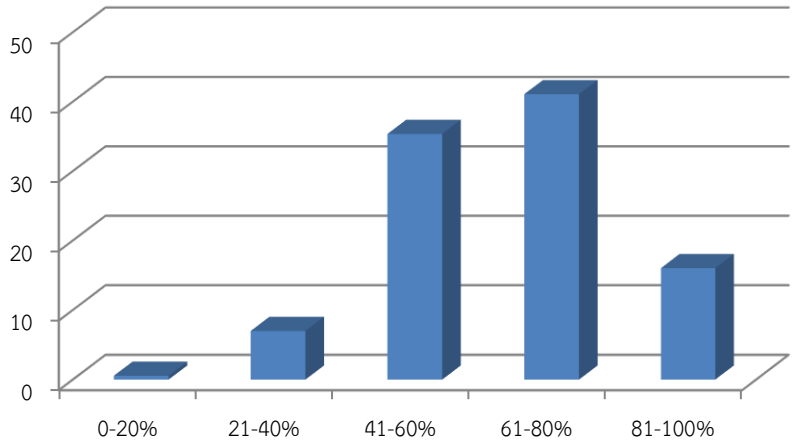


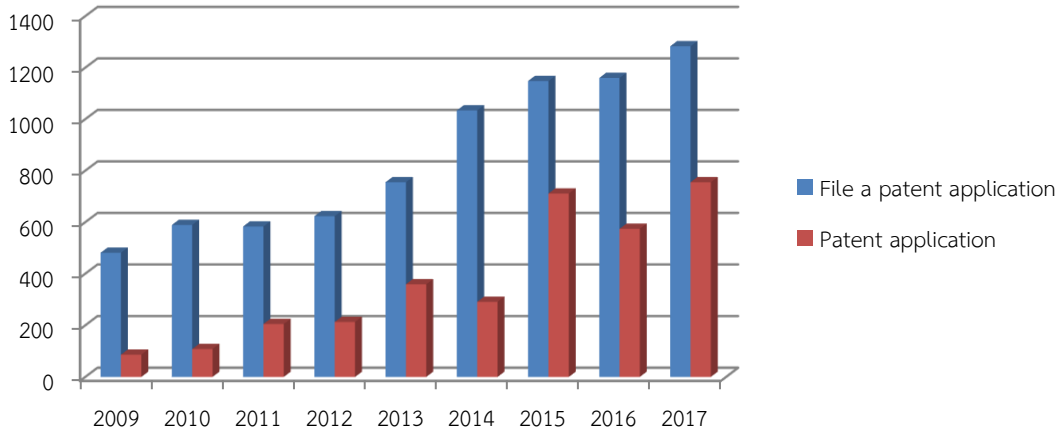
Chart 1 presents in general that respondents who attempted to improve their products from their previous work at 61-80% ranked the highest (41.07%). On second are the respondents who attempted to improve their work from their previous work at 41-60% (35.35%). And lastly are the respondents who attempted to improve their work from their previous work at 0-20% (0.55%).

Table 5 Percentage of respondents who understood the patent registration process

Answer	3rd year	4th year	5th year	Total
Understood the patent registration process (0-20 %)	5.71	5.52	4.97	16.20
Understood the patent registration process (21-40%)	4.42	4.97	4.79	14.18
Understood the patent registration process (41-60%)	10.32	13.81	11.23	35.36
Understood the patent registration process (61-80%)	4.42	11.97	10.13	26.52
Understood the patent registration process (81-100%)	0.74	3.50	3.50	7.74
Total				**100.00**

Table 5 presents the students who answered the questionnaires of understanding the patent registration process at 41-60% with the highest percentage (35.36%). Running second are students who answered the questionnaires of understanding the patent registration process at 61-80% (26.52%). And the least are students who answered the questionnaires of understanding the patent registration process at 81-100% (7.74%).

The number of patent applications of Universities in Thailand has been increasing since 2014. Universities register for patent applications with more than 1,000 applications. If considering the number of universities that gets approved of their patent applications, the statistic shows that since 2015 the number of patent application has increased as shown in chart 2



Source: Department of Intellectual Property (2560b)

Table 6 Mean Standard Deviation and needs assessment ranking of information problem solving and file a patent application

Lists	Expectation level		Practice level		$PNI_{Modified}$	Need rank
	$\bar{X}$	SD	$\bar{X}$	SD		
1 Understanding the registration of a patent application process	3.70	1.08	2.95	1.17	0.495	1
2 Describing your product due to drafting of registration of a patent application	3.73	1.07	2.99	1.16	0.476	2
3 Creating products and registration of a patent application	3.76	1.05	3.03	1.15	0.459	3
4 Knowing the advantages of registering a patent application	3.79	1.07	3.08	1.12	0.417	4
5 Acknowledgement of intellectual property patents	3.84	1.00	3.14	1.04	0.375	5
6 Creative product development is essential in checking the product origin	4.08	0.78	3.50	0.87	0.240	6

Table 6 (Continued)

Lists	Expectation level		Practice level		$PNI_{Modified}$	Need rank
	$\bar{X}$	SD	$\bar{X}$	SD		
7 Presentation of the product that other people would be able to use	4.16	0.74	3.57	0.86	0.237	7
8 Trying to develop better Products	4.20	0.77	3.65	0.85	0.212	8
9 Concerns in the benefit of the products	4.26	0.74	3.73	0.84	0.195	9
10 Attempting to solve the problem creatively	4.19	0.76	3.67	0.84	0.194	10
11 Use of information based on regularly research	4.16	0.74	3.64	0.83	0.193	11
12 Analyzing task information clearly before work begins	4.18	0.75	3.65	0.79	0.192	12

Table 6 shows that with the expectation of practice, first on the rank is the Concerns in the benefit of the products at ($\bar{X}$ =4.26). On second, is the Searching of information tasks before the work starts at ($\bar{X}$ =4.23). On third is Understanding the patent filing process at ($\bar{X}$ =3.70).

When considering the level of this practice, researcher found that respondents search for information of the task to understand what they were given before they start working ($\bar{X}$ =3.76). Followed by the Awareness of their creative product benefits at ($\bar{X}$ =3.70) and the least of all is the Understanding of the filing of a patent application process ($\bar{X}$ =2.95)

Considering the order of needs, it was found that respondents have a need to understand how to apply for patent protection in the most demanding order at ($PNI_{Modified}$=0.495). Second necessity is how to write a description of their work in order to get approval of their patent application at ($PNI_{Modified}$=0.476) and also how to create products and file a patent application ($PNI_{Modified}$=0.459)

Discussions

From the needs assessment of creative product development and filing patent application, the 3 issues were discussed as follows 1) the creative product development 2) the application for patent protection and 3) students promotion to understand the following details of the steps and the process of patent filing.

1) The creative product development

The research's topic of Miron-Specktor & Beenen (2015) on Motivating Creativity found that the Effects of Sequential and Simutaneous Learning and Performance Achievement Goals on Product Novelty and Usefulness. Many organizations had to encourage their personnels to solve the problem creatively, newly and usefully. According Mayasari et al. (2016)'s research on exploration of student's creativity by integrating STEM knowledge into creative product. The creative idea was the ability which should be standardized in the 21st century which will enter to the era of data and knowledge, innovation to respond the challenge in the future according to the research's result found that undergraduate pre-service teachers tried to develop the product at least 0.55% which meant that most of them tried to develop better product. However, the

research found that undergraduate pre-service teachers had ever invented the product such as new invention, instructional media, design of cover page tale of children, which differed from the other at 65.74% but only students in 3rd year was studied, so they should pass the creative skill training or invention depending on their own learning knowledge. The researcher studied the documents and relevant researches of the creative product development which found that information problem-solving IPS of Brand-Gruwel, Weperels & Walraven, (2009) supported the creative product development with 5 steps for successfulness as follows 1) define the information problem 2) search information 3) scan information 4) process information and 5) organize and present information problem solving. To be more successful , the creative product development considered the 4 rules as follows: 1) orientation 2) monitoring 3) steering and 4) evaluation. The basic skills which the students must have at least 4 skills; computer skills, evaluation skills, reading skills and writing skills. The more interesting information must be searched to protect the copied creative product. Information Problem-Solving can inform the information of researched products around the world. Furthermore, the researchers can search more information of the products that are interested until the creative products are finished. Brad-Gruwel et al. (2005) developed the ideas of mixing needed skills of data access and data from the internet, so the persons who had the Information Problem Solving found new, needed, and reliable information, and finally got new ideas. Therefore, the teachers teach the knowledge and increase the ability of information Problems-Solving to their students so that they can be successful in problem solving and created the new products. When the learners can create the products systematically, they will get their jobs in the future, in accordance with the relevant research literature which found that following the education standard of both USA and Europe, every students must have the skill of Information Problem-Solving which create the knowledge and the decision ability. The skill of Information Problem-Solving (Willer & Eisenberg, 2014) must have clear steps, standard curriculum stating the searching engine, the evaluation of relevant and accurate data. The curriculums aim to improve the students at the Master degree (Dirkx et al, 2011) and the research of Raes, Scheelens, De Wever, & Vanderhoven (2012) found supplementary study with Information Problem Solving from website which support the learners to get more knowledge.

2) The application for patent protection

Department of Intellectual Property (2560a) reported that Thai universities submitted the application for patent protection totaling 7,612 application forms, and increased every year because the Bureau of Higher Education Standards and Quality. Office of the Higher Education set the quality assurance criteria in B.E. 2015 and one of the criteria of quality assurance was the patent approval , and the government's policy and universities concentrated the innovation for sustainable, so the undergraduate pre-service teacher should have the patent knowledge and intellectual property. From the research found that undergraduate pre-service teachers (74.58%) thought they didn't know the details of patent application, 65.74% even they had the creative products and 85.07% never applied the patents even they had the creative products. This research responded with the research result which found that undergraduate pre-service teachers understood the steps of patent application at the highest level (7.74%) or at the fair level (35.36%) and expected or needed to understand the steps at the lowest level. The research result showed that they did not realize the benefit of patent application, so they did not prioritize to understand the steps.

The application for patent protection must be applied immediately, otherwise it will effect in the negative way. The products which can be applied for patent should have the following condition in accordance with Patent Act B.E.2522 (1979). Patent Act B.E. 2522 (1979), Patent Act B.E. 2522 (1979) and Patent Act (No. 3) B.E. 2542 (1999). The three patent types available in Thailand are as follows: 1) Patent for Invention Example of invention protected: New product or process, improvement for example in the following fields: machinery, tools, chemicals, biotechnology, etc. Protection: 20 years (non-renewable). 2) Petty Patent Example of invention protected: New invention which would qualify for an invention patent except that it has no strong, technical innovative steps. Protection: 10 years (non-renewable). 3) Design Patent Example of invention protected: Ornamental aspects or aesthetics of an article including features pertaining to the shape, configuration or pattern. Protection: 10 years (non-renewable). It shall be noted that the following inventions are not eligible for patent protection in Thailand: Microorganisms which would be found in nature or any substances extracted from animals or plants; Scientific or Mathematical rules and theories; Computer programs (which are protected under copyright); Processes of diagnosis, treatment, or remedy used in curing human or animal diseases; Inventions which are contrary to public order or morality, public health, or welfare.

3) The promotion of understanding the details of the steps and the process of patent filing to the students.

The research found that undergraduate pre-service teachers were not sure or did not know that their universities had the unit which suggested the patent application (76.44%). This showed that the agencies concerned the intellectual property gave less information about the patent application to undergraduate pre-service teachers , so the faculty should spread the information of the intellectual property knowledge by coordinating with the academic office/ department so that they will learn more knowledge of intellectual property, then learn and understand the process of patent application.

Suggestions

1. Suggestions for use of the research finding

The results of the needed assessment from the research can be used to improve and develop curriculums in education programs for Undergrads. The curriculum needs to provide a comprehensive coverage of the content used in future careers and may modernize the subject content by adding the knowledge of intellectual property. Faculties may arange a meeting to each program division to analyze each subject contents for their courses. Then combine the courses that has similar contents together and adding new courses that provides knowledge on intellectual property. Moreover, schools should promote developing products creatively with skills using Information Problem Solving; IPS in courses that create new inventions. This can be of help to the educational program graduate students to have sufficient knowledge for their teaching careers in the future and also in compliance with the government policies that focus on promoting their citizens to create a new invention and to have knowledge of intellectual property to protect their invention.

2. Suggestions for the future research

2.1 Qualitative research should be conducted by an in-depth interview in group discussions to study why the results of the needed assessment for creative development and the application for a patent are high and the causes of it to determine the solutions to address the problems.

2.2 There should be a study on how to promote attitudes and attributes that are appropriate for creative development in the educational program curriculum. The results of the study show that most of the undergraduate pre-service teachers were not aware of the importance of defining problems or studying what they have been assigned to understand the tasks before they start working, which may lead to errors in the development of creative work and they tend not to be creative. Therefore, the attitude and attributes of the creators should be further studied.

2.3 There should be a checklist created for creatively developing products and filing of patent applications for undergraduate pre-service teachers that can be used to guide them before and after creating art work products. Moreover, these can be information that will be able to use to file a patent application that is appropriate for the work.

References

Brand-Gruwel, S., Wopereis, I., & Vermetten, Y. (2005). "Information problem solving by experts and novices: analysis of a complex cognitive skill." *Computers in Human Behavior 21*(3): 487-508.

Brand-Gruwel, S., Wopereis, I., & Walraven, A. (2009). A descriptive model of information problem solving while using internet. *Computers & Education*, *53*(4), 1207-1217.

Department of Intellectual Property. (2017a). *Patent* . Retrieved October 20, 2017, from https://www.ipthailand.go.th

Department of Intellectual Property. (2017b). *Thailand Patent Search.* Retrieved October 20, 2017, from http://patentsearch.ipthailand.go.th/DIP2013/complexsearch.php

Dirkx, E., Schwenk, R. W., Glatz, J. F., Luiken, J. J., & van Eys, G. J. (2011). High fat diet induced diabetic cardiomyopathy. *Prostaglandins, Leukotrienes and Essential Fatty Acids (PLEFA)*, *85*(5), 219-225.

Hemarajata, C. (2017). *Nature of Intellectual Property Law.* 11th ed. Bangkok: Niti-Tham.

Kanjanawasee, S. (2009). *Classical Test Theory.* 2nd ed. Bangkok: Chulalongkorn University Printing House.

Mayasari, T., Kadarohman, A., Rusdiana, D., & Kaniawati, I. (2016). *Exploration of student's creativity by integrating STEM knowledge into creative products* (Vol. 1708).

Miron-Spektor, E., & Beenen, G. (2015). Motivating creativity: The effects of sequential and simultaneous learning and performance achievement goals on product novelty and usefulness. *Organizational Behavior and Human Decision Processes, 127*, 53.

Raes, A., Schellens, T., De Wever, B., & Vanderhoven, E. (2012). Scaffolding information problem solving in web-based collaborative inquiry learning. *Computers & Education*, *59*(1), 82-94.

Selvi, K. (2007). Learning and creativity *Phenomenology of Life from the Animal Soul to the Human Mind* (pp. 351-370): Springer.

Selvi, K. (2011). Teachers' lifelong learning competencies. *International Journal of Curriculum and Instructional Studies, 1*(1).

Sompuet, P. (2013). *Development of a blended learning model with case-based learning using yonisomanasikara approach to develop reflective thinking and professional media ethics decision making for undergraduate students of rajabhat university.* Ph.D. Chulalongkorn University Library.

Songkram, N. (2011). The Project -based Learning and Collaborative Learning Model for Innovative knowledge Creation for Undergraduate Students in Higher Education Institutions. *Proceedings of Global Learn Asia Pacific 2011* - Global Conference on Learning and Technology, Australia, 1079-1084.

Songkram, N. (2012). The blended learning model with active learning for knowledge construction and creative problem solving ability for undergraduate students in higher education. *Proceedings of the Fourth Asian Conference on Education 2012,* October 24-28 2012, Osaka, Japan.

Songkram, N. (2013). Effect of organizing active learning and hybrid learning on design of virtual field trip and to enhance creativity for undergraduate education students. *Journal of Education, Silpakorn University* 10 (2) (Nov.2012 – March 2013).

Songkram, N. (2014). Innovation: Transforming learners into innovators. *2nd ed.* Bangkok: Chulalongkorn University Printing House.

Thai Patent Act B.E. 2522. (1979). Government Documents: Government Gazette.

Thai Patent Act (No. 2) B.E. 2535. (1992). Government Documents: Government Gazette.

Thai Patent Act (No. 3) B.E. 2542. (1999). Government Documents: Government Gazette.

The Secretariat of the Cabinet. (2017). Thailand 4.0. Retrieved October 20, 2017, from *http://www.soc.go.th/index.php*

Torrance, E. P. (1969). Creative positives of disadvantaged children and youth. *Gifted Child Quarterly, 13*(2), 71-81.

Torrance, E. (1972). Can we teach children to think creatively?. *The Journal of Creative Behavior*, *6*(2), 114-143.

Walton, A. P. (2003). The impact of interpersonal factors on creativity. *International Journal of Entrepreneurial Behavior & Research, 9*(4), 146-162.

Wendler, C., Bridgeman, B., Cline, F., Millett, C., Rock, J., Bell, N., & McAllister, P. (2010). The Path Forward: The Future of Graduate Education in the United States. *Educational Testing Service*.

Willer, D., & Eisenberg, M. (2014). Mapping educational standards to the Big6 *Information Literacy. Lifelong Learning and Digital Citizenship in the 21st Century* (pp. 81-90): Springer.

Wongwanich, S. (2007). *Needs assessment research. 2nd ed.* Bangkok: Thammada Place.

Zhou, C. (2015). Bridging Creativity and Group by Elements of Problem-Based Learning (PBL) *Pattern Analysis, Intelligent Security and the Internet of Things* (pp. 1-9): Springer.

Authors

Miss Thidarat Tannirat, Ph.D. (Candidate)
Educational Communication and Technology, Faculty of Education Chulalongkorn University, Thailand
noo_darat@hotmail.com

Assoc. Prof. Noawanit Songkram, Ph.D.
Educational Communication and Technology, Faculty of Education Chulalongkorn University, Thailand
noawanit.s@chula.ac.th

Assoc. Prof. Jaitip Nasongkhla, Ph.D.
Educational Communication and Technology, Faculty of Education Chulalongkorn University, Thailand
jaitip.n@chula.ac.th

* This research paper is a grant from the National Research Council of Thailand 2018