The Design of a Pedagogical Seminar Course to Prepare Senior High School Students for Science and Technology Project

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Abstract
Regarding to the issue of building up the STEM workforce to drive Thailand move pass the middle-income trap, STEM school nurturing new generation STEM in high school education level was set. The pedagogy of learning in this school was designed by a backward design including the seminar course. In the first year of Grade 10th, seminar courses are generally provided for students in order to prepare for science and technology's student Project in 11th grade. The learning outcomes are as important as the contents (Academic Comprehension), skills and attitude relevant to the traits and skills of school's curriculum. To clarify, the seminar's learning activity aims to encourage students constructing their knowledge and attitude through the journal reading including discussion and presentation with peers who are interested in the same field. According to the self-evaluation results, most students are able to develop academic contents, skill sets and attitude. The correlation of academic effectiveness of students between the seminar course and science technology projects was at a moderate level (0.52).

Keywords: Seminar Course, Science and Technology Project, Academic Comprehension, Skills

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1. Introduction

STEM education was first introduced in the Unites Stated referring to the integration of science, technology, engineering, and mathematics [1]. The goal of STEM education is to promote students' interest in STEM subjects which could encourage them to continue work in STEM fields. STEM education is now widely implemented in many countries. The goal of STEM education in Thailand is to produce the workforce which aim to help Thailand moves pass the middle-income trap. Project-Based Learning (PBL) is the one tool for supporting STEM education that has proven to be successful encouraging students to learn, apply knowledge and improve their soft skills. Using PBL, students obtain essential skills, such as solving problems, critical thinking, analyzing, and evaluating information, teamwork, and communicating effectively [3].

Project-based learning is a learning process through research activities (Abidin, 2014). In review, Project-Based Learning model that can be used to improve student creativity (Sahtoni et al., 2017). Various studies have shown that scientific-based learning model is very effective in improving students' scientific skills (Fikriyah et al., 2015) and scientific literacy in all students as well as motivate them to pursue careers in science, technology, and engineering [1]. Moreover, Project–Based Learning (PBL) is an approved method that equips learners not only with the 21st century skills (critical-thinking, problem-solving, life–long learning skills, creativity, innovation, collaboration, real-life- setting communication skills), but also has remarkable effectson enhancing learners' English language skills [4].

The subject for preparing students to learn their project is seminar course. The K-12 Engineering Education Programs (KEEP) Seminar Series for high school, College of Engineering, and the Raggio Research Center for Science, Technology, Engineering, and Mathematics (STEM) Education at the University of Nevada, Reno. From the teacher's point of view, the research seminar class solved various problems that had previously been encountered in working with students conducting investigative projects. The advantages of seminar classes are that students start to know what they are doing and why they are doing it. The multidisciplinary nature of the research seminar course allowed high school students to discover that scientists in different disciplines can work together productively to achieve their goals which are not always reinforced in a traditional classroom situation [8].

2. Review of Related Literature

At The Beacon High School in New York City, all senior science research projects were undertaken and developed through a one-semester course called Senior Science Seminar. The major student outcome for the course is a research paper with an abstract, an introduction, methods, results, and discussion. The condition of the paper was about 10 pages in length. Each student also created a PowerPoint presentation that is relevant to their paper. Students presented their projects to the Science Seminar Class, and to an additional science teacher who was unfamiliar with the students' work during a school-wide project assessment week. In the course, students wrote the literature review early on, teacher comments were made, and students revised this review again to make the final paper [5].

In a children's literature (CL) course in a college of applied sciences in Oman (X-CAS), on students' active engagement in learning. The seminar promotes critical reading and writing skills as participants read a wide range of sources. The course engaged them actively in

critical thinking by raising questions on literary texts, sharing ideas and improving their communication and presentation skills [6]. The seminar in the San Diego, that is unique in the fact that it requires publication by students within the course of the semester. This requirement has meant that so far the options for student research projects have been limited to topics within such a short period of time, such as double star astrometry. The students select a project, write a proposal, collect and analyze data, and write their paper and submit it for publication [7]. The research seminar class is offered to junior and senior students at Cy-Fair High School in Houston, Texas. A multidisciplinary research seminar class offers gifted high school students the opportunity to make a research proposal, conduct an investigation, write a formal research paper, and present results both orally and visually. These highly motivated students are able to do an in-depth study of a topic which interests them while receiving continuous feedback from their classmates and instructors [8].

3. Research Methods

3. 1 Methodology

3.1.1 Participants

The participants of this work were 66 students of the 10th grade in 2022. All students had to attend seminar courses to provide students for preparing them to do science project. All students were required to pass the seminar course before to do Science project.

3.1.2 The seminar course approach

This course aims to train students in a comprehensive presentation of their academic work. Presentation skills, listening skills to capture the essence of academic lectures, learn the science process from academic articles. Reading skills for interpreting academic articles, writing summaries and abstracts. From the learning outcome, the author focused on the essential skills that are categorized into three parts, the first was called comprehension that include reading and academic writing. The second was presentation skills. The last was English comprehension that are reading, writing, listening and communication.

3.1.3 Research Tools

In this research, there were 2 instruments for evaluate this research. First, the soft skills assessments were evaluated by self-assessment by google form. There were three skills to assess which were comprehension, presentation and English proficiency.

Table 1 shows the skills to assess in this research (Journal Comprehension, Presentation skills and English proficiency).

Table 1: The skills to assess in this research

Comprehension	Presentation	English Proficiency
- Interpret the main idea of an academic article - Separate the component of an academic article - Summary of issues in the form of abstracts from reading academic papers.	- Communication skill and exchange and knowledge - Create media to be used in presentation - Academic presentation skills	- Listening - Speaking - Reading - Writing

For comprehension, authors evaluate from the understanding of the article that can show in the reading and writing to abstract form. Communication skills are one essential skill for the 21st century. In this paper, communications skills include media creation to presentation skill, academic presentation skills and answer the questions to audiences. English language proficiency means the full command of language skills, including proficiency in listening, speaking, reading, and writing of the English language.

3.1.4 Learning outcome and activity.

Table 2 shows the activities and the learning outcomes in this research.

Table 2: The activities and the learning outcomes in this research

Activity	Learning Outcome	Activity details
Search for paper	1. To practice literacy skills and English Proficiency.	1. Students choose one subject that they are interested such as Physics, Chemistry, Engineer and Technology etc. 2. Students who are interested in the same subjects are random and work in a group together. 3. Each group searched for the journal publications that they were interested in and read from the database by themselves, and under the adviser's guideline. 4. Then, each group chooses one final paper together in order to comprehend it and advisor guide student about the method to find the journal publication.
Reading and discussion	1. To practice comprehension, academic writing and English Proficiency. 2. To practice collaboration	1. Each group read, comprehended, and discussed the journal article by sharing ideas and brainstorming together. 2. Each group consulted about journal reading comprehension on the topic of correct, reading comprehension with the advisor in order to progress their work. 3. After discussing with the advisor, each group created their abstract in order to assess overall comprehension about the journal paper they read which express to the reading literacy skill. (Genlott, 2013). The abstract was assessed as the reading's literacy outcome. 4. Then, each group created the media for presentation and practiced to present.
Presentation	1. To practice presentation skill.	1. Each group presented a whole journal publication that they read and discuss with peers and the teacher in order that students could construct knowledge from discussing with peers and teacher.

4. Results & Discussion

In this work, the results were divided into two parts. The first assessing from self-assessment to assess Reading Comprehension, English Proficiency and Presentation Skills (Total score = 5) using t-test. The second is comparing the effectiveness of students of Seminar Course (10^{th} grade) and science project (11^{th}grade) by Pearson correlation.

Table 3: The results from self-assessment from Journal Comprehension, Presentation skills, English proficiency and Total scores

Skills	Experiment	n	Mean	SD	t	p
Journal comprehension	before	66	4.13	0.65	-5.389	0.00
	after		4.53	0.49		
Presentation skills	before		4.00	0.67	-3.375	0.01
	after		4.27	0.69		
English Proficient.	before		3.62	0.70	-3.005	0.04
	after		3.90	0.69		
Total 1-3	before		3.89	0.56	-4.573	0.00
	after		4.21	0.53		

Table 3 shows the results from self-assessment of students. It found that the Mean score after seminar course was higher than before course. The significant difference is 0.00, 0.01, 0.04 and 0.00 in journal comprehension, presentation skills, English Proficiency and total respectively. The results shown students improved journal comprehension, presentation skills and English proficiency in seminar course. The mean score of journal comprehension is highest and the mean score of English proficient.

Table 4: The correlation of academic effectiveness of students between the seminar course and science technology projects.

	Seminar	Project
Seminar	1	
Project	0.5217	1

Table 4 shows the correlation of academic effectiveness of students between the seminar course and science technology projects that evaluate from the grade of both courses. The results show the correlation is moderate level (0.52).

5. Conclusions

The seminar aims to train students in academic presentations, covering speaking skills, presentation skills, and listening skills in capturing the essence of academic lectures. Learn the scientific process from academic papers. Reading skills for interpreting academic articles, writing summaries and abstracts. According to the course regulation, this subject focused on learning fundamental skills to continue and prepare the student to create the Science project later. Students were anticipated to gain various skills and attitudes. For instance, reading literacy, discussion, presentation, and answering skills. From the results, seminar courses help students to improve their skills. Moreover, the opinions about seminar course from students that seminar course made them familiar with journal, they like it, but I want English teachers to participate in the assessment, many students like this course because they can share

knowledge in class and encourage them to dare to present in English. Some students like the pair grouping method because it makes friends who like the same subject so that they can work together. However, seminar course is difficult to them because it has to use basic knowledge and English skills. From teacher's opinion, the advisor has an important role to guide and suggest student for learning the seminar course, especially learning the journal's structure, improvising student to self-learning and all students could construct knowledge from each process of learning. For instance, discussing with the advisor, peer-discussion, presentation, and answering.

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