

# The Project-Based Learning Model via Generative Artificial Intelligence to Promote Programming Skills for Vocational Students

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## Abstract

The project-based learning model via generative artificial intelligence, or PjBL model via Gen-AI, is a research tool that was initiated based on the concept of project-based learning management focusing mainly on self-directed learning, in which learners are able to learn and practice through the projects they are interested in as to their aptitudes and competencies with the aid of generative artificial intelligence technology. The learning model developed in this study can be employed as a guideline for the instruction management designated specifically to promote programming skills. This study is intended to develop the PjBL model via Gen-AI as a guideline to further develop the PjBL system via Gen-AI to promote programming skills for vocational students. The suitability of the PjBL model via Gen-AI was assessed by nine experts from various educational institutions. The study results insist that the PjBL model via Gen-AI is suitability is at the highest level. According to the research results, it can be summarized that the PjBL model via Gen-AI can be used as a guideline to further develop the project-based learning systems via generative artificial intelligence to promote programming skills for vocational students in Thailand.

**Keywords:** PjBL model via Gen-AI, project-based learning, generative artificial intelligence, programming skills, vocational students

## 1. Introduction

### 1.1 Introduce the Problem

The curricula developed on the basis of the High Vocational Certificate B.E. 2567 are intended for use in vocational education management with an attempt to enhance the standards of vocational education. Thereby, the said vocational curricula must comply with National Qualifications Framework, ASEAN Qualifications Reference Framework, National Education Standards, National Qualifications Framework for Vocational Education, Professional Standards, National Skill Standards, and other standards both in and out of Thailand. Emphasizing on learning to practice, the main objective of the education management in this style is to improve the competencies of skilled workers, including their morality, ethics, professional ethics, and appropriate work habits, to be consistent with the demands of labor market, communities, and society. In addition, it is intended to promote cooperation in education management and joint curriculum development among vocational institutes, educational institutions, agencies, workplaces, and organizations at community, local and national levels (Office of the Vocational Education Commission, 2024).

Education management in Thailand for the 21<sup>st</sup> century focuses primarily on flexibility, creativity, challenges, and complexity, which is regarded as an education that will make the world change in a rapid manner, full of new and exciting challenges, problems, opportunities, and possibilities. Vocational colleges in the 21<sup>st</sup> century, therefore, will place importance on the project-based curriculum, a curriculum that allows learners to engage more with the real-world problems or issues related to humanity, and the questions about future concerning cultures, societies, and cosmopolitanism. The image of vocational colleges will change from a mere building to the nerve center that connects instructors, learners, and communities to the knowledge base at global level. At the meantime, the role of instructors will change from just passing on knowledge to supporting and assisting learners to turn information into bodies of knowledge and then apply them in practical use. This is considered the learning style that can further create knowledge and promote culture of information retrieval (Nuangjamnong et al., 2020).

Pongsawadi Technological College is a learning organization that is determined to develop and equip learners with

vocational competencies as well as morality so that they are able to pursue careers in the future. The ultimate aspiration of this college in education management is to develop bodies of knowledge along with morality. This is to enable students to develop their knowledge in such a way that they can keep up with the current technologies, and at the same time, they must be students with high morality. The development of knowledge herein refers to the attempt to encourage students to learn, seek knowledge by themselves, have self-discipline, have initiatives and creativity, and adapt themselves to any changes. At the meantime, students must have morality, honesty, integrity, discipline, responsibility for themselves and others, gratefulness, and ethics. Pongsawadi Technological College offers 6 programs in vocational certificate (VC) and five programs in high vocational certificate (HVC) (Pongsawadi Technological College, 2023).

### *1.2 Systematic Review*

The project-based learning is a form of learner-centered beyond schooling, which encourages learners to conduct self-directed learning based on their interests, aptitudes, and competencies, and allows them to apply their knowledge and experiences derived from learning in practical implementation (Nilsook et al., 2021). In this style of learning, learners shall be allowed to carry out every step of learning process, e.g., defining a topic, setting up a learning plan, designing the learning, creating a system, applying the said system, doing the practical work, and evaluating that work. It is believed that the project-based learning will help learners gain bodies of knowledge by means of step-by-step independent research based on scientific processes. Moreover, learners will have a chance to use artificial intelligence technology, to do data retrieval, and use their creativity in conjunction with their problem-solving skills to accomplish the assigned projects. All of these are said to help improve learners' skills and knowledge that can be applied in real life and in the creation of project works, which can obviously represent the competencies of learners (Wongkumsin & Singhwee, 2020; Chatwattana & Nilsook, 2017).

Artificial intelligence (AI) is a set of technologies that are developed and widely applied in solving problems. The core essence of AI is machine learning, which is a complex algorithm devised to deal with problems. In other words, AI will classify, group, and predict or forecast the data for use in decision-making, planning, and administration in order to increase organizations' efficiency. Besides mathematical and statistical processing methods used to find relationships between data, AI is also utilized to create models that can predict the results accurately based on original data. AI technology can be categorized into several types according to its usage, such as machine learning, natural language processing, deep learning, and generative artificial intelligence (Kingchang et al., 2024).

Generative artificial intelligence (Gen-AI) is an artificial intelligence processing technology that can make inanimate objects equal to users or humans. Gen-AI has a system that can process data as the human brain does, so it can yield action outcomes which will bring about the creation of new innovations and new products in the new formats (Muengsan & Chatwattana, 2024). Thus, Generative AI is considered a type of artificial intelligence technology that can produce contents in various forms, such as text, image, and sound, including the data that can be synthesized in the learning of computer programming (Siripipattanakul et al., 2024). Nowadays, Gen-AI has been applied in different fields for convenience and as a tool to promote learning in the form of digital anthropology, with the ultimate aim to initiate new styles of learning focusing on the interaction with a variety of platforms (TechTarget, 2023).

Programming skills refer to the skills that rely mainly on understanding of the principles of computer programming. To illustrate, a set of commands are used to solve problems and enable the computer to function as desired by means of analytical thinking and systematic problem solving (Rattanakha & Chatwattana, 2023). Computer programming requires a variety of knowledge, and the skills in this field consist of five characteristics as follows, i.e., 1) systematic thinking, 2) computational thinking, 3) critical thinking, 4) problem solving, and 5) creative thinking. According to the aforementioned details, it is necessary for learners to possess these characteristics in order to design and develop the computer programs that are capable of solving the specified problems (Pitiwong et al., 2020).

Referring to the above principles, theories and reasons, the researchers have had an idea to develop the project-based learning model via generative artificial intelligence to promote programming skills for vocational students with an expectation that this model can be employed as a guideline to manage the project-based learning in which artificial intelligence technology is used to provide knowledge in the classroom. It is also projected that the learning management of this style can promote learners' programming skills and ability to apply information technology media in practical use with comprehension and in a constructive manner.

This research is related to the design and development of the PjBL model via Gen-AI to promote programming skills for vocational students, and the research objective and hypothesis are as follows.

- To synthesize the conceptual framework of the PjBL model via Gen-AI to promote programming skills for vocational students.
- To develop the PjBL model via Gen-AI to promote programming skills for vocational students.
- To study the results of the development of the PjBL model via Gen-AI to promote programming skills for vocational students.

The results of evaluation on the suitability of the PjBL Model via Gen-AI to promote programming skills for vocational students are at the high level.

## 2. Method

This research is related to the design and development of the project-based learning model via generative artificial intelligence (PjBL model via Gen-AI) to promote programming skills for vocational students. This model is based on the system approach (Khemmani, 2018; Utranan, 1982), and the research methodology is as follows.

### 2.1 Population

The population for this research is nine experts from various educational institutions, all of whom were selected by means of purposive sampling. In this study, the researchers selected experts based on the criterion that each expert have at least seven years of experiences in education and in the design and development of instruction system. However, all the experts were requested to voluntarily participate in the study.

### 2.2 Instruments and Data Analysis

The instruments employed in this research consist of (1) the PjBL model via Gen-AI, and (2) the evaluation form on the suitability of the PjBL model via Gen-AI, consisting of scoring questions (5 levels). Statistics used for data analysis include mean and standard deviation (SD).

The methodology can be divided into three steps as follows.

At the first stage is synthesis of the documents and the research relevant to establish the conceptual framework, the researchers had studied and analyzed the documents and the researches, which are concerning higher vocational curriculum, project-based learning, generative artificial intelligence (Gen-AI), and programming skills.

At the second stage is development of the PjBL model via Gen-AI. In this stage, the researchers based the design and the development of this model on the principles of system approach consists of four main elements.

At the third stage is concerning the study of the PjBL model via Gen-AI. The criteria for evaluation and the interpretation of results (Srisa-Ard, 2013).

- 4.50 – 5.00 points, the suitability is at the highest,
- 3.50 – 4.49 points, the suitability is at the high,
- 2.50 – 3.49 points, the suitability is at the moderate,
- 1.50 – 2.49 points, the suitability is at the low,
- 0.00 – 1.49 points, the suitability is at the lowest.

## 3. Results

The results of the development of the project-based learning model via generative artificial intelligence (PjBL model via Gen-AI) to promote programming skills for vocational students can be summarized as follows:

### 3.1 The Conceptual Framework of the PjBL Model via Gen-AI

As to the study, analysis, and synthesis on the documents and the researches related to the development of the project-based learning model via generative artificial intelligence (PjBL model via Gen-AI) to promote programming skills for vocational students, the researchers acquired some guidelines to establish the conceptual framework of this study, which includes higher vocational curriculum, project-based learning, generative artificial intelligence (Gen-AI), and programming skills, as seen in Figure 1.

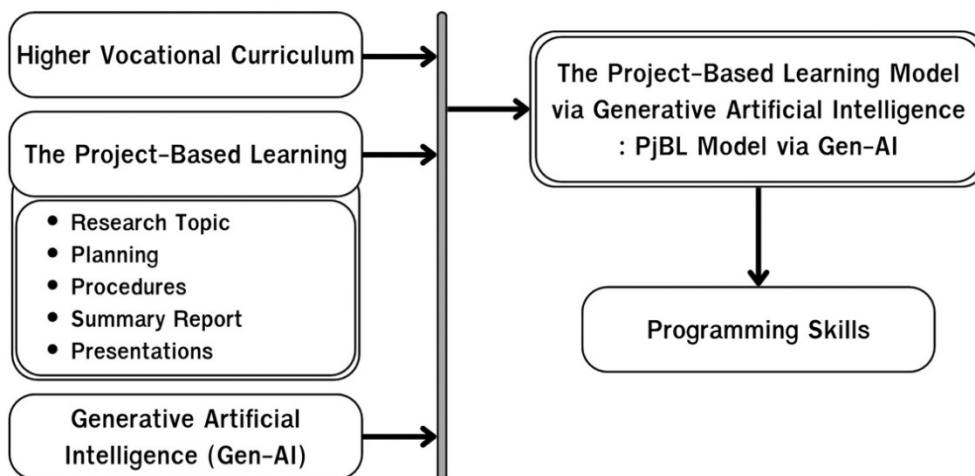


Figure 1. Conceptual framework

### 3.2 The Development of the PjBL Model via Gen-AI

The PjBL model via Gen-AI fabricated in this study can be applied as a guideline to further design and develop the other project-based learning systems via generative artificial intelligence (PjBL systems via Gen-AI) to promote vocational students’ programming skills, which are regarded as one of the indispensable characteristics that the vocational students should have. This is because the said skills shall assist them in systematic thinking and promote the use of technologies to solve problems in an efficient manner. The design and the development of the PjBL model via Gen-AI are based mainly on the system approach consisting of four major elements, i.e., input factor, the PjBL learning process via Gen-AI, output, and feedback, as illustrated in Figure 2.

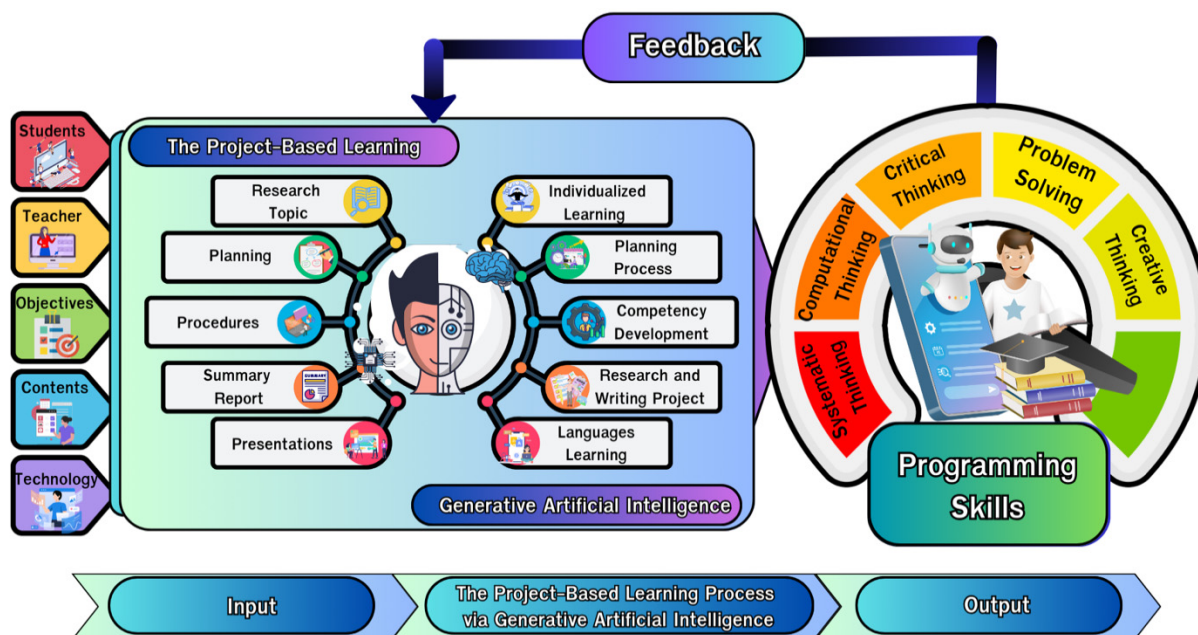


Figure 2. The Project-Based Learning Model via Generative Artificial Intelligence: PjBL model via Gen-AI

Figure 2 illustrates the PjBL Model via Gen-AI, which consists of four main elements as follows:

1) Input factor

- Students: This refers to the vocational students of High Vocational Certificate Program at Pongsawadi

Technological College, all of whom are capable of using internet technologies.

- Teacher: This refers to the person who can pass on skills and bodies of knowledge to the students. Thereby, the teacher herein must be able to use internet technologies and facilitate the instruction management process.
- Objectives: This refers to the objectives established by the teacher, and the skills or abilities that the teacher wants the students to achieve. Whereby, the said objectives must be in consistence to the contents and knowledge in each lesson.
- Contents: This refers to the contents provided in the curriculum of High Vocational Certificate (HVC) B.E. 2567, Digital Industry and Information Technology.
- Technology: This refers to the application of scientific knowledge and scientific procedures in the development and implementation of the tasks in a systematic manner; whereby, the students and the teacher primarily employ the technology of Gen-AI as a tool to facilitate the instruction management with an intention to enhance programming skills of the students.

2) The PjBL learning process via Gen-AI, which is initiated from the integration of theories related to the project-based learning and Gen-AI technology. The details of this element are as below:

Project-based Learning, in which the learning process is divided into five, steps as follows:

- Research Topic Step: The teacher sets up a learning management plan as to the course objectives while giving advice and suggestions to the students so that they can understand the overall concepts of the project-based learning. Then the students are allowed to research information, work in group, brainstorm, study feasibility, define their project topics, summarize problems, and prepare for their project plans.
- Planning Step: The teacher approves the projects and gives some feedback, and then monitors the learning stages in the projects. The students create their project plans, present the project topics, receive feedback, and make improvements.
- Procedures Step: The teacher monitors and checks the working process of the students while listening to their problems and feedback. The students produce their own workpieces, test them, and solve the problems found therein.
- Summary Report Step: The teacher checks the project workpieces and gives some feedback about the project results. The students examine their problems and report their summary.
- Presentations Step: The teacher gives helpful support to the projects during the authentic assessment. In addition, the teacher together with some experts evaluates the said projects in terms of their capacity. At the same time, the students have their projects assessed by themselves and by the others students.

Generative Artificial Intelligence (Gen-AI), which consists of the following five steps of learning process:

- Individualized Learning Step: This step refers to the use of customized tools to do the quick search for information by means of Gen-AI in order to get the desired results.
- Planning Process Step: It is the step of using the tools to set up a working plan carefully, quickly, and precisely so as to achieve the outcomes or work efficiency as desired.
- Competency Development Step: This refers to the use of tools to increase the students' vocational competencies so that they can learn, interact, search information, or solve any problems in a rapid manner.
- Research and Writing Project Step: It is related to the use of tools to study the information of interest including analysis, synthesis, or application of the said information. Then the acquired information is promptly used in project writing, checking for errors, or projects summary.
- Languages Learning Step: This step is about the use of tools to study the structures of language use in order to obtain the outcomes of language sentences very quickly on the condition that the sentence structures and the translation of passages must be grammatically correct and compliant to the principles of any specific languages.

3) Output, which is the outcomes directly resulting from the project-based learning management via generative artificial intelligence to promote programming skills for vocational students. The output is divided into five characteristics as follows:

- Systematic thinking is a holistic thinking in a systematic way, and it involves the study of all interrelated components starting from smaller to bigger ones. It is also a logical thinking, focusing on intelligent problem solving methods in order to derive accuracy, precision, and quickness in the whole.

- Computational thinking is the process of analyzing problems in order to obtain the systematic approaches that can be used to find out solutions. Computational thinking is also a process of solving problems in different ways, such as logical sequencing, data analysis, and step-by-step creation of solutions.
  - Critical thinking is a process of thinking and analyzing information in a systematic manner, which is considered an important skill in decision-making.
  - Problem solving refers to the use of hands-on experiences derived from observation, data collection, data analysis, interpretation, and conclusion, to find out problem-solving methods that can practically deal with problems rationally.
  - Creative thinking is believed to initiate from programming skills. This is because there must be some ideas about the functions and features of programs before designing them. After completing the programming, the said programs must be developed easily and can respond well to the needs of users.
- 4) Feedback, which is the process in which the data derived from data collection, analysis on learners' outcomes, suggestions and opinions from experts, and the outcomes from the learning process, are reflected back to the project-based learning process via artificial intelligence technology in order to improve the PjBL model via Gen-AI. This is to enhance the suitability and the usefulness of the said model.

### 3.3 The Study on the Suitability of the PjBL Model via Gen-AI

The study on the results of the design and the development of the PjBL model via Gen-AI was carried out with the nine research participants from various educational institutions. The results are shown in Table 1 and Table 2.

Table 1. Results of the assessment of the PjBL model via Gen-AI (overall elements)

Assessment issues	Mean	SD	Interpretation
1. The suitability of the principles and the concepts used to develop the PjBL Model via Gen-AI.	5.00	0.00	Highest
2. The suitability of the elements of the PjBL Model via Gen-AI.			
2.1 Input factor	4.78	0.42	Highest
2.2 The PjBL learning process via Gen-AI	4.89	0.31	Highest
2.3 Output	4.67	0.47	Highest
2.4 Feedback	4.67	0.47	Highest
Overall	4.80	0.33	Highest

Regarding Table 1, it is found that the overall suitability of the design and the development of the PjBL model via Gen-AI (overall elements) is at highest level (Mean = 4.80, SD = 0.33). It can be concluded that the PjBL model via Gen-AI contains all elements and it can be employed as a guideline to further develop other PjBL models via Gen-AI to promote vocational students' programming skills, which are considered one of the necessary characteristics that shall assist them in systematic thinking and encourage them to use technologies to solve problems in an effective manner.

Table 2. Results of the appropriateness of the PjBL model via Gen-AI (individual element)

Assessment issues		Mean	SD	Interpretation
1. Input factor	1.1 Students	5.00	0.00	Highest
	1.2 Teacher	4.89	0.31	Highest
	1.3 Objectives	4.67	0.47	Highest
	1.4 Contents	4.89	0.31	Highest
	1.5 Technology	4.89	0.31	Highest
2. The PjBL learning process via Gen-AI				
2.1 Project-Based Learning	2.1.1 Research Topic	4.89	0.31	Highest
	2.1.2 Planning	4.89	0.31	Highest
	2.1.3 Procedures	5.00	0.00	Highest
	2.1.4 Summary Report	4.89	0.31	Highest
	2.1.5 Presentations	5.00	0.00	Highest
2.2 Gen-AI	2.2.1 Individualized Learning	5.00	0.00	Highest
	2.3.2 Planning Process	4.78	0.42	Highest
	2.2.3 Competency Development	4.56	0.50	Highest
	2.2.4 Research and Writing Project	4.78	0.42	Highest
	2.2.5 Languages Learning	4.78	0.42	Highest
3. Output	3.1 Programming Skills	4.93	0.15	Highest
4. Feedback	4.1 Result of Evaluation on Programming Skills	4.67	0.47	Highest
Overall (individual element)		4.85	0.28	Highest

Table 2 shows that the overall suitability of the design and the development of the PjBL model via Gen-AI is at highest (Mean = 4.85, SD = 0.28). It can be summarized that the PjBL model via Gen-AI has such appropriate elements that it can be applied as a guideline to facilitate the project-based learning, which encourages learners to search for knowledge and meanwhile create their own bodies of knowledge. This is in line with the student-centered learning concept, in which learning is initiated from practices and learners must be able to apply and enhance their learning skills and creative thinking skills. Furthermore, the results are consistent with the research of Kingchang et al. (2023), who insisted on the practice of systematic thinking, and decision-making as to one's aptitudes, as well as the use of technology in an effective manner.

#### 4. Conclusion and Discussion

The PjBL model via Gen-AI was initiated by the application of relevant principles, concepts, theories, and technologies in the project-based learning management according to the high vocational certificate programs. The learning management of this kind is intended to respond to Thailand's education situations and accommodate the 21st century skills. At the same time, it encourages learners to conduct self-directed learning based on their interests, aptitudes, and competencies, and allows them to make use of their knowledge and experiences with the aid of generative artificial intelligence technology in practical implementation. It is expected that, by this way, learners shall be equipped with the skills of systematic thinking, computational thinking, problem solving, creative thinking, team working, and presentation of their own works.

According to the results of evaluation on the suitability of the development of the PjBL model via Gen-AI, it is evident that (1) the overall suitability of the development of the PjBL model via Gen-AI (overall elements) is at highest level (Mean = 4.80, SD = 0.33), and (2) the overall suitability of the development of the PjBL model via Gen-AI is at highest level (Mean = 4.85, SD = 0.28) as well. The evaluation results herein are in accordance to the research of Wongkumsin and Singhwee (2020), who stated that the integration of the project-based learning with the usage of generative artificial intelligence technology is a kind of out-of-class learning format that focuses mainly on learners. This learning style promotes self-directed learning based on interests, aptitudes, and abilities of learners; and it encourages learners to apply their knowledge and hands-on experiences in practices and presentation of their works.

Moreover, the outcomes of this study are consistent with the research of Siripipattanakul et al. (2024), who said that the application of artificial intelligence technology will pave ways for the creation of new innovations that can produce contents in various forms; and it also assists in the design of customized learning process, writing articles, learning in language translation, and programming. The aforementioned results are also complying with the research of Kingchang et al. (2023), who explained that building relationships between teachers and students will help them communicate in the same direction. Not only that, the findings are also in line with the research of

Rattanakha and Chatwattana (2023), who said that programming skills are the skills that rely mainly on understanding of the principles of computer programming, using a set of commands to solve problems. It is believed that programming skills also contribute to the development of academic achievement, too.

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**Authors contributions**

Sukan Saeliang developed the main idea of this research, wrote and composed the manuscript, developing the tools and studied the results. Dr. Pinanta Chatwattana rechecked the manuscript before it was to be submitted. The two authors have approved the final version of this manuscript for publication.

**Competing interests**

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Obtained.

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**Data sharing statement**

No additional data are available.

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