Project-based learning using LEGO/Logo: a case study in the integration of thinking skills development and vocational morals

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ABSTRACT

The research focuses on a case study of a Project-Based Learning activity to integrate the development of thinking skills and vocational morals by creating automatic robots using LEGO/Logo box in a collaborative effort between instructors and students. To develop thinking skills, the initial phase of the project was designed to involve participants in the use of virtual-based training about critical and creative thinking. The developmental phase aimed at creating LEGO at both a basic level and LEGO as a robot, as well as to program the robot with the Logo program. This collaborative approach allowed instructors to integrate the learning process with vocational morals. The purpose of the achievement phase was to test and evaluate the work and to determine whether the students could work in compliance with the regulations, collaboratively and at an appropriate level. The outcomes may have been a result of previous knowledge and experience, an ability to solve problems, intention, attention and a determination to work against the clock, a curiosity to know, play and enjoy the things they have developed. The role of the instructor was to facilitate and to guide the students to learn together, as well as to provide resources and tools so that they could learn systematically and to their full potential. The students were found to have the ability to learn by themselves in an on-going way, as well as demonstrating an ability to think, analyze and solve problems. Hence, the morals would precede the knowledge in the future. Moral development was strengthened through teamwork and problem solving.

Keywords: *Project-Based Learning, LEGO/Logo, Thinking Skills, Vocational Morals*

INTRODUCTION

Section 22 of Thailand's National Education Act B.E. 2542 (Office of the National Education Commission, 1999) states that instruction must be based on the principle that all learners have the ability to learn and develop themselves. It noted that learners are the most important stakeholders and that the method of instruction should encourage learners to develop themselves in accordance with their nature and to their full potential. Furthermore, Section 24 In organizing the learning process, educational institutions and agencies concerned shall:

- Provide substance and arrange activities in line with the learners' interests and aptitudes, bearing in mind individual differences.
- Provide training in thinking process, management, how to face various situations and application of knowledge for obviating and solving problems.
- Organize activities for learners to draw from authentic experience; drill in practical work for complete mastery; enable learners to think critically and acquire the reading habit and continuous thirst for knowledge.
- Achieve, in all subjects, a balanced integration of subject matter, integrity, values, and desirable attributes.
- Enable instructors to create the ambiance, environment, instructional media, and facilities for learners to learn and be all-round persons, able to benefit from research as part of the learning process. In so doing, both learners and teachers may learn together from different types of teaching-learning media and other sources of knowledge. Finally,
- Enable individuals to learn at all times and in all places. Cooperation with parents, guardians, and all parties concerned in the community shall be sought to develop jointly the learners in accord with their potentiality.

Chaowakeratipong (2002) explained that learning achievement should be an indicator of the learning characteristics of learners. For instance, (1) happy learning arises from the idea that instruction should be based on individual differences and the working process of the brain for learning, as well as leading to the development of emotional intelligence. Learners could learn in a natural atmosphere and a friendly environment where they could learn various things that could be used in real life. (2) Learning from thinking and real practice or "learning with the brain and two hands" results from instruction which encourages learners to think, pose questions, and sharpen their problem solving skills with reasons. (3) Learning from various sources of learning and learning with other people is one important objective for student-based learning in which the learners seek knowledge inside and outside the school from documents, materials, places, enterprises and persons such as peers, experts and local wise men. (4) Holistic learning or integration is the mixture of knowledge in numerous fields along with ethics, morals as well as desirable attributes in every subject. Furthermore, (5) learning at their own pace encourages learners to seek knowledge by themselves so that they can observe and study the nature of inquiry. In this way, learners would come to know with which style they are the most adept. At the same, the learning activities would allow the learners to plan their own learning, to know their learning process and to practice meditation, self-discipline, and self-

knowledge. It could be argued that the student-based learning approach is a new way of instruction where, through self-reflection and practice, each learner is able to understand and integrate new knowledge in their daily life and, at the same time, become a skilled, good and happy person.

The project-based learning approach is one method of instruction which places an emphasis on the learners because the learning process begins with the choice and planning by learners of what to do in real situations. These decisions are based upon direct experience and reflect the activities that interest the learners. The learners have opportunities to develop emotional intelligence from working with others and to sharpen some desirable attributes such as self-discipline, punctuality, perseverance, and generosity without necessarily being aware that this is an offshoot of the process of instruction. Moreover, this approach allows LEGO/Logo to be used in developing thinking skills, teamwork, problem solving and happy learning. It also supports responsibility, working against the clock, punctuality, orderliness, neatness, carefulness, and intent.

LEGO/Logo is used to build a piece of work from blocks, gears, motors and sensors that is either static or able to move through the controlling language called Logo (Harel & Papert 1991; Papert 1993). Logo is a programming language that is able to control the blocks called LEGO. Both were developed by Papert. This tool is a suitable vehicle for practising thinking process and problem solving (Papert 1980; 1993). The foregoing corresponds with research undertaken by Takomthong (2007) which states that Project-Based Learning approach is valuable for gaining knowledge or seeking answers that learners need to know or are doubtful about. Learners have numerous ways to do that in accordance with their interests, and a group may make a decision together through various kinds of techniques such as group process, thinking, problem solving, and sharing ideas. Besides, the learners who learn through project will see the relationship between ideas and facts that interconnect and they will be able to use this in other situations to integrate their knowledge through doing their project. They will work in a group and know how to seek information, as well as knowledge, by themselves (Tragoolsrid, 2009). According to interviews with the instructors who used the Project-Based Learning approach, it was found that the majority of instructors found the following challenges or obstacles to using the method successfully: (1) Thinking Skills, (2) Teamwork and Learning, (3) Responsibility, (4) Time Management, and (5) Vocational Morals. In terms of the results from observations and the interviews, it was found that the importance given to the role of vocational morals in the learning process were quite small. The majority of the instructors did not pay high regard to vocational morals, and this resulted in problems in instructing students who lacked discipline. Such students skipped classes, came late, never respected the instructors, had neither responsibility nor perseverance, were careless and showed little honesty. Furthermore, the instructors also had no time to prepare themselves fully or to revise their instructional techniques because they had other duties to carry out. This resulted in their unpunctuality in teaching, lack of time to provide guidance or to check on the progress of their students. They also had no time to give warnings to those who were disobedient either.

As a result of the importance and the background of the above-mentioned problems, the researchers decided to conduct a case study on the use of Project-Based Learning to integrate thinking skills development and vocational morals by using LEGO/Logo activities. It was decided that the results of this research would be presented to instructors and related personnel as a means of informing policy decisions and to demonstrate how learners might be developed in accordance with their nature and potential. The learners were encouraged to learn both collaboratively and through their own thinking processes. Furthermore, they would learn through practice and enjoy the learning process. They would not only become skilled, but have a heightened moral awareness, and they could apply this knowledge in everyday life with effectiveness and efficiency.

LEARNING OUTCOMES

There are three dimensions to the learning outcomes framework for the project namely, knowledge, skills, and vocational morals. This is broken down into 80 percent for knowledge of theory and skills and 20% for vocational morals, making a total of 100% or 100 points. Vocational morals are integrated into the continuous learning process as shown in Figure 1.
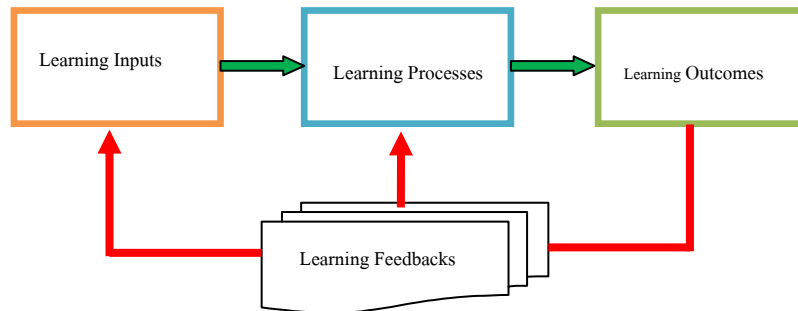

Figure 1: The framework of the learning system integrated with vocational morals.

VOCATIONAL MORALS

Vocational morals in instruction, as defined in Thailand's National Education Act B.E. 2542, are as follows:

Instructors must integrate knowledge from various aspects in a balanced state to cultivate good ethics, morals, values and desirable attributes in all subjects. The instructors must be good role models for students. The desirable attributes of teachers in a school may be summarized as (1) a good friend who is friendly, respectable, reasonable and enduring; (2) a person whose aim is to develop knowledge by providing concepts through a step-by-step process and who acts at

all times with good intentions; (3) a person who is persuasive in manner, so that the students know what they are learning and have fun;(4) a person who works with justification and verification; and (5) a provider of guidance so that the students know how to become good people, how to know deeply and how to sustain vocational morals as they lead their life.

Students should exhibit the attributes of (1) personal discipline through honesty, orderliness, initiative, courage and self-dependence; (2) vocational discipline through responsibility, human relations, ideals and pride in working within the law as well as seeking knowledge continuously; and (3) social discipline through cultural nurturing, natural conservation, altruism, enthusiasm for democracy, religion and the royal institution.

RESEARCH OBJECTIVE

The objective of this research was to study the integration of vocational morals and thinking skills development in a collaborative Project-Based Learning activity by instructors and students to build robots using LEGO/Logo.

RESEARCH METHODOLOGY

The research methodology was as follows:

Sample group

The sample group consisted of 10 instructors and 20 students from Phang Nga Technical College and 10 instructors and 10 students from the Regional Education Office in Phang Nga province. There were 50 people in total. They were chosen through a purposive sampling method and by their consent.

The Development of Thinking Skills

The *Initial phase* involved virtual-based training on creative thinking (Jitgarun, Tongsakul, & Meejaleurn, 2008) and on critical thinking (Jitgarun & Tongsakul, 2009). The *Developmental phase* first involved the creation of LEGO at basic level, and then the creation of LEGO as a robot. The robot was programmed with Logo programming language to integrate with vocational morals. Finally, the *Achievement phase* involved the testing and evaluation of the work (the robot).

Data collection

Observation and interviewing were the techniques employed for data collection. Observation involved walking around the classroom during the activities and the training to determine what variables or indicators affected the development of learning (such as behaviors, postures and interest).

Interviewing involved asking questions of instructors, learners and related persons about the conditions suitable for learning and the factors which affected the learning achievement in the three dimensional framework of knowledge, skills and vocational morals.

RESEARCH RESULTS

The results from the research on the development of thinking skills through LEGO/Logo activities in a Project-Based Learning approach emphasizing on vocational morals are summarized below.

Initial phase

The participants were trained in thinking skills by the use of virtual-based training on critical and creative thinking. As part of the training, the LEGO/Logo box was used in an activity called "the highest and the strongest". It was necessary for the instructors and the students to work against the clock under the conditions laid down. The instructors acted as facilitators to encourage the students to work as a team and to use creative thinking. According to the observations and the interviews carried out by the researchers, the variables and the factors which affected "the highest and the strongest" were intent, interest and care. As part of the activity, the instructors had to "cheer" the students to finish their work. It was found that the activity was challenging for both the students and the instructors because they competed not only with themselves, but with the other groups (as shown in Figure 2).

Figure 2: The LEGO activity called "the highest and the strongest".

Developmental phase

LEGO blocks were used to build a robot and the robot was programmed with Logo programming language to make the robot run around a post, as designed. According to the observation, it was found that the instructors and the students helped one another to build a perfect robot. Everybody worked in their teams against the clock with intent and care to make an automatic robot. According to the interviews, this activity enabled everybody to solve problems so that the robot would run around the post faster. In some groups gears were adjusted, whereas some groups used a programming technique to enable the robot to turn in a

narrower area (as shown in Figure 3).

Figure 3: LEGO blocks were used to build an automatic robot and to make it run around the post.

According to the observations, the instructors and the students reported that they had fun and were excited to see their robot work automatically to get to the finish line before or after its rivals (as shown in Figure 4).

Figure 4: Competition between automatic robots to run around the post.

LEGO blocks were used to build an automatic robot and then a sensor was used to enable the robot to run along a line. According to the observations, the instructors and the students shared their opinions and worked together so that they could make the robot run faster. They needed to program the robot so that it could run and turn along the curved line. The students had to be attentive and keen to understand the operation of the automatic robot, as well as able to think of ways to solve problems collaboratively. They needed to be patient and to work until they were able to finish the assignment (as shown in Figure 5).

Figure 5: How to test whether the automatic robot would run along the line.

As well as running along the line the automatic robot had to negotiate obstacles by

using sensors and pieces designed to assist it to pass obstacles easily. According to the observations, the instructors and the students needed to apply the knowledge and skills from previous activities and they had to try to solve problems with patience. When the robot was tested in the real field, it was found that the sample group had used Logo programming language to program the robot (as shown in Figure 6).

Figure 6: Robots competing by running along the line and negotiating obstacles.

Achievement phase

According to the results of the test and the evaluation of the work, 36.10% instructors and students or 36.10% were able to build an automatic robot to run as they had programmed. These groups won a gold medal while 30.56% received an honorable mention, 16.67% received a silver medal and 16.67% a bronze medal.

DISCUSSION

The integration of Vocational Morals and Project-Based Learning approach through LEGO/Logo activities to build a robot provided an opportunity for collaboration between instructors and students. The students were able to apply thinking skills and to enjoy the learning experience. The instructors understood the learning process, and they saw the activities as being important for learning development. However, it was recognized that vocational morals should be integrated in a systematic manner. For instance, the students should never be forced to learn too much. There were occasions when the students needed guidance, but the amount required depended on individual differences within the group and the need to balance intervention through guidance with the students' need to take responsibility for their learning development. The instructors were able to use virtual-based learning on critical thinking and creative thinking, together with LEGO/Logo activities to develop thinking skills and integrate these with vocational morals in a proper and systematic manner. Moreover, the instructors and the students demonstrated an ability to do the project effectively and efficiently and to create a model for everyday life as well.

CONCLUSION

From this research project, it may be concluded that:

> *..to encourage learners to be curious, to have fun and enjoy learning requires learning by doing, as well as collaboration. The instructors need to be ready to provide guidance where necessary and to collaborate with students. They should provide the resources and the tools to support the learning in an appropriate manner to the full potential. This will result in the learners who could learn by themselves continuously all their life with the ability to think, analyze, solve problems and lead a moral life.* (Office of the Education Council, 2009, p. 9).

ACKNOWLEDGEMENTS

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