

Developing Innovative Learning Model In Robotics Education For Students In Primary And Junior High Schools

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Abstract: Learning with robots plays increasingly vital roles of education in the future. According to constructivist theory of Duffy and Cunningham, robotics education can provide students having practical experience and then can create knowledge, understand technology and generate innovative skill. Several innovative learning processes are developed for engineering education, however it might not appropriate for younger students. This research was aimed to develop the 7-steps of innovative learning model with robotics kits: (1) Motivation and inspiration of creating robots (2) Creative idea development (3) Design thinking (4) Prototyping development (5) Validation and trouble shooting (6) Deployment application and (7) Self-Esteem with robotics competition. Each learning step leads to developing of learning contents, activities, support tools and environments to enhance innovation skills of 7-14 year-old students in the genius engineer project (iDektep) in Kasetsart university. A Focus Group Discussion (FGD) with senior engineers from industries, teachers from primary schools and the iDektep project were evaluated the content and they then constructed validity of the model. The FGD and teachers' and students' perspectives on the learning model were then found as following, firstly the content and construct validity of the model were valid. Secondly, this model was the worthy guideline for the teachers to design of learning contents, activities, support tools and environments related to the students' age and knowledge levels. Thirdly, the robotics kits applied in the learning model encourage the students to learning by doing that can make themselves understanding and knowledge which were stimulated by teachers.

Keywords: Innovative Learning Model, Innovation Competences, Robotics Education, Constructivist Theory.

1. INTRODUCTION

Robotic education or pedagogical robotics is a discipline created to teach children to robotics and programming in an interactive way from a very young age. In Thailand and many countries, Robotics Education is well-known within the so-called STEM (Science, Technology, Engineering and Mathematics) education (Iberdrola, 2023). It is a robotics teaching that teaches skills by learning to invent Lego robots, emphasizing coordination and promotion of development with Constructivism Learning theory, and robot technology. It allows students to gain knowledge in engineering, science, mathematics and also promotes imagination, creativity, and natural courage including having fun in the same time (K&A International, n.d.). In summary, Robotics education will make students easy to understand technology, as well as enhancing innovation skills in the students.

Innovative learning model for global education began to be collected on the website in 2016, and currently there are a total of 62 models (Transcend, 2023) in the "Innovative Models Exchange" database."-the free searchable database. The objective of the creation was to help schools handle the challenges of finding, introducing and implementing new education models. It provides educators with ideas and useful tools to help them redesign the educational process. In the past, mostly models were suitable for 8-years-old students and more, but nowadays there are several models for younger ages. In Thailand, recently, innovative learning models with robot kits have begun to be used to develop professional teachers in order to develop innovative skill of students. According to the research of Sirisamphan and Kitroongrueng (2021), the purposes were to

develop professional teacher by improving and expanding innovation in creative learning in order to develop students in western region. It was only the PLAN Model, not the “Innovation” tools. Moreover, there were many studies about using innovative tools in Thai learning namely Gamification, such as the study of Poondej, and Lerdpornkulrat (2017). The study was aimed to examine the satisfaction of teacher and students in applying gamification concept or game into classroom. Robots kits are primarily used to provide technology education and that a robot can take on the role of a tutor, tool or peer in the learning activity. The LEGO Mindstorms are useful for learners from various technical backgrounds by providing various programming (Mubin, Omar, et al. 2013). Robot kits which provide the option of educating but also providing about mechanics, e.g. motor, and electronics, e.g., Arduino. R. Balogh, (2010). To develop innovation skills for students, innovative learning models and robot kits are the important parts for teachers to design of learning contents, activities, support tools and environments. Several innovative learning processes are developed for engineering education, however it might not appropriate for younger students in Thailand.

This research was aimed to develop the 7-steps of innovative learning model with robotics kits: (1) Motivation and inspiration of creating robots (2) Creative idea development (3) Design thinking (4) Prototyping development (5) Validation and trouble shooting (6) Deployment application and (7) Self-Esteem with robotics competition. A Focus Group Discussion (FGD) with senior engineers from industries, teachers from primary schools and the iDektep project were evaluated whether this model was the worthy guideline for the teachers to design of learning contents, activities, support tools and environments.

2. The 7-Steps of Innovative Learning Model

A learning theory called constructivism emphasizes the learner's active engagement in creating their own understanding by creation of mental images and then incorporate new knowledge into their beliefs rather than simply taking it in passively. This theory encourages more in-depth understanding of learners to construct knowledge or innovation themselves (McLeod, 2023). According to constructivism learning theory, the 7-steps of innovative learning model is developed as shown in Fig. 1. The robot kits in this study is the Automated Guided Vehicle (AGV) as seen in Fig .2.



Fig. 1. 7 steps of active project base learning and coaching

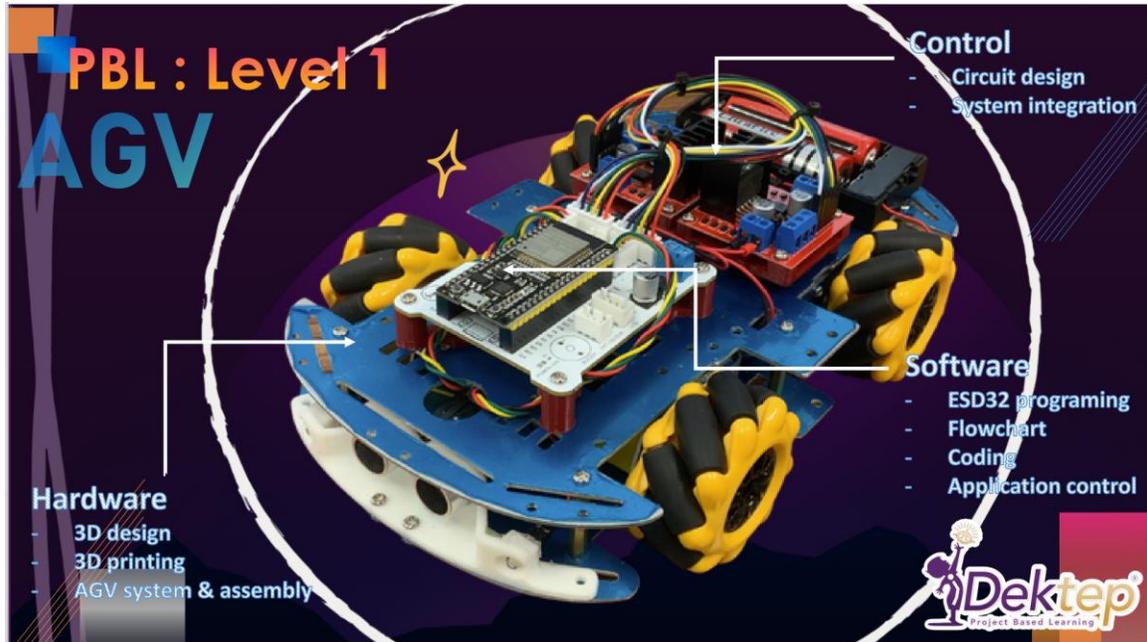


Fig. 2. Robot kits (Automated Guided Vehicle: AGV) in this study

- 1) Motivation and inspiration of creating robots served as a manual for the construction and operation of a genuine robot. In order to formalize motivation, it is necessary to define the notions of robot needs and drives, which are connected to the relevant objectives in many domains through experience. (Romero, A. et al., 2020). Students are motivated to develop a robot to help any disabled persons instead of a wheelchair.
- 2) Creative Idea development is just putting into practice various approaches to investigating concepts and creating solutions that best address the issue in the most efficient way. By determining the precise components of a concept that have the greatest impact, a pool of ideas is refined step by step (Digital Promise, n.d.). In this study, the creative idea of students is developed. The variety of robots to help disabled person are exposed. The teachers lead students to know an Automated Guided Vehicle (AGV) that can help the movement of the disabled person.
- 3) Design thinking method employs a non-linear, iterative process to comprehend people, question presumptions, reframe challenges, and develop original solutions for prototyping and testing. This method, which entails five steps (Empathize, Define, Ideate, Prototype, and Test), is particularly beneficial when used to problems that are unclear or unidentified (Interaction Design Foundation, n.d.). The mind map of AGV building is established in this stage. The design thinking is developed and 2D-3D drawing is applied to present the idea of students as shown in Fig. 3.

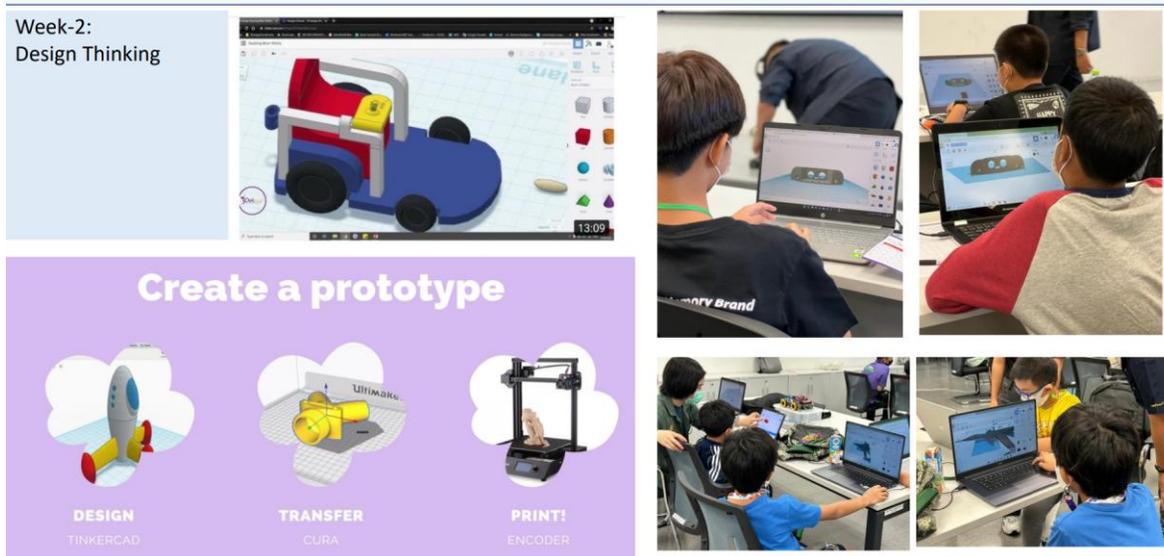


Fig. 3. 2D-3D drawing in the design thinking stage

- 4) Before the project's ultimate release, product development and bug corrections might take place during the prototype stage of software development. This can also apply to beta testing, where a limited group of users assesses the initial project before it undergoes full development. (Martinez, P., 2023). The students understand the important of the prototype stage together with developing a hardware, software and control system. In this stage, the students are learning by doing a AGV- prototype can be seen in Fig.4.

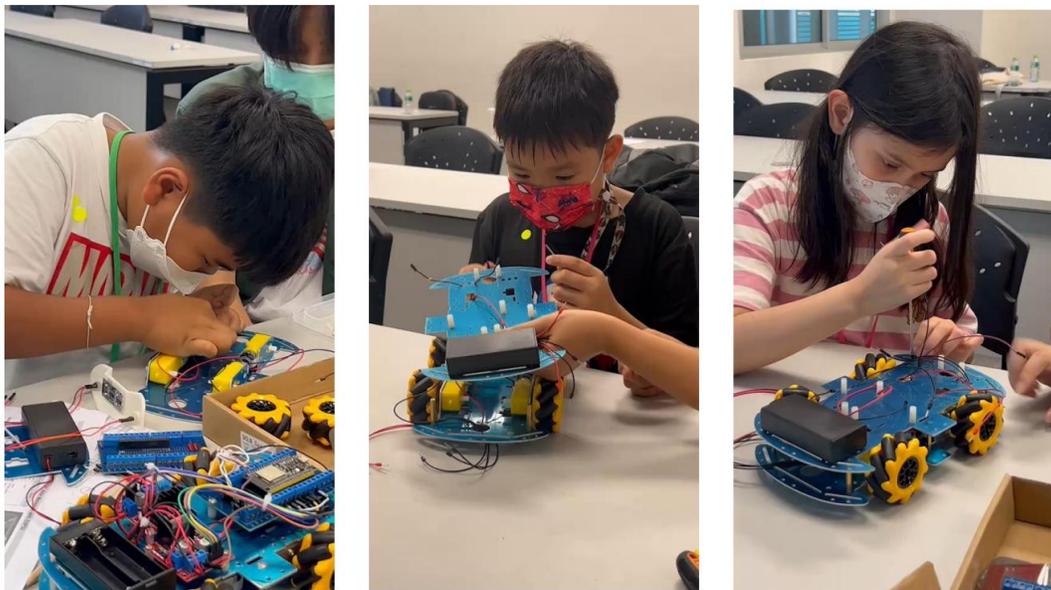


Fig.4. the AGV-prototype development.

- 5) Validation and troubleshooting are the process of ensuring that the issue you are attempting to address is pertinent and significant to the users who will be touched by it (Mondoka, M., 2022). In this study, the goal of problem validation is to gain a deeper understanding of the issue at hand and make sure that our efforts to find a solution will be fruitful. In this study, the robot kits as the Automated Guided Vehicle (AGV) was fabricated. The learning activities with AGV lead students to validate and troubleshooting the AGV as shown in Fig.5.



Fig. 5. AGV-Validation and Troubleshooting

- 6) The process of installing, configuring, upgrading, and enabling a single program or group of apps that make a software system usable, such as facilitating a specific URL on a server, is known as application deployment, also known as software deployment (VMware, 2023). In this study, Blink application to control the movement of the AGV is applied in this stage as shown in Fig.6.



Fig. 6. Blink application to control the movement of the AGV

- 7) This robotics education also has a purpose on creating self-esteem. Robotics will have a beneficial effect and have significant potential as a cognitive learning tool to improve students' self-worth and self-perception. In particular, the intervention reduced gender inequalities in self-esteem and showed positive inferences in both self-esteem and self-perception, with the latter having statistically significant effects as well (Eteokleous, N., 2021). In this stage, the self-esteem of students is developed through AGV competitions in a classroom. The award from the competition, receiving a certificate and AGV produced by the students can improve the self-esteem of students as shown in Fig.7.



Fig. 7. The awarding of certificates

3. RESEARCH METHOD

Focus groups are a qualitative data collection method that uses the encouragement of small group members to explain, argue, express opinions on discussion points. It is a technique that encourages group members of approximately 6-12 people to discuss and express their opinions widely on specific issues according to the aims, with a moderator who influence the group to express their opinions without anyone directing any opinion or decision. It is also a study technique with the interaction of group members and checking among themselves in the group, which is a two-way Communication (Teerawittayalert, 2016).

The 7-steps of innovative learning model has been applied to the 7-14-year-old in the iDektep project in Kasetsart University since year 2021.

To investigate how the learning model was the worthy guideline for the teachers to design of learning contents, activities, support tools and environments, six-key informants were in the Focus Group Discussion (FGD) consists of one senior engineer, one teacher from a primary school with 8-year teaching experience, three teachers from the iDektep project graduated from faculty of education, and two teachers from the iDektep project graduated from faculty of engineering.

To investigate whether the robotics kits (AGV) applied in the learning model encourage the students to learning by doing that can make themselves understanding and knowledge, ten students from the iDektep project were in the Focus Group Discussion (FGD).

4. Results and Discussion

Content and construct validity are efficient for validating your research equipment. Both assess the effectiveness of your research tool in slightly different ways. They can aid in assessment of how well the business owner understand their customers, products, and services. In order to satisfy customers and advance the business, the proper questions have to asked in the appropriate manner (Dovetail Editorial Team, 2023). The content and construct validity of the model were valid.

From FGD of the engineer and teachers, the 7-steps of innovative learning model was the worthy guideline for the teachers to design of learning contents, activities, support tools and environments related to the students' age and knowledge levels. Moreover, the learning contents and activities can be adjusted effectively for students in different age. The sequence and content of this learning model is represented to the innovative process as same as using in the industry.

From FGD of the ten students, the robotics kits (AGV) applied in the learning model encourage the students to understand the innovative process and engineering knowledge. The AGV stimulate students to focus and desire to study more about robotics. The teaching skill of teachers is the important make the students to understand the technology of AGV and the innovation development process. Most of students cannot explain about the 7-steps of innovative learning model. However, the students can describe the step-by-step of AGV prototype creation.

5. CONCLUSIONS

This paper has presented the 7-steps of innovative learning model with robotics kits: (1) Motivation and inspiration of creating robots (2) Creative idea development (3) Design thinking (4) Prototyping development (5) Validation and troubleshooting (6) Deployment application and (7) Self-Esteem with robotics competition. The Focus Group Discussion (FGD) with senior engineers from industries, teachers from primary schools and the iDektep project were evaluated the content and they then constructed validity of the model. The FGD and teachers' and students' perspectives on the learning model were then found as following, firstly the content and construct validity of the model were valid. Secondly, this model was the worthy guideline for the teachers to design of learning contents, activities, support tools and environments related to the students' age and knowledge levels. Thirdly, the robotics kits applied in the learning model encourage the students to learning by doing that can make themselves understanding and knowledge which were stimulated by teachers.

This study only designs and develops the learning innovation model to guideline the teachers and encourage the students to study a robotics in Thailand; therefore, the future research should focus on: 1) innovative skill of students is measured 2) the sample size should be expanded 3) the quantitative research method should be applied

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