Online ROBOT-STEM Activities on Outcome-based Learning

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Abstract: This paper presents how robot can inspire the young students through the online STEM activities. ROBOT-STEM knowledge management is based on the robotics engineering with the outcome based learning to improve the development level of learners. ROBOT-STEM activities are the demonstration of learning happened at the end of learning experience. R^2 Camp is organized by the robot, real estate and facility management to provide the real-world situation based on outcome based learning. Basic concept of robot and real estate management are introduced briefly, and then robotics application is presented. Evaluation is shown by pre-test and post-test. Results describe that the learners can reach the basic knowledge by 10.4%. Pre-test and post-test average scores are of 2.59 and 3.11, respectively.

I. INTRODUCTION

Robot is a kind of education tool that make students to enjoy the interactive way on technology. For example, an educational robotics cloud assist students acquire the soft skills as collaboration, communication and creative thinking. In [1], another prospective study has been shown that innovation effectiveness is influenced in the inventive mentality [2]. The concept of science, technology, engineering, math (STEM) is interesting for education in this digital world [3]. Several STEM in [4], [5], [6], [7] have been related on the technology-based learning. In [8], a set of soft skills in STEM which required the ability to adapt and change, a commitment to lifelong learning, good communications skills, and creative thinking for the 21st century skills. Moreover, an educational robot has been used to promote STEM learning in [9], and *PlatypOUs* is a mobile robot platform for developing and teaching STEM [10].

In addition, there are many researches related to the robot used as teaching tools. RoboSTEM education in [11] and the LearnBlock in [12] have been presented as an educational programming tool that robot can support learning using the cognitive apprenticeship theory [13]. Robot is a kind of assist technology tools that can enhance learning experiences for young people understanding in science and technology [14]. Explored maker-based approach is a way to create the educational robotics activities in online learning [15].

Fig. 1: Soft skills of 21st century skills [16].

The objective of STEM is to develop the soft skills as creativity, collaboration, communications of learners [3]. Active learning approaches [16] are highly beneficial for acquiring 21st century abilities, particularly soft skills in Fig. 1 that is described details below.

1) Creativity: Course assignments, projects, lectures, exams and laboratories are tools for teaching and learning methods.
2) Collaboration: Course assignments, projects, and laboratories are examples for learning methods.
3) Entrepreneurship: Project and lecture are examples of classroom practices.
4) Oral communication: Course assignments and projects are examples for teaching and learning process.
5) Written communication: Course work and report are used for teaching and learning methods.

Fig. 2: Robot activities.

Fig. 3: To promote R^2 Camp on Facebook.

Fig. 4: SANDEE Robot.

Outcome-based education (OBE) [6] with the student-centered education is an approach for the learning outcome of course in the lesson plan that instructor can design and develop the OBE activities using graphic, video and presentation. Fig. 2 shows that robot can inspire people to understand the technology.

The contribution of this paper is to introduce the robotics engineering in the online STEM activities with outcome-based learning. Online ROBOT-STEM activities named *R^2 Camp* has been organized by the robotics engineering and to demonstrate how soft skills applied in the online STEM activities in the real estate management to the real world. Therefore, the soft skills can develop the creativity and leadership responsibilities through the R^2 Camp.

This paper is organized as follows: Section II provides a brief overview of the R^2 Camp online STEM activities. Section III explains the online R^2 Camp platform. Section IV describes results and the conclusion is shown in Section V, respectively.

II. PROPOSED ONLINE ROBOT-STEM ACTIVITIES

According to COVID-19 pandemic in Thailand, the robot and real estate management camp (R^2 Camp) is the online ROBOT-STEM activities which has been organized to continue the learning from home and to provide activities through the online platform. The R^2 Camp started the promote on the Facebook page's department of Robotics Engineering, website:

https://web.facebook.com/RobotSSRU that students and interested people can join by online registration this camp as shown in Fig. 3.

A. ROBOT-STEM Activities on R^2 Camp

ROBOT-STEM activities are organized by the robotics engineering and real estate management. Fundamental of robot and real estate management are introduced briefly to make learner understand how theory is important to apply in the real world. Robot named SANDEE is representation of robot application on real estate management that learner can understand the real application as shown in Fig. 4. Fundamental of robotics engineering and real estate management are as follows.

1) Fundamental of robotics engineering: The topics of robotics engineering consist of:

- Topic of robot implementation and development is presented how to create and control a robot through the basic electronic devices and idea of internet of thing (IoT).
- Topic of Robot application in residential area is introduced how to apply a robot to replace a human work for well-being in the world.

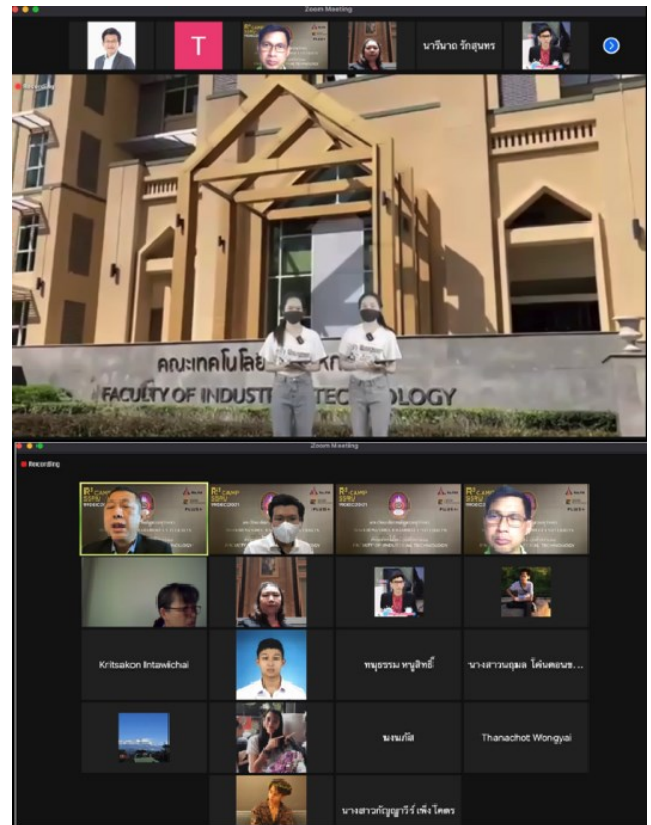Fig. 5: The online R^2 Camp platform.

Fig. 6: Online Open ceremony of R^2 Camp.

2) Fundamental of real estate management: The topics of real estate management consists of the real estate and facility management as follows:

- Overview of plus property & real estate and facility management is concerned with the facility management technologies.
- Topic of academic achievement of real estate and facility management is presented about collaborating with prominent enterprises that can lead the learner to understand about real estate business.

III. Online R^2 Camp Platform

The online R^2 Camp platform is available at *https://rbe.fit.ssru.ac.th* illustrated in Fig. 5. This online platform is organized as:

A. Open Ceremony

Online R^2 Camp started on December 19th, 2021. Online open ceremony is presented in Fig. 6. High school students and involved people logged into the Zoom meeting. Before the open ceremony, learners must take firstly a 15-minute pre-test about basic concept of robotics engineering and overview of real estate management concerning.

B. Presentation about robotics engineering

Robotics presentations in Fig. 7 and introduction to robot skeleton in Fig. 8 are available in video on web page with details below.

1) Design and development of robots: First, the speaker explains the meaning of a robot, which is a puppet that takes the form of a human. There are machines inside that can perform many tasks instead of human beings. There are 6 types of robots presented: industrial robots, service robots, operation robots, entertainment robots, stationary robots and mobile robots. Next, describe the structure of the robot: user interface, sensors, actuators, robot outlines and power supply. Finally, it leads to the way robots are built and developed: design, build, test and solve problems.

2) Topic of robotics for home/residences services: Speaker presents examples of works that have put robots into practical applications such as construction robots, floor cleaning robots, grill cleaning robots and lawn mowing robots. The learners discussed how they use robot cleaning in their home. This subject is connected to the soft skills.

At the end of each session, learners have a discussion time to share their experiences about robots in real life. After that, learners have to take a 15-minute post-test for the R^2 Camp assessment about basic concept of robotics engineering and overview of real estate management concerning.
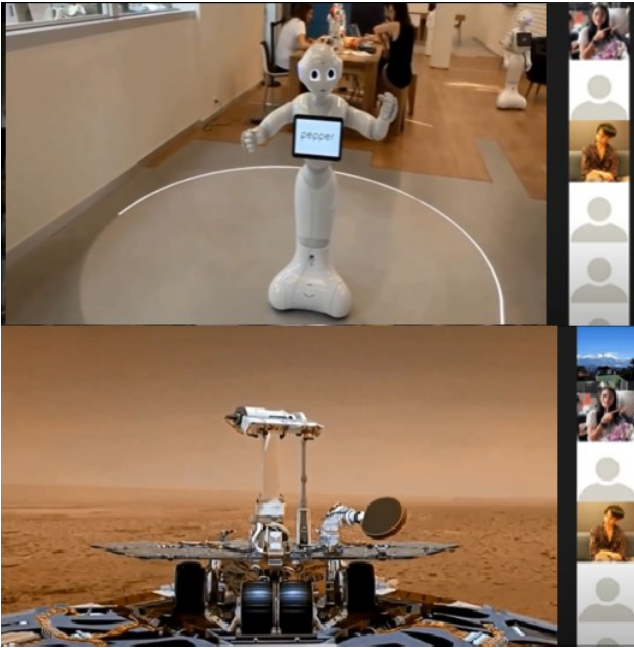
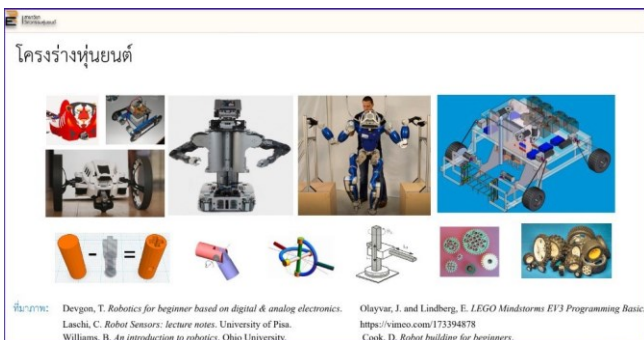Fig. 7: Presentation about fundamental of robotics.

Fig. 8: Introduction to robot skeleton.

Fig. 9: Presentation about overview of real estate management.

Fig. 10: Facility management concerning with the industrial revolution.

C. Presentation about real estate management

Robot and real estate management presentations are shown in Fig. 9. Speaker introduces the concept of facility management concerning with the industrial revolution shown in Fig. 10. Several robots are replacing human work in condominium such as robot for cleaning the pool and delivery robot. Robot named SANDEE shown in Fig. 4 in 3D video is used for helping learners who can develop their knowledge and inspiration. SANDEE robot is designed for delivery objects such as food and drink, letter and parcel within the condominium with alerts via the mobile application. SANDEE robot can carry a maximum weight of 80 kg.

Template of 3D glasses in Fig. 11 for 3D video are provided and available for download on web page. Learners can prepare their own 3D glasses to enjoy the 3D SIRI CAMPUS tour. Presentation of real estate management is presented in the 3D video of SIRI CAMPUS tour illustrated in Fig. 9 and facility management will lead students in their knowledge and skills as detailed below.

1) Overview of plus property & real estate and facility management: Speaker discusses the Plus Property about an introduction to facility management technologies, and give an example of seven jobs related to the facility management shown in Fig. 12. Growth rate of facility management market in 2019-2024 is presented in Fig. 13. Then, students discussed about the associated occupations in the real estate management.
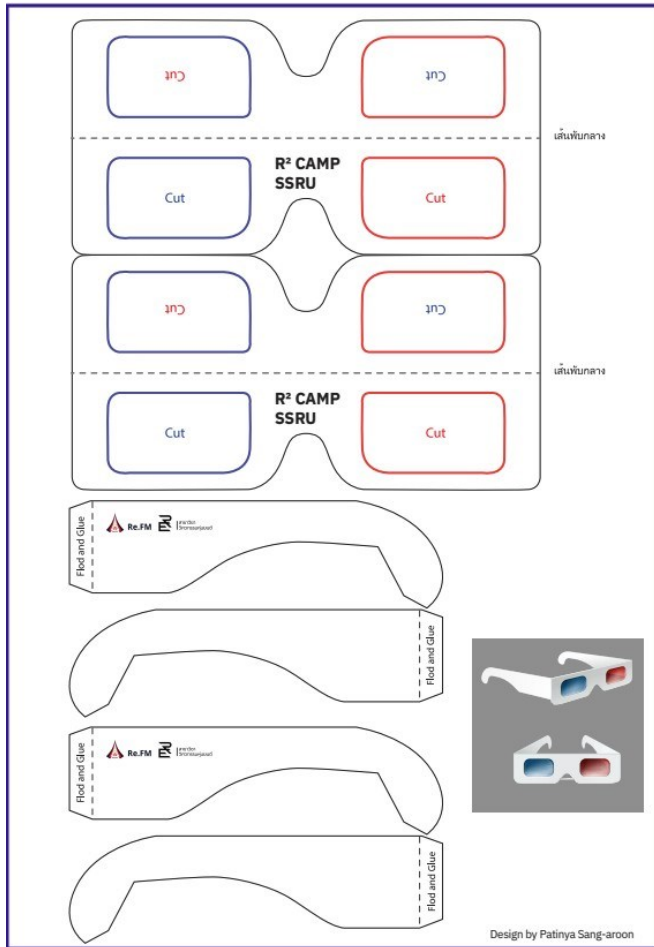
Fig. 11: Template for 3D glasses.

2) Academic achievement of real estate and facility management: Speaker describes the academic accomplishments of real estate and facility management and collaborating with prominent enterprises. In this session, students can ask the question to speaker and senior students on the employee about costs, pain points, job pressure and teamwork. After the Q&A session, students played the quiz games for souvenirs and took a 15-minute post- test about overview of real estate management.

D. Close ceremony and Questionnaire

Before receiving an online certification, learners have to do the satisfaction questionnaire. The satisfaction questionnaire of R^2 Camp for online STEM activities is designed to measure the learners' satisfaction with their learning. This questionnaire will help teachers and organizer of R^2 Camp to understand how satisfied students are and to evaluate and improve the online camp. It consists of four general questions, three essential concepts of the robotics and three concepts of real estate and facility management.

Fig. 12: Plus property.

Fig. 13: Growth rate by region of facility management market in 2019-2024.

IV. RESULTS AND ASSESSMENT

Online R^2 Camp started on December 19th, 2021 at Department of Robotics Engineering at Faculty of Industrial Technology, Suan Sunandha Rajabhat University. Learners and involved people logged into the Zoom meeting for joining the online camp. Firstly, learners must complete the pre-test in 15 minutes shown in Fig. 14 before an opening ceremony activity. These camp activities are then split into two contents as introduction to robotics engineering and overview of real estate management. Then, learners have to take a 15-minute post- test detailed in Fig. 15 and satisfaction questionnaire in Fig. 16 before closing ceremony. Finally, all learners will receive an online certification.
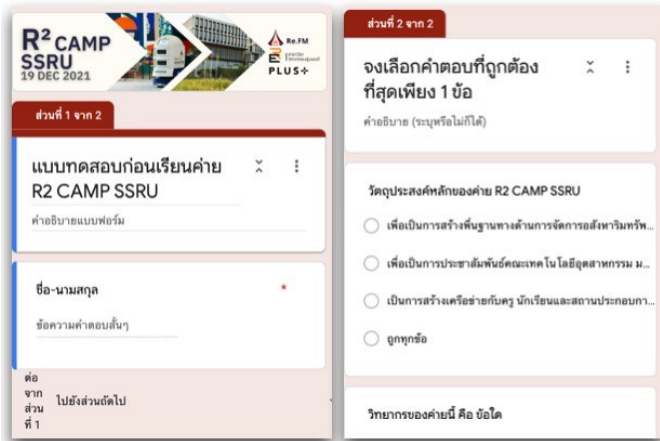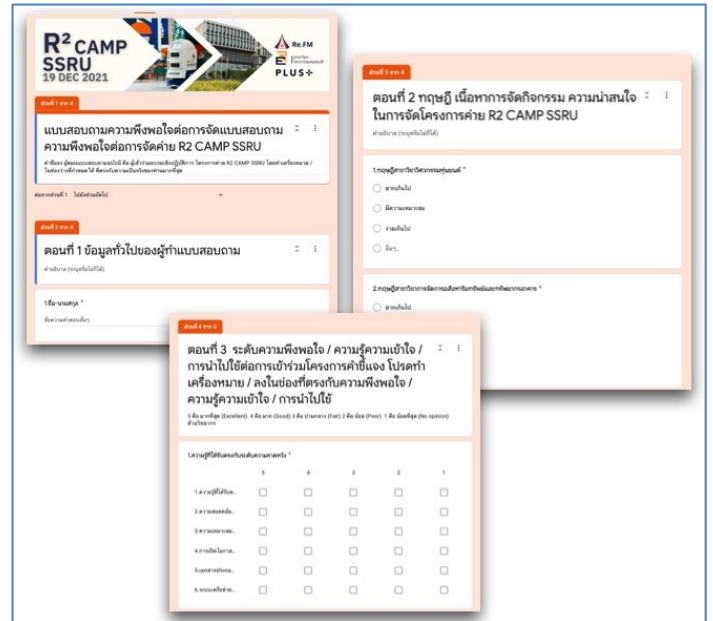
Fig. 14: Pre-test created by Google Forms.

Fig. 15: Post-test created by Google Forms.

R² Camp online STEM activities were attended by 17 high school students. The maximum score of pre-test and post-test is of 5. Table I shows the average pre-test and post-test scores of 2.59 and 3.11 with the standard deviation of 1.00 and 1.17, respectively. It is seen that the fundamental knowledge of learners has increased slightly by 10.4%. When working on this online camp, learners are happy, enjoyable and have a good experience. After joining the camp, learners will have an idea to plan their future job.

TABLE I: Pre-test and Post-test Scores.

Test	No. of Questions	Average score	Standard Deviation (SD)
Pre-test	10	2.59	1.00
Post-test	10	3.11	1.17

According to the satisfaction questionnaire in Fig. 16 for the online ROBOT-STEM activities, R² Camp is divided into three parts. The first parts contain four general questions concerning the background of high school students.

Fig. 16: The satisfaction questionnaire of R² Camp.

TABLE II: Results of R² Camp satisfaction questionnaire.

Part I: Satisfaction score of camp information notification	
Topics	Percentage
Departments' Facebook pages	66.70
CAMPHUB website	16.70
School guidance counsellor	16.70
Knowledge of robotics engineering:	
Difficult	16.70
Reasonable	83.30
Easy	0
Knowledge of real estate and facility management:	
Difficult	0
Reasonable	100
Easy	0
Video presentation of robotics engineering	83.30
Video presentation of real estate and facility management	100

The second section covers three essential concepts in robotics, real estate, and facility management. In the final section, there are six questions of the satisfaction in the R² Camp online ROBOT- STEM activities are included.

The results of satisfaction questionnaire consist of two parts as

1) Satisfaction score of camp information notification shown in Table II.
2) Conceptual components of satisfaction score shown in Table III.

The satisfaction results of 17 students from 14 to 18 years old are summarized as follows. Firstly, the satisfaction score of camp information notification are 66.7% of response from the departments' Facebook pages, 16.7% from the CAMPHUB website, and 16.7% from the school guidance counsellor.

TABLE III: Results of R^2 Camp satisfaction questionnaire (cont.).

Part II: Conceptual components of satisfaction score (max of 5)	
Topics	Score
Level of expectation	4.50
Correspondence of the camp activities to content	4.70
Appropriate time	4.70
Question & Answer	4.70
Provided document	4.70
Channels of communication and networks	4.70
Average satisfaction score of conceptual	4.67

Only 16.7% of students said that the knowledge of robotics engineering is difficult. All students thought the video presentation of real estate and facility management is reasonable and 83.3% of students are acceptable for robotics video presentation. Finally, the conceptual components of satisfaction score are as: the level of expectation is of 4.5, correspondence of the camp activities to content is of 4.7, appropriate time is of 4.7, Q&A is of 4.7, provided document is of 4.7, and channels of communication and networks is of 4.7. The average satisfaction score of conceptual is 4.67 of 5.

V. Conclusion

This paper introduces the active learning and outcome-based learning in online ROBOT-STEM activities for R^2 Camp. The goal of the R^2 Camp is to give the knowledge of robotics engineering and how to apply in the real estate & facility management. Then, SANDEE robot is an example of robotic applications in the real estate and facility management for delivery services. Soft-skills and outcome-based methods are modified on robotics for real estate services as well as in the real estate and facility management. We focused on both robotics and real estate and facilities management abilities during the events. This online camp was attended by 17 high school students with various background in science and technology.

The results demonstrate that the post-test of students' knowledge increased by 10.4% compared with the pre-test. It is noticed that 50% and 27% of R^2 Camp students have been enrolled in the department of robotics engineering and real estate & facility management, respectively. Finally, it may be concluded that R^2 Camp can inspire and motivate young people to interest in the robotics engineering and real estate & facility management.

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