A Study of Currents and Needs in the Computing Science Using a Robot for Online Learning

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***Abstract*—This study aimed to 1) Investigate current conditions and needs for studying computing science utilizing robots as learning resources. 2) Compare current conditions in computing science by using robots as learning resources across gender and class level. 3) Compare the needs of computing science by using robots as learning resources across gender and class levels. The sample of this study included 288 high school students from Thailand selected by convenience sampling. The questionnaire was used to explore currents and needs in computing science using a robot. The content validity of the questionnaire is accepted. The result of study showed that students were studying through lectures rather than the more effective learning style of critical thinking, which was the goal of the computing science courses. Students did not use robots for their class and lack of hand-on experiences. Therefore, students desire to improve their abilities by employing robots as learning aids and assembling electronic was a gender differences on some current conditions. Male students can pursue further education by themselves, and male students were more likely to practice critical thinking skills than female students. In addition, male students felt more motivated than female students. The difference between class levels found that grade 7 students had the most chances to use robots in their studies and enjoy the current learning approach in general skills. Students of grades 9 and 11 had more chances to practice coding than grade 12 students. Grade 7 students got more inspired to study computing science than their grade levels.**

***Index Terms*—Computing science, STEM, robots, currents, need.**

I. Introduction

Computing science is a discipline that emphasizes students' ability to think computationally. It uses fundamental knowledge of digital technology and media and information literacy by breaking down problem's components into smaller parts. It is then used to formulate an algorithm for problem solving through small projects that are integrated with other subjects and connected to real life. This process uses mathematics and science through engineering design processes and technology selection (STEM) that will help learners to respond to today's rapid changes [1]. According to Thailand's core curriculum of basic education (Revised Edition 2017), computing science disciplines replace subjects in the categories of technology, occupational, and technology divisions. There are three aspects to computing science principles: Computer Science (CS) 2) Information and communication technologies (IT) 3) Digital Intelligence (DL) [2], [3].

A robot is a machine tool that is composed of both hardware and software. that is meant to give functionality for the intended application and is either operated manually or automatically by the users. There are two types of robots: 1) Fixed Robot is a type of robot that cannot move its position by itself. It is often used in industrial applications. 2) Mobile Robot is a type of robot that can move by using its wheels or legs. This robot is widely used in schools to teach students how to program [4], [5].

In STEM education, robots have been used as a teaching aid and found that it improves student learning efficiency, academic performance, Computing thinking skills, and social skills. In addition, robots can also stimulate learners' curiosity with fun, exciting, and challenging activities [6]-[8].

Therefore, the current research is interested in studying the current condition and the needs for learning management using robots as teaching aid in computing science courses. The findings will serve as a guide for teachers and schools in terms of offering appropriate online learning activities and administration.

II. Research Objectives

The objectives of this research are to:

1) Investigate current conditions and needs for studying computing science utilizing robots as learning resources.
2) Compare current conditions in computing science by using robots as learning resources across gender and class level.
3) Compare the needs of computing science by using robots as learning resources across gender and class levels.

III. Research Methodology

A. Participants

The study used convenience sampling with high school students in Thailand. Thailand had a total number of 1,087,169 high school students in 2021, with 437,136 boys (40.2%) and 550,033 girls (59.9%) [9]. The current study included a sample of 288 high school students, comprising 93 males (32.3%) and 195 females (67.7%). The number of participants separate by gender is shown in Table I and separate by grade level is shown in Table II.

TABLE I: Frequency of Samples Separated by Gender

Gender	N	percent
male	93	32.3
female	195	67.7

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total	288	100.0

TABLE II: FREQUENCY OF SAMPLES SEPARATED BY GRADE LEVELS

Grade	N	percent
7	13	4.5
8	25	8.7
9	26	9.0
10	53	18.4
11	106	36.8
12	65	22.6
Total	288	100.0

B. Procedures

The study was authorized by the university under the code of research ethics. Participants were given a detailed explanation of the study aims and techniques for administering the questionnaire. The questionnaire did not identify any personal information and kept the study confidential. There were also no questions that had an emotional impact on the respondents.

C. Data Analysis

To investigate data distribution, the study used descriptive statistics such as frequency and percentage, as well as quantitative analyses such as mean and standard deviation. The t-test is used to determine if two samples are different by comparing their differences. The one-way analysis of variance (ANOVA) was also used to compare the mean of three or more groups to test class levels, on currents and needs.

D. Questionnaire

The procedures for creating the questionnaire are as follows:

1) Created a questionnaire based on interviews with computing science educators and related literature.
2) Three experts assessed the content validity of the questionnaire (IOC: Index of Item-Objective Congruence method). Each item's IOC index ranges from 0.67 to 1.00. As a result, this questionnaire may be used to gather information.

The questionnaire is divided into three sections:
Part 1: Respondents' general information
Part 2: Current condition
Part 3: Needs
In parts 2 and 3, the survey are 5-rating scales:
1 means the level of conformity is lowest
2 means the level of conformity is low
3 means the level of conformity is medium.
4 means the level of conformity is high
means the level of conformity is highest

IV. RESULTS

A. The Analysis Results of Current Conditions and Needs

The analysis results of the current condition in computing science course are shown in Table III.

From Table III, in general, two sections, *Instructional Strategies* and *Practicing Skills*, were at average levels ($\bar{x}$=3.46, S.D.=0.82 and $\bar{x}$=3.45, S.D.=0.89), while the *others* section was at high levels ($\bar{x}$=3.56, S.D.=0.84). The item "*Opportunity to use robots in my studies*" is the lowest average score ($\bar{x}$=2.75, S.D.=1.3), and the item "*I normally study through lectures*" received the highest average score ($\bar{x}$=3.89, S.D.=0.91).

TABLE III: THE ANALYSIS RESULTS OF THE CURRENT CONDITION IN COMPUTING SCIENCE COURSE

Current state	M	S.D.	Meanings
Instructional Strategies	**3.46**	**1.16**	**Average**
I normally study through lectures.	3.89	0.91	High
Teaching aids make it easier for me to absorb the information.	3.74	0.99	High
I often have the opportunity to participate in group activities and discuss ideas	3.62	1.03	High
I frequently learn from teacher demonstrations (e.g., teachers show how to use Tinker Cad, how to assemble a robot).	3.55	1.15	High
Overall, I enjoy the current learning style.	3.50	1.12	Average
I regularly engage in hands-on practice in the classroom. (e.g., assembly of robots, making video clips, etc.)	3.24	1.17	Average
Opportunity to use robots in my studies	2.75	1.30	Average
Practicing Skills	**3.45**	**1.09**	**Average**
I am constantly given opportunity to hone my skills in collaboration with others.	3.58	1.07	High
I am frequently given the opportunity to work on problems that are aimed at solving them.	3.54	1.06	High
I am frequently given opportunities to use my critical thinking skills.	3.53	1.02	High
I am constantly given the opportunity to practice coding.	3.16	1.17	Average
Other	**3.53**	**0.97**	**High**
I am excited to study computing science.	3.62	0.94	High
Learning environment in computing science is stimulating.	3.57	0.96	High
I am constantly inspired to study computing science.	3.50	1.00	Average
I constantly apply my knowledge of computing science in real life.	3.43	0.99	Average

The analysis results of students' need in computing science course are shown in Table IV.

TABLE IV: THE ANALYSIS RESULTS OF STUDENTS' NEEDS IN COMPUTING SCIENCE COURSE

Needs	M	S.D.	Meanings
ts in LearningoboR	**3.61**	**1.02**	**High**
The need to develop more coding skills	3.73	1.00	High
The need of robots to assist in the development of coding abilities	3.72	1.00	High

Needs	M	S.D.	Meanings
The need for activities that can assemble the robot by yourself	3.68	1.01	High
The need to practice block-based coding (e.g, Scratch programming)	3.61	1.04	High
The need to practice normal coding (e.g., C programming)	3.56	1.01	High
The need for online materials to study self-coding practice	3.55	1.00	High
The need for robotics-based activities to teach computing science	3.48	1.03	Fair
ctivityA earningL	**3.88**	**0.91**	**High**
The need for a space where activity in computing science courses can take place outside of classroom hours.	3.89	0.91	High
The need for activities that are incorporated into other courses	3.88	0.92	High
OSkills ther	**3.83**	**0.95**	**High**
The need for material that can be utilized in the actual world	3.93	0.96	High
The need for content related to electronic devices such as sensors, circuits, LEDs, small motors, etc.	3.88	0.91	High
The need to practice assembling electronic devices such as sensor circuits, LED circuits, small motor driver circuits, etc.	3.77	0.97	High
The need to practice thinking abilities step by step through activities such as flow chart design.	3.74	0.97	High

From Table IV, in general, all sections, *Robots in Learning* ($\bar{x}$=3.61, S.D.=0.79), *Learning Activity* ($\bar{x}$=3.88, S.D.=0.91), and *Other Skills* ($\bar{x}$=3.83, S.D.=0.96) were at high levels. The item "*The need for material that can be utilized in the actual world*" is the highest average score ($\bar{x}$ =3.93, S.D.=0.96), and the item "The need for robotics-based activities to teach computing science" received the lowest average score ($\bar{x}$=3.48, S.D.=1.03).

B. Comparison Results on Current Conditions across Gender and Class Level

Pertaining to analyzing the differences of gender on currents and needs in the Computing Science, the present results revealed that there were differences of gender on current states in three items.The first was the opportunities to use robots that the findings found that males had opportunities to use robots more ($\bar{x}$= 3.01, S.D.=1.40) than female ($\bar{x}$ =2.62, S.D.=1.24). The second item was that students gain opportunities to use their critical thinking skills. The results showed that male ($\bar{x}$= 3.71, S.D.=1.06) gained more opportunities to use their critical thinking skills than female students ($\bar{x}$=3.44, S.D.=0.99) at p< 0.05. Finally, there was a significant difference of gender on students' excitement to study computing science. The findings presented those male students ($\bar{x}$ = 3.80, S.D.=0.93) were higher excited to study computing science than female students ($\bar{x}$=3.54, S.D.=0.94).

The differences of gender on currents and needs in the computing science are shown in Table V. To find out the differences of grade levels on current states and needs, Table VI shows Descriptive statistics of some current state items differing for gender and Table VII shows the differences of grade levels on current states. The findings revealed that students in various grade levels had different opportunities to use robots ($F(5, 282) = 2.645$, $p < 0.01$). To consider each grade level, a Post Hoc Test found that students in first grade had the most opportunities to use robots, compared to students with other grade levels. In addition, students' enjoyment into the current learning style differed for grade levels ($F(5, 282) = 2.664$, $p < 0.01$). Students with the first-grade level enjoy the current learning style the most ($\bar{x}$=4.15, S.D.=0.90), compared to students with other grades. Furthermore, the opportunity to practice coding also differed for grade levels ($F(5, 282) = 4.057$, $p < 0.01$). a Post Hoc test showed that students with grades 9 ($\bar{x}$=3.58, S.D.=1.21) and 11 ($\bar{x}$=3.33, S.D.=1.14) got more opportunities to practice coding than students with grade 12 ($\bar{x}$=2.78, S.D.=1.31). Additionally, students in different grade levels had different inspiration to study computing science ($F(5, 282) = 2.581$, $p < 0.01$). The findings found that students in third grade ($\bar{x}$=3.85, S.D.=0.78) were more inspired to study computing science than those with other grades.

TABLE V: THE DIFFERENCES OF GENDER ON CURRENTS STATES IN THE COMPUTING SCIENCE

Item	Gender	F	t	df	Sig.
Opportunity to use robots in my studies	male	0.355	2.388	286	0.023*
	female		2.288	163.024	
I am frequently given opportunities to use my critical thinking skills.	male	1.509	2.098	286	0.043*
	female		2.042	169.183	
I am constantly inspired to study computat -ing science.	male	0.152	2.168	286	0.031*
	female		2.171	181.812	

*$p<0.05$

TABLE VI: DESCRIPTIVE STATISTICS OF SOME CURRENT STATE ITEMS DIFFERING FOR GENDER

Item	male		female	
	M	S.D.	M	S.D.
Opportunity to use robots in my studies	3.01	1.40	2.62	1.24

I am frequently given opportunities to use my critical thinking skills.	3.71	1.07	3.44	0.99
I am constantly inspired to study computing science.	3.65	1.06	3.44	0.97

TABLE VII: THE DIFFERENCES OF GRADE LEVEL ON CURRENTS STATES IN THE COMPUTING SCIENCE

Item	variance	SS	df	MS	F-ratio
Opportunity to use robots in my studies	Between Groups	21.976	5	4.395	2.645*
	Within Groups	468.520	282	1.661	
	Total	490.497	287		
I enjoy the current learning approach in general skill	Between Groups	16.420	5	3.284	2.664*
	Within Groups	347.580	282	1.233	
	Total	364.000	287		
I am constantly given the opportunity to practice coding.	Between Groups	26.526	5	5.305	4.057*
	Within Groups	368.804	282	1.308	
	Total	395.330	287		
I am constantly inspired to study computing science.	Between Groups	12.603	5	2.521	2.581*
	Within Groups	275.393	282	0.977	
	Total	287.997	287		

*P<0.05

Table VIII shows mean and standard deviation of some current state items differing for grade levels. The results using POST HOC test from TURKEY that shows in Table IX, revealed that students in grade 8 (=3.44, S.D.=0.87) received opportunities to practice coding more than students in grade 12(=2.78, S.D.=1.31). Moreover, students in grade 11 (=3.33, S.D.=1.14) received opportunity to practice coding more than students in grade 12(=2.78, S.D.=1.31).

TABLE VIII: MEAN AND STANDARD DEVIATION OF SOME CURRENT STATE ITEMS DIFFERING FOR GRADE LEVELS

Item	Grade 7		Grade 8		Grade 9		Grade 10		Grade 11		Grade 12	
	M	S.D.	M	S.D.	M	S.D.	M	S.D.	M	S.D.	M	S.D.
Opportunity to use robots in my studies	3.31	1.03	3.12	1.24	3.27	1.28	2.58	1.26	2.73	1.31	2.45	1.34
I enjoy the current learning approach in general skill	4.15	0.90	3.56	1.12	3.92	0.94	3.43	1.08	3.52	1.16	3.20	1.15
I am constantly given the opportunity to practice coding.	3.62	0.87	3.44	0.87	3.58	1.21	2.85	1.08	3.33	1.14	2.78	1.31
I am constantly inspired to study computing science.	3.85	0.69	3.48	0.77	3.85	0.78	3.34	0.94	3.63	1.17	3.23	0.88

TABLE IX: DIFFERENCE OF RECEIVING OPPORTUNITIES TO PRACTICE CODING FOR DIFFERENT GRADE LEVELS

Dependent Variable			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
item	grade					Lower Bound	Upper Bound
I am constantly given the opportunity to practice coding.	8	12	.792*	0.265	0.036*	0.03	1.55
	11	12	.546*	0.18	0.032*	0.03	1.06
	12	8	-.792*	0.265	0.036*	-1.55	-0.03
		11	-.546*	0.18	0.032*	-1.06	-0.03

*P<0.05

From Table X showed that almost 50% of participants never did ADDITIONAL RESEARCH ABOUT ROBOTS because they do not have a chance for using a robot. Therefore, they are not interest in studying a robot more. Furthermore, the findings showed that male (51.5 percent) did ADDITIONAL RESEARCH ABOUT ROBOTS more than female students (49.2 percent). in addition, from Table XI showed that a half of students in grade 7 and 9 did not be assigned a homework in Computing Science.

TABLE X: FREQUENCIES OF DOING ADDITIONAL RESEARCH ABOUT ROBOTS

behavior	male		female	
	f	Percent	f	Percent
Never	46	49.5	99	50.8
Less than an hour	30	32.3	63	32.3
1 - 3 hour	13	14.0	31	15.9
More than 3 hours	4	4.3	2	1.0
Total	93	100.0	195	100.0

Note(s): f = frequency

TABLE XI: FREQUENCY OF IN A WEEK, HOW MANY HOMEWORKS DO YOU HAVE? FOR STUDENTS IN GRADES 7 AND 9

item	grade 7		grade 9	
	f	percent	f	percent
No homework	6	46.2	11	42.3
1-2 homeworks	5	38.5	13	50
3-4 homeworks	1	7.7	1	3.8
more than 5 homeworks	1	7.7	1	3.8
total	13	100.0	26	100

Note(s): f = frequency

V. Discussion

A. Objective 1: Current Conditions and Needs

Students are now studying through lectures rather than the more effective learning style of critical thinking, which is the goal of the computing science courses. Students do not use robots for their class and lack of hand-on experiences. Therefore, students desire to improve their abilities by employing robots [10] as learning aids and assembling electronic parts, as well as practicing traditional and block coding [11].

B. Objective 2: Is There a Gender Difference in the Current Conditions and Needs?

The results of this study revealed that there are gender differences on some current conditions. Male students can pursue further education by themselves despite the fact that the school does not utilize robots as learning aids [12]. Male students are more likely to practice critical thinking skills than female students. In addition, male students felt more motivated than female students in this subject According to Sadler [13], female high school students are less engaged in STEM than male students, and interest in STEM is on the decline.

C. Objective 3: Is There a Difference between the Grade Levels in the Current State and Needs?

The findings revealed that grade 7 students have the most chances to use robots in their studies and enjoy the current learning approach in general skills. Students of grades 9 and 11 have more chance to practice coding than grade 12 students. Grade 7 students got more inspired to study computing science than their grade levels. These results are consistent with Chua Kah Heng that found that grade levels affected students' attitude on chemistry [14]. Richard Owino Ongowo [15] identified that students in grades 11 and 12 got the lowest scores on self-regulation and motivation for learning biology.

VI. Conclusion

According to the survey results, the teaching approach in the computing science courses mostly relied on lectures. This is in direct conflict with the course's objectives, which required students to think through the process of practicing various abilities in order to be compatible with 21st-century competencies. Furthermore, the teaching approach at each grade level is at odds with the government's policy. There is also a lack of essential instruments, such as robots, that can be used in learning to aid comprehension and develop critical thinking. As a result, the administrators or those involved should have clear policies and appropriate funding for schools.

VII. Limitation

In this research, a small number of convenient randomized samples were used. This may prevent the use of accurate statistical references to the majority of the population. The sample group in this study had a gender and stratification ratio not dispersed. The sample group had significantly more females than males. However, there are more female students in Thailand than male students. In addition, the number of students in each grade year is not the same. The next research may compare academic scores by different academic archivers.

Conflict of Interest

The authors declare no conflict of interest

Author Contributions

Nattanan Muenmaroung was the one who carried out the current study and prepared the article. Surachai Suksakulchai was in charge of developing research methodology and data collection methods. The questionnaire was created by Nattanan Muenmaroung and Wuttiporn Suamuang, who also served as the corresponding author. The final version was approved by Surachai Suksakulchai and Wuttiporn Suamuang.

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