Teachers' Perception for Integrating Educational Robots and Use as Teaching Assistants in Thai Primary Schools

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Abstract

This study focused on teachers' perception for integrating educational robots into learning and the feedback of teachers and students who used an education robot prototype as a part of learning. Data were collected from 510 primary school teachers who were used in a confirmatory analysis of factor model. Confirmatory Factor Analysis (CFA) indicated a good fit with a six-factor model in the observed data, which could be presented through six dimensions of robotic education quality, including social interaction, cognitive function, teaching method, learner characteristics, main features, and content. The prototype-testing phase was carried out using 5th grade students at a primary school in Thailand. The robot was tested for 10 hours, which included 20 students participating in the focus group. The research results showed that integrating the six dimensions of robotic education into the educational robot prototype resulted in a strong positive improvement in the focus groups learners' behavior and supported the instructors during the learning process. In contrast, some teachers lacked experience and confidence with robots integrated with LMS, which caused challenging obstacles in teaching. The results were achieved when integrating the six-factor model into education robots to improve student learning. Future researchers should expand their studies to look into the opportunities and challenges that teachers and school administrators face in the classroom.

1- Introduction

Technology is currently developing rapidly, meaning that children now grow up with digital appliances and various technologies from a young age, which has a significant influence on society, culture, and learning. In particular, 71% of learners aged 15-24 use the internet daily [1]. These learners' skills and willingness to use technology has resulted in education institutes increasing their use of technology in the classroom. Moreover, robots are highly important modern technology, and their use is expected to increase [2, 3]. Education research into the use of robots in the United States has focused largely on STEM learning (Science, Technology, Engineering, and Mathematics) [4]. These robots have been utilized to develop problem-solving skills and build comprehension of science and technology among primary school students.

Many studies have also used educational robots as class aids to enhance learning. Educational robots have been used to support in-class learning activities to stimulate learners to respond and interact with lessons [5, 6]. In addition, education robots have been used as a tool to inspire and support learning as well as in building learning experiences [7]. They have also been used to enhance learning, such as by using teaching assistant robots to teach learners of English as a second language (ESL) in primary school, or using teaching assistant robots to improve English as a foreign language students' understanding of science. The research found that the average pre-learning scores were lower than the post learning scores, with the students scoring 26.9% and 42.3%, respectively. Meanwhile, combining the teaching assistant robot with gamified teaching or gamification robots enhanced interaction between the lessons and learners as well as motivated their learning because the teaching assistant robots brought joyfulness, excitement, interaction, and made the learning engaging [8]. Chang et al. (2010) [8] separated the results into the use of robots for STEM, robots to act as teaching support, and teaching assistant robots to support learning by games.

Presently, educational robots designed with gamification in combination with lessons for language and brain development are of interest since such robots can enhance student engagement by attracting their attention [9]. However, it has been found that the gamification robot cost remains high, such as NAO and LEGO Mindstorms, which instructors could not use widely [10]. The problem of interface design was difficult to use and content and activities design was not appropriate with learners either. Instructors are therefore not able to use robots to help with teaching in schools in a broad manner [11]. In the present study, the researcher developed a gamification robot combined with online lessons to support learner achievement and engagement by developing cheap and effective robots and organizing new teaching and learning trends to enhance engagement through gamification. Teaching and learning by gamification can be described in two ways. First, it can involve building games for non-entertainment contexts or learning purposes, or second, it could involve converting existing lessons into game forms [12].

Previous studies have developed and integrated gamification for educational robots with instruction methods [13, 14]. Meanwhile, the use of robots has been found to affect skills development and problem solving with gamification among students [15], in addition to enhanced motivation, participation engagement, and interest [16]. Furthermore, learners' intention to learn, lesson comprehension, knowledge learning, skills, academic expertise, and engagement have improved through effective teaching and learning. Student engagement with their learning also affects their learning achievement. Participation and engagement involves integration between verbal and non-verbal activities, while gestures and facial expression are communication forms that support participation and engagement [17]. Teaching games have been proposed to stimulate participation and engagement, learners' attention, competitiveness, and through teachings, attitudes, and various skills, which have be found to contribute to learning. When games are developed and used in class, important factors include the nature, the role of the academic game, score criteria, and winning. Crucially, the designer must create a suitable design for gamified teaching in class.

An education robot was developed to enhance learners' participation and engagement with lessons, in part due to the robot being shaped like a toy and its ability to interact in an excited manner, which enhanced learner attention. The following research questions arise from the basis of the present study:

- How do teachers envision integrating educational robots into learning?

- What feedback did the teachers and students face as they used the education robot prototype as a part of learning?

This study is organized as follows: Section 2 proceeds with a critical factors literature review and presents the factors to maximize the design of educational robots as teaching assistants in Thailand. Section 3 describes the methodology, the quantitative and qualitative data collected for this mixed-methods research, and the research process in detail. Section 4 begins by presenting the analytical results for the construct validity utilized confirmatory factor analysis (CFA) to check the suitability and correction of the structural equation modelling and how data were collected and organized. Section 5 discusses the results and shows how education robots interacted with learners' feedback and improved student engagement. Finally, Section 6 presents the successes and challenges and answers the research questions.

2- Literature Review

Educational robots are a type of social robot that have been developed to enhance learners' participation and engagement with lessons. Many studies have reported the advantages of gamification for educational robots. However, few studies have reported the problem of gamification for educational robots facets of confirmatory factor analysis of quality factors to maximize the design of educational robots as teaching assistants in Thailand. To analyze the selected articles, we focused on systematic reviews and synthesized the findings over the past fifteen years to assess the influence of educational robots on children in the learning context. Six major factors were examined including (1) Social interaction, (2) Cognitive function, (3) Teaching method, (4) Learner characteristics, (5) Main features, and (6) Content.

2-1- Social Interaction

Actions or ideas transfer between individuals or groups of people with a teaching assistant robot educational and motivate children. Thus, the value of integrating children's learning comes from their social and emotional development.

In this study, actions or ideas transferred between individuals or groups of people with a teaching robot serve to educate and motivate children, meaning that the value of integrating children's learning comes from their social emotional development [18]. Integrating childhood education is derived from children's social development and their emotions from learning together. It is broadly accepted that robots can aid students' communication and ability to respond to others [19] by fostering participation and interaction between learners and educational robots [20, 21]. Previous results suggest that educational robots enhance the development of student abilities to participate in new activities and engage intellectual skills [22], creating good emotional relations, and responding to social needs. The result is the interaction that is more effective since they have the skills to understand others [23]. This supports good emotional relations and can increase the acceptance of social members. Therefore, robots can interact with humans in a friendly way and understand human emotions, in addition to expressing emotions through facial expressions, voice, gestures, and body movements in accordance with the conversation context [24]. Another study suggests that robots' sympathetic expressions affect children's positive sense [22], and most students responded that their main motivation was friendship with the robot [26]. Users of social robots must feel safe and comfortable, and the robot should match the user's personality. Additionally, robots capable of understanding user's feelings and emotions affected their attitude. A suitable emotional response to users was therefore important for the user's confidence and satisfaction, including acting upon the user's command. Robots involved in social interaction should perceive the user's social behavior and respond to their touch, and likewise be able to interpret and avoid obstacles. Thus, AI features are used in robots to facilitate interactions between humans and robots.

2-2- Cognitive Function

Cognitive function means that learners seek knowledge and learn new information [26]. Studies on the components of robotics for education have found that children have different learning potential that often depend upon their learning experience based on comprehension of the lesson, as well as their interpretation, understanding, and application of using robots [27]. In designing robot/student interactions, the robot must be able to evaluate a student's learning through a pre-test and post-test [28]. Furthermore, Eklundh, Kerstin, Anders Green, and Helge Hüttenrauch [29] discussed students' reflection to build interaction with educational robots, which could be useful for future robot design.

2-3- Teaching Method

In this study, teaching method refers to the content, teaching technique design, and learning procedure guidance to achieve learning targets [30]. The aim was to develop the learning and teaching design in schools integrated with educational robots [31]. Robots used as teaching aids affect student learning by developing their self-knowledge and self-test knowledge. From the study, educational robots were found to be suitable for the STEM (science, technology, engineering, and math) education curriculum in primary and secondary schools [6, 32]. Furthermore, McLurkin, Rykowski, John, Kaseman, and Lynch [33] evaluated the impact of educational robots in STEM education, and found their use to be effective, cheap and durable for education methods. Altin and Pedaste [31] concluded that the most popular methods were problem-based learning, constructivist, and competition-based learning. Moreover, other methods included discovery learning, communication-based learning, and project-based learning. Nag, Katz, and Saenz-Otero [34] support the use of robots in problem-based learning, which affects students' skills development in mathematics, physics, strategic planning, and meaningful communication. However, Altin and Pedaste [31] debated whether there might be a lack of evidence showing that STEM educational robots helped with discovery, learning, collaborative learning, problem solving, project-based learning, competition-based learning, compulsory learning, and meeting target achievements. Therefore, additional research is required to examine how teaching aids can be adjusted when using robots [35], while teachers must receive training on how robots can be used in the classroom [13].

2-4- Learner Characteristics

Learner characteristics refer to the age and sex of the learners' specific characteristics, such as learning interest. UTAUT (Unified Theory of Acceptance and Use of Technology) is used to evaluate robot technology acceptance [36]. The following elements have been identified as directly influencing technology acceptance: Expectation of effectiveness, expectation of ease of use, and social influence [36]. Age, sex, and voluntary use were used as control variables for technology acceptance.

2-5- Main Feature

The main features required for the robot include robot operation stability and ease of use, as well as other characteristics such as not being a danger to children. Surveys found that many details about the acceptance of using robots [36], with the main qualification of robot being "easy to use," confidence with using a robot, followed by the safety rules and working stability [37]. Additional robot characteristics include being durable for use with children [38].

2-6- Content

It is important that the teacher make a decision about the course content that is most appropriate for the course. At present, technology has developed rapidly and robots are increasingly used in schools [39]. At the same time, the current generations of school-aged children have become used to using modern technology [2]. Meanwhile, studies have found that robots influence children's understanding and development of foreign language skills, social interaction, and ethics [6, 40, 41] because they stimulate learning interaction and participation in learning activities [5, 6]. Moreover, Mubin, Stevens, Shahid, Al Mahmud, and Dong [42] and Benitti [13] revealed that the TARAL robot could aid student learning of foreign languages, science, and technology. Similarly, other studies found that teaching robots aid primary schools to develop learning interaction and stimulate participation [8, 43]. In addition, they also help students interested in learning a foreign language [5] and telling a story. Barker and Ansorge [44] showed that students' learning achievement improved by using robots in science, while Kazakoff, Sullivan, and Bers [45] found that robots help the learning of how to write operation control programs. Other researchers have suggested that robots are effective at helping the learning of science, engineering, and technology [46, 47].

3- Methodology

In this study, both quantitative and qualitative data were collected for this mixed-methods research. Qualitative interviews and a quantitative survey were combined to examine the factors relating to teachers' perception on the quality of educational robots.

The order of the methodology steps is as follows (Figure 1):

- A literature review was conducted to explore contextual factors relating to educational robots by selecting systematic reviews.

- Focus group interviews were conducted with professionals to verify and confirm the contextual factors and create a model.

- For sample and data collection, a survey on proposed model questionnaire was created containing 21 questions, which were divided into six factors of (1) social interaction, (2) cognitive function, (3) teaching method, (4) learner characteristics, (5) main features and (6) content. Confirmatory Factor Analysis was carried out using LISREL to examine the structure of the contextual factors (CFA model).

- Prototype development was used as a step to develop a prototype for gamification robot from the gamification theory.

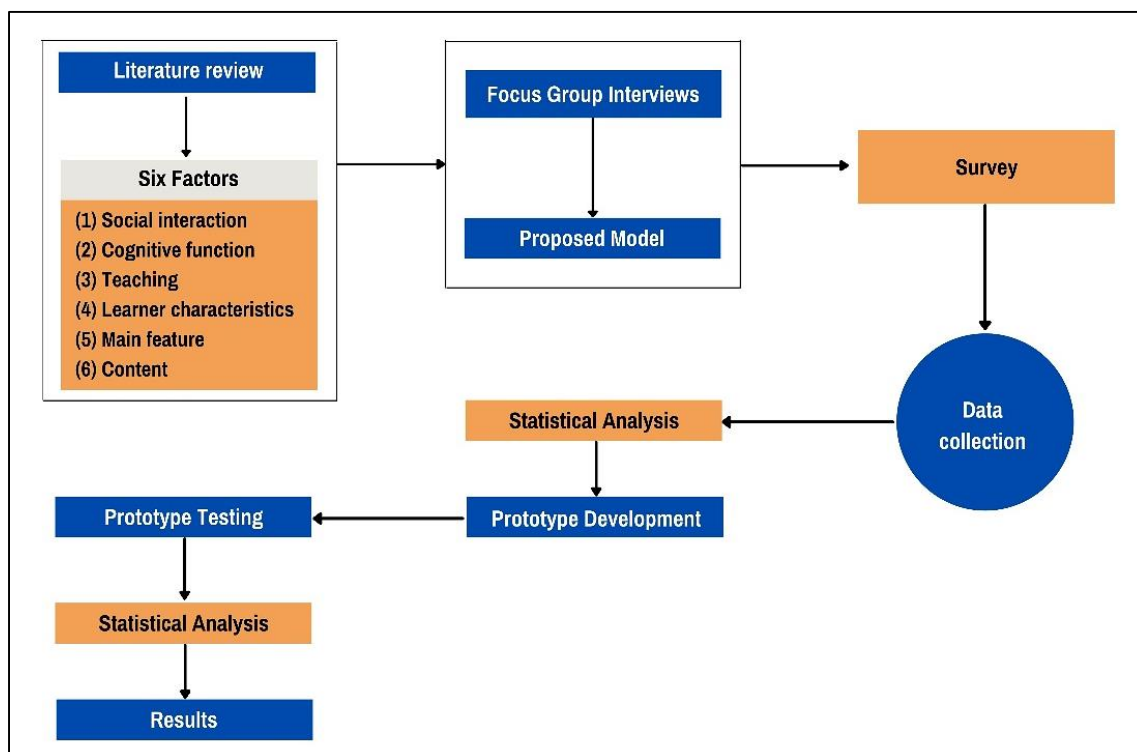- Prototype testing was conducted on the robot for 10 hours among 20 students at a primary school.

Figure 1. Research methodology steps.

3-1- Sample and Data Collection

Survey data was collected from primary school teachers after developing the 21 questions based on the six related literature reviews: (1) Social interaction, (2) Cognitive function, (3) Teaching aid, (4) Learner characteristics, (5) Main feature, and (6) Content.

Data were collected from 19 schools by multi-stage sampling, which were categorized separated by school size, (small, medium, and large) from all schools in Thailand. The data collected from school instructors could then be then separated into 255 public school sets and 255 private school sets.

Data were collected from 510 primary school teachers, of which 78.6% were female and 21.4% male, while 34.9% were aged between 21-30 years and 29.41% were aged between 31-40 years. From the sample, 31.6% had over 10 years of work experience. The sample group of teachers taught Thai (15.5%), Mathematics (14.5%), English (11.6%), and Society (10.2%) (see Table 1). The sample group included teachers of Prathomsuksa 1 - Prathomsuksa 6 (Primary school first to sixth grades) at similar percentages (see Table 2).

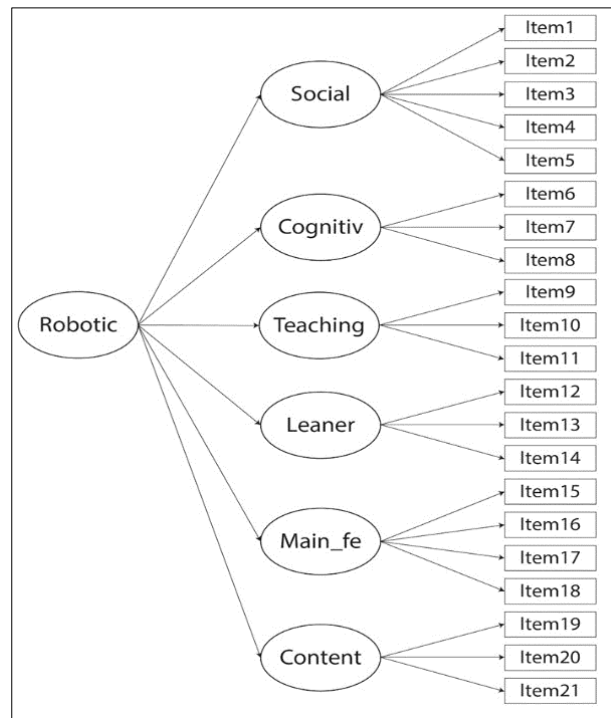**Table 1. Teaching sampling group by subject (N=510).**

Sample characteristics	Frequency	Percentage
Thai	79	15.5
Mathematics	74	14.5
English	59	11.6
Society	52	10.2
Science	50	9.8
Physical/ Health education	46	9.0
Computer/ Information computer technology	33	6.5
History	22	4.3
Music/ classical dance	18	3.5
Occupation	17	3.3
Art	16	3.1
Chinese language/foreign language	14	2.7
Mathematics/Science	10	2.0
Others	9	1.8
Early childhood/learner improvement	8	1.6
Integration/ Project	3	0.6

Table 2. Class teaching sampling (N = 510).

Sample characteristics	Frequency	Percentage
Prathomsuksa 1 (1st Grade)	144	28.2
Prathomsuksa 2 (2nd Grade)	138	27.1
Prathomsuksa 3 (3rd Grade)	155	30.4
Prathomsuksa 4 (4th Grade)	140	27.5
Prathomsuksa 5 (5th Grade)	167	32.7
Prathomsuksa 6 (6th Grade)	169	33.1

Questionnaires were mailed to the sample group. The questionnaires were divided into six sections (Figure 2): (1) Social interaction (Social) of learning aid robot, (2) Cognitive function (Cognitiv) of learners by using learning aid robot, (3) Teaching aid (Teaching) by using learning aid robot, (4) Learner characteristics (Learner), (5) Main feature (Main_fe) of learning aid robot, and (6) Content (Content) of subject for learning aid robot.

Figure 2. Model structure of the teaching aid robot for primary school learners.

The analytical results of the Correlation matrix by Bartlett's Test of Sphericity Chi-Square ranged from 499.138-1218.173, d_f between 3-10 and $p = 0.000$, which was significantly different at 0.01, showing that the correlation coefficient of the observed variables was not the identity matrix, and that the variables were sufficiently related to be able to analyze the composition. The index value of Kaiser-Mayer-Olkin (KMO) was 0.649-0.845.

4- Analysis and Results

The analytical results for the construct validity utilized confirmatory factor analysis (CFA) to check the suitability and correction of the structural equation modelling by confirmatory factor loading and R^2 check for the variation indicator (Table 4). The analytical results from the perspectives of teachers to help teach in primary schools can be separated into six factors (Table 5): (1) Social interaction, (2) Cognitive function, (3) Teaching, (4) Learner characteristics, (5) Main_Fe, and (6) Content.

4-1- Factor 1 Social Interaction

The component variables of social interaction had a construct reliability (ρ_c) equal to 0.877. Considering the observed variables for social interaction factor, it was found that the indicators that had the most important weight for identifying social interaction factor were robot built friendly (item 2), which had a weight value of 0.77, while the covariance value (R^2) of the indicator for the social interaction factor equaled 56%. This was followed by the weight of the indicator for robot with artificial intelligence (AI) for sensing, interpretation, and responding (item 5), which equaled 0.73, while the covariance value (R^2) of the indicator for social interaction factor equaled 64.0%. The least weighted variable of social interaction was likely to be the robot is shaped like an animal or cartoon, which attracts attention (item 4). This variable had a weight value of 0.62, while the covariance value (R^2) of the indicator for the social interaction factor equaled 46.0%.

4-2- Factor 2 Cognitive Function

The component variables of cognitive capacity had a construct reliability (ρ_c) equal to 0.889. Considering the observed variables for cognitive function, it was found that the robot installed with a pre-test program (item 6) had the most important weight in determining the measurement of cognitive capacity (cognitive capacity) with the highest weight variable equal to 0.80, while the covariance value (R^2) of the indicator of cognitive function factor equal to 78.0%. The least weighted variable of cognitive function factor was the robot was given recommendations from learners (item 8), which had a variable weight equal to 0.76, while the covariance value (R^2) of the indicator for cognitive function factor equaled 62.0%.

4-3- Factor 3 Teaching Method

The component variables of the teaching method had construct reliability (ρ_c) equal to 0.806. Considering the observed variables for teaching method factor, it was found that the variable with the highest weight of teaching method

factor indicator was robot cooperated with teaching by problem-based learning (item 10) with the highest weight variable in teaching method factor equal to 0.67, while the covariance value (R^2) of the indicator for teaching method factor equaled 62%. The least weighted variable of the teaching method factor was robot aided teaching by project-based learning (item 11), which had a weight of 0.58, while the covariance value (R^2) of the indicator for the teaching method factor equaled 53.0%.

4-4- Factor 4 Learner Characteristics

The component variables of learners' characteristics construct reliability (ρ_c) equaled 0.767. Considering the observed variables for learner characteristics, it was found that the most important indicator was learner attention, which was important to education quality by learning aid robot (item 14) with a weight of 0.77, which had a weight of 0.58, while the covariance value (R^2) of the indicator for the teaching method factor equaled 78.0%. The least weighted variable of the learner sex was important to education quality by learning aid robot (item 13) with a variable weight of 0.48, while the covariance value (R^2) of the indicator for the teaching method factor equaled 23.0%.

4-5- Factor 5 Main Feature (Main_fe)

The component variables of main feature factor has a construct reliability (ρ_c) equal to 0.926. Considering the observed variables for main feature factor, it was found that the most important was the robot was easy to work with (item 16), with the highest weight variable equal to 0.83, while the covariance value (R^2) of the indicator for the cognitive function factor equaled 79.0%. The least weighted variable of the main feature factor was physicality of the robot (item 17) with a variable weight of 0.80, while the covariance value (R^2) of the indicator for the main feature factor equaled 78.0%.

4-6- Factor 6 Content

The component variable of content had a construct reliability (ρ_c) equal to 0.918. Considering the observed variables for content factor, the most important variable was using a robot aid in technology teaching (item 21), which had a weight of 0.79, while the covariance value (R^2) equaled 81.0%.
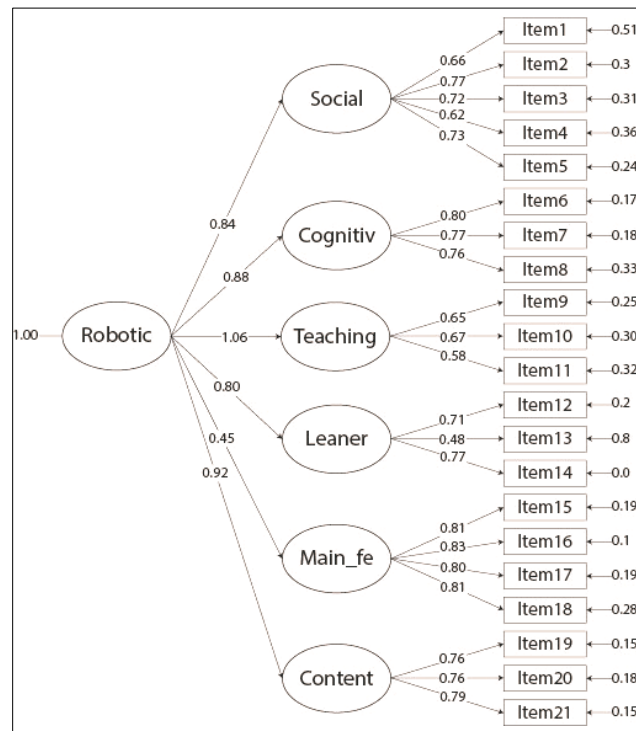

Figure 3. Analysis of the goodness of fit indices in education quality with a learning aid robot.

4-7- SEM Analysis

SEM analysis was conducted for hypothesis testing by Maximum Likelihood using the LISREL program by considering the statistics used as indicators for six items, namely χ^2, CFI, GFI, AGFI, RMSEA, and SRMR (see Table 3). In this study, the hypothesized theoretical model showed a good fit with the collected data. The goodness of fit provided evidence that the hypothesized model was stable, in which ($P-value > 0.05$). The best fitting solution is illustrated in Figure 3. All estimated path coefficients were significant.

Table 3. Fit indices of six components.

Fit measure	Criterion	Model Value	Note
χ^2/df	< 2.00	1.296	Fit
CFI	> 0.95	1.000	Fit
GFI	> 0.95	0.970	Fit
AGFI	> 0.90	0.950	Fit
RMSEA	< 0.05	0.024	Fit
SRMR	< 0.05	0.021	Fit

Table 4. Factor loading weight of dimension for the model of education quality by learning aid robot from teachers' perspectives.

Variables	B	beta	SE	t	R^2	Factor score coefficient
Education quality by learning aid robot (Robotic_EDQ)						
Social interaction (Social)	0.84	0.94	0.057	14.76	0.89	0.11
Cognitive function (Cognitive)	0.88	0.92	0.040	21.89	0.85	0.15
Teaching aid (Teaching)	1.06	1.00	0.048	22.15	1.00	-0.03
Learners characteristics (Learner)	0.80	0.76	0.051	15.61	0.58	0.42
Main feature (Main_fe)	0.41	0.45	0.091	4.49	0.70	0.30
Content (Content)	0.92	0.90	0.042	21.71	0.82	0.18

Table 5. Summary of factor analysis items and factor loadings.

Items	Factor Loadings					
	1	2	3	4	5	6
Factor 1 Social Interaction						
1. Robot's emotional expressions stimulated learning (by robot voice, facial expression, happiness, sadness, amazement, fear, and body movement).	0.66					
2. Robot is friendly with learners (by smiling, greeting, getting along with them, inviting to play games, telling a story).	0.77					
3. Robot stimulated attention (by blinking lights, noise, and touch).	0.72					
4. Robot is shaped like an animal or cartoon, which attracts attention.	0.62					
5. Robot has artificial intelligence (AI) for sensing, interpretation, and responding.	0.73					
Factor 2 Cognitive Function						
6. Robot is installed with a pre-test program.		0.80				
7. Robot is installed with a post-test program.		0.77				
8. Robot was given recommendations from learners.		0.76				
Factor 3 Teaching Method						
9. Robot cooperated with the teaching method of play-based learning (games and rewards, levelling up to increase the challenge).			0.65			
10. Robot cooperated with teaching by using problem-based learning (learner-centered teaching was stimulated by using problems to motivate learners to seek knowledge and solve problems).			0.67			
11. Robot aided teaching by using project-based learning (teaching is student-centered, wherein students gain deeper knowledge and understanding through self-knowledge and project work).			0.58			
Factor 4 Learner Characteristics						
12. Age of learners was important to education quality by learning aid robot.				0.71		
13. Sex of learners was important to education quality by learning aid robot.				0.48		
14. Attention level of learners was important to education quality by learning aid robot.				0.77		
Factor 5 Main Feature (Main_fe)						
15. Robot worked steadily (continuously for a long time).					0.81	
16. Robot was easy to work with.					0.83	
17. Robot was safe and not physically dangerous to children.					0.80	
18. Robot was patient with children.					0.81	
Factor 6 Content						
19. Robot was used as a teaching aid in foreign language learning.						0.76
20. Robot was used as a teaching aid in science learning.						0.76
21. Robot was used as a teaching aid in technology learning.						0.79

4-8- Prototype Development

The results from confirmatory factor analysis (CFA) showed that the friendliest robot shape is likely to be an animal toy or cartoon, which should be friendly, interesting, and respond to learners. Robots interested learners to present and respond to its facial expressions. Aspects influencing the design of the educational robots included attractiveness, intractability, strength, compactness, portability, and cost. In this study, an educational robot prototype called TARAL (Teaching Assistant Robot as Active Learning) was created from the results of confirmatory factor analysis (CFA), which was designed for the specifications of the gamification robot to be compact, portable, and suitably shaped for primary school students [24]. In addition, the robot was required to be able to speak and make sounds to stimulate learners during teaching and learning activities. Furthermore, research and evaluation was required to test and evaluate the robot using qualified tools. The gamification robot was developed from the gamification theory. Thus, the external shape was designed to be a light, portable toy capable of communicating with learners through eye color (grey, blue, green, violet and pink) to show the learner's progress. It also had a loudspeaker to greet learners with expressions such as "Let's play a game", "I am hungry", "Excellent", and "Good job" to enhance engagement between the learners and robot (see Figure 4).

Figure 4. Overview of the TARAL Robot's hardware structure

The robot was developed from a Raspberry Pi 3 Model B board running on Python. A multi-thread working interface with an LCD screen was used to show the robot's eyes. It was connected to a loudspeaker for the robot's voice, and had a camera to evaluate learners' QR codes. Furthermore, the body of the robot was constructed using a 3D printer (see Figure 5).

Figure 5. Internal structure of the TARAL Robot

The gamification robot was linked with a Learning Management System (LMS) (Figure 6) using an opensource model as the main system. For instance, the course content of the LMS system and developed plugin system acted as the supplementary system of function. The level-up system was developed to generate QR codes so that the learner could scan to interface with the robot [27].
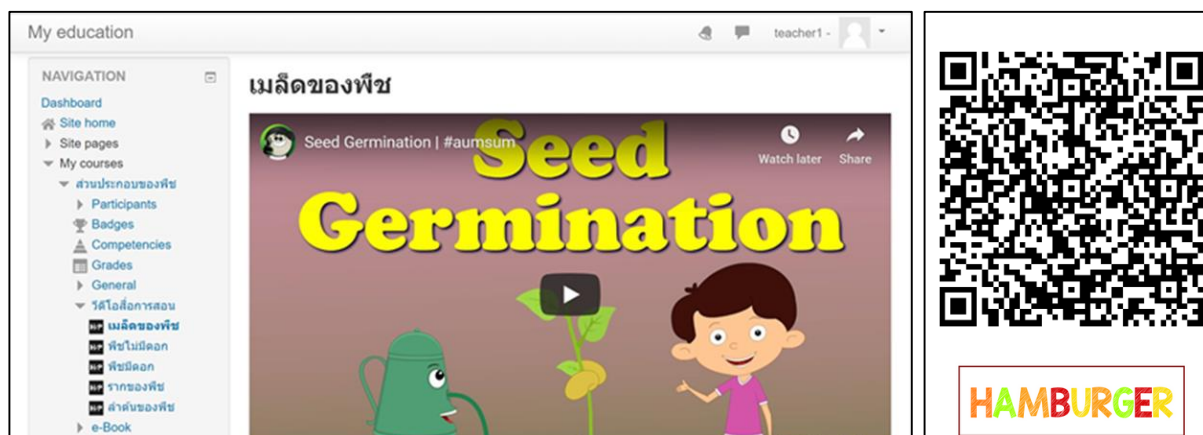

Figure 6. Learning Management System (LMS)

4-9- Prototype Testing

The teaching and learning process started from students accessing the LMS that used a module system separated into two parts. First, instructors can add any subject material onto the system through various channels (VDO, E-Book, or URL). Furthermore, the instructors could evaluate students' learning by creating tests for them to complete, such as Subjective Tests and Objective Tests. Second, learners could study five lessons given by the instructor. In Prathomsuksa 5 (5th Grade), the students learned about plants in the science group, which comprised seeds, non-flowering plants, flowering plants, roots, and plant structures. The student learning content was divided into five subject levels so the teacher could set the content priority and students could select their own avatars. After that, the avatars had to be raised by taking a quiz.

The robot was tested for 10 hours at a primary school, with 20 students participating in focus groups. All the students did a pre-test, middle test, and post-test. The quiz included pre-learning and post-learning skills with 4 choices, 5 topics, and 10 questions for each topic for a total of 50 questions. The quiz also included an exercise with five topics that had 10 questions each for a total of 50 questions. The researcher used t-test statistics for data analysis and found that the average learner score with the gamification robot and mobile application had higher post-test thinking skill scores ($\bar{\chi} = 35.70$, SD = 10.14) than the pre-test scores ($\bar{\chi} = 19.50$, SD = 7.10)) Sig=0.000<0.05. It was found that the average score after learning with the gamification robot with the mobile application was higher for post-learning engagement ($\bar{\chi} = 172.55$, SD = 20.27) than the score for pre-learning engagement ($\bar{\chi} = 110.60$, SD = 25.14) (Sig=0.000<0.05).

5- Discussion

Technology plays an important role in the classroom, and education robots can interact with learners' feedback joyfully and improve student engagement with lessons. In this study, developed education robots using the results from confirmatory factor analysis showed improved learning. The factor analysis showed the weight separated into three groups (Table 4): 1) over 0.85; 2) between 0.85 - 0.5; and 3) under 0.5. The characteristics and feedback of the teachers and students used robot prototype of each group are described as follows: The first group characteristics were related to teaching, while the second group was learning and teaching development and activities, and the third group was the robot specifications. For the first group, the teaching method weight was the highest at 1.06 (the highest effective dimension). The learning and teaching development and activities in which learners could learn anywhere at any time, and where many learners could learn simultaneously as the robots stayed with each learner [48]. The feedback from learners showed that the robot could be taken anyway thanks to its low weight, and it could react, speak, be fed, and respond with either a voice or song. The teaching method by an academic computer game involving both exercises and skill practice comprised the objectives, rules, competition, challenge, imagination, entertainment, and control. The instructor could evaluate the learners in real time by engineering analysis data, i.e. by fixing start times and enabling quiz scores to be analyzed quickly, while predicted future learning results would adjust adaptive questions [47].

The second group involved learning and teaching development and activities. The feedback from the learners showed that emotional development and engagement were used so that the robot could react to the learners enthusiastically, in an exciting way, and ensure that the learners enjoyed the activities by engaging with it and attempting to answer questions as correctly as possible [49]. Learners received real items form the instructor, such as hats, socks, scarfs, badges, and so on, which were the same items they received from the computer game shown on the screen in order to

stimulate and motivate the learner to learn. Most learners commented that the school should use robots. From the interviews, most of the instructors who used the robot commented that the learners were more interested in learning and attempted to level up quickly [50]. Sometimes, instructors warned their learners to study the pre-test lesson in advance, but the teachers had to remind them to study the lessons ahead of the e-learning system. From observations, it was found that the learners were interested in learning from the robot's reactions robot at a satisfactory level, with an average pilot period of 10-15 hours. The instructors at each school actively assisted in the experiment, which was also well supported by the schools [26]. Furthermore, the teaching and learning arrangement depended on the readiness of learners, including their responsibility and discipline, while the challenge of learning affected the success of the test [18, 51].

For the third group, the robot specifications, it was found that the main features (Main_fe) had a weight of 0.41. The feedback on robot specifications included it being small, easy to carry, cute, and light. The specifications were suitable for learners [52]. The interactive robot was based on the game concept and was a tool for teaching and a learning aid, while it could also be used for competition, support, challenge, and engagement, which complied with the idea to link the game to mobile application software and comply with robot technology standards [53].

6- Conclusion

The objective of this research was to determine how teachers envision integrating educational robots into learning. Prototype testing found that the education robot designed from the confirmatory factor analysis (CFA) results served to improve the focus group learners' behavior and support the instructors during the learning process. As for the first research question, we concluded that teachers envision integrating educational robots into learning six major factors examined as (1) Social interaction, (2) Cognitive function, (3) Teaching method, (4) Learner characteristics, (5) Main features, and (6) Content presented a good fit. The research showed that the teaching method and teaching development and activities are most important and needed to succeed in education robots learning. Previous studies have shown that education robots need to be supported by instructional design. Education robots could be integrated into a pedagogical strategy for the benefits of students' learning and development. The connection between activities would create more effective learning. Regarding the second research question, feedback from this study indicates several of the successes and challenges that teachers may encounter when integrating robotics into their teaching activities. In terms of success, students were very interested in the robot; learners were interested in the robot because of the robot's speech, voice, and eye color changes when they levelled up. The impact of the robot uses engagement for students' learning. Integrated LMS with robots was shown to be a challenge. Some students had a short attention span, while some teachers lacked experience and confidence with robots integrated with LMS. The biggest challenge for teachers and students is to be more dedicated outside of the classroom. This will reveal possible opportunities for teachers to use education robots to improve student learning and engagement. Future researchers should expand their studies to look into the opportunities and challenges that teachers and school administrators face regularly in the classroom.

7- Declarations

7-1- Author Contributions

Conceptualization, methodology, software, validation, formal analysis, investigation, resources, data curation, K.P., N.S., K.P. and N.S.; writing - original draft preparation, writing - review and editing, visualization, K.P. and N.S.; supervision N.S.; project administration, N.S.; funding acquisition, K.P. and N.S. All authors have read and agreed to the published version of the manuscript.

7-2- Data Availability Statement

The data presented in this study are available on request from the corresponding author.

7-3- Funding

7-4- Conflicts of Interest

The authors declare that there is no conflict of interests regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been completely observed by the authors.

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