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THE EXPLORATION OF APPLYING LEGO NXT IN THE SITUATED SCIENCE AND TECHNOLOGY LEARNING

Bih-Yaw Shih ,
Tsung-Hao Chen,
Sun-Ming Wang,
Chen-Yuan Chen

Abstract. *The current study explores the learning effects of applying LEGO NXT in the science and life technology course based on the situated learning theory. Two fifth-grade classes of experimental group use LEGO NXT in the teaching; and the other two are control group by integrating information technology into the teaching. The results reveal that the learning effects of students instructed with LEG NXT in the teaching are superior to students instructed with information technology integrated in the teaching. Meanwhile, using LEGO NXT is sufficient playfulness but not ease of use. Furthermore, Using LEGO NXT in the teaching has a positive impact on learning effects.*
Key words: *expectation-confirmation theory, LEGO NXT, post-acceptance model of IS continuance, situated learning.*

Introduction

Many teaching theories focus on improving students' learning efficiency through self reflection in teaching. Teaching has no longer limited on passing knowledge, and other aspects have drawn some attentions including students' capability of problem solving, creativity, and logical reasoning ability. Also, whether students can apply the learned knowledge to solve the problems encountered in life is one of the goals in teaching. Along with the increasingly advanced technology nowadays, there are more and more sources that can be applied in teaching so as to enable educators to study on new teaching tools as well as applying the learning theories to create new implementation. With the assistance of new technologies, some learning theories are easier to fulfill, and teachers have more options of teaching aids for achieving better learning effects.

To create learning situation, it is common among teachers to include technology in teaching activities. Many researchers are positive to the integration of technology and teaching such as films, pictures, computer animation, and flash games etc. in the situated learning. It can be seen that this teaching method indeed facilitates students' learning meaningfully and efficiently, also, with longer period of memory retained.

LEGO Robotics is one of the newly invented, educational toys of science. The philosophy of its design originates from constructivism and Seymour Papert's constructionism, and its aim is to enable children to learn the knowledge of mathematics and science by designing and manipulating the LEGO robotics. Meanwhile, children can cultivate problem solving ability and creativity in the thinking process. Thus, it was selected to simulate the real situation in the research.

Bih-Yaw Shih
National Pingtung University of Education, Taiwan
Tsung-Hao Chen
Shu-Te University, Taiwan
Sun-Ming Wang, Chen-Yuan Chen
National Pingtung University of Education, Taiwan

Situated Learning

Situated Learning theory was proposed by Brown, Collins, and Duguid in 1898. They claim that knowledge is contextually situated and is influenced by the context, activity, and the culture in which it is used. When teaching students, teachers need to provide great amount of knowledge in a short time and often capture a knowledge concept detached from a situation and request students to memorize and recite it repeatedly. However, it can only create temporary learning effects. When students situated in a real scenario, they often need to re-learn the relevant knowledge; which means the knowledge learned in a detached scenario cannot be implanted in a real situation.

Lev Vygotsky (1978) thinks individual's recognition originates from the process of external social interactions, and the problem solving ability and decision-making ability are deeply influenced by cultural and social environment. Also, language is one of the phenomena and products of social culture. Therefore, without the knowledge of social cultures and situational contexts, learning is not complete (Chen, 2008).

Situated Learning Theory emphasizes that knowledge must be learned in constructed situational contexts. Knowledge is meaningful if it is generated from applying it to a situation and is explained in a situation. In this way, learners can actually apply the knowledge as well as facilitating his/her understanding and memory (Young, 1993)

During the process of acquiring knowledge, Situated Learning Theory stresses on the initiatives of the learner. Through authentically situated activities, students generate interests which enable students to actively explore and construct knowledge instead of passively accepting external stimulus. So that students can understand the meaning and implication of the knowledge (Wu, 2000). When knowledge is constructed in an authentic environment, learners can understand the meaning of the knowledge and construct individual recognition history through the interaction with the situation, which can facilitate the transfer and implication of the knowledge to learners (Brown et al., 1898).

Moreover, in the process of situated learning, teachers play an important role and the relation between teachers and students is similar to the traditional relation between masters and apprentices. Students actively engage in the situation, observing and imitating teachers, for constructing their own knowledge and skills. Teachers are subsidiaries, guides, trainers, and consultants, intervening and scaffolding to support students' learning when students encounter problems (Chen, 2008).

Therefore, all aspects may influence learners' views, motivation and learning strategies, including teachers' teaching strategies, their beliefs, their expertise in the subject area, their instructions and students' interaction (Kao, 1996).

In light of what mentioned above, the principles of activity design of Situated Learning Theory are as follows:

Stress on the authenticity of learning activity: Many people criticize that students learn fragmental and rigid knowledge at school which cannot be implanted in real situations effectively. Situated Learning Theory emphasizes learning from real activities, real situations or simulated situations so that the knowledge acquired is meaningful; it can further be applied in real situations. Thus, teachers should create a learning environment of "quasi-experience personally" in teaching design.

Stress on the active inquiry and operation: Situated Learning Theory claims that the subject of learning is students, and the focus of teaching activities is for students to construct their own knowledge in the learning process instead of one-way knowledge provided by teachers. Dewey once said "learning by doing" while Situated Learning Theory stresses on students' ability of initiatives and operation. Lave(1988) thinks situated learning is learning by doing, and "recognize through action", "understand through action", and "reflect through action", which facilitates students' actively exploration of and construction of knowledge.

Stress on the role of teachers: According to Lev Vygotsky's Cognitive-Developmental Theory, "Scaffolding Instruction" has a great impact on nowadays education. Teacher's supporting students in learning may facilitate the learning effects. The role of teacher in situated learning is a model for students' observation and imitation, assisting students at the beginning of the

learning and withdrawal gradually with less assistance after they have developed problem solving ability Furthermore, triggering students' motivation of and interest in learning is one of teachers' roles. Once students have learning motivations and interests, they will learn actively instead of receiving knowledge passively or learning with their willpower.

Interaction with the social culture: No matter what relationship the situated environment is, teacher and student, parents and children, or peers, all interactive relationship cannot be detached from the context of social culture. Thus, cooperating with others, sharing knowledge, participating together and reconstructing knowledge are the center of Situated Learning Theory. Because people is part of environment, and knowledge is applied in social environment, and in the interaction between activities and cultures.

In fact, it is not possible to construct an authentic "real situation" in school; however, with the recently developed technology, teachers adopt the multimedia and the computer technology which seems to be sufficient to simulate a situation (Shih et al., 2012a, b). It then becomes popular to design a lesson by using "Situated Learning Theory" because teachers can design the lesson by themselves as well as setting up questions and grasping teaching focus so that students can learn more efficiently through the focus of learning activities. Therefore, the Situated Learning Theory was adopted in this study to construct a simulating situation for students' exploration and manipulation by LEGO NXT Robotics.

Expectation-Confirmation Theory (ECT)

In 1980, Oliver proposed the Expectation-Confirmation Theory(ECT) (Figure 1) as a fundamental model of studying consumer satisfaction with products. The theory discussed the factors of consumer repurchase intentions. The consumer repurchase intentions depend on the satisfaction with the product and the results of satisfaction are from the comparison of the consumer expectations before the purchase and the perceived performance of using the product after the purchase.

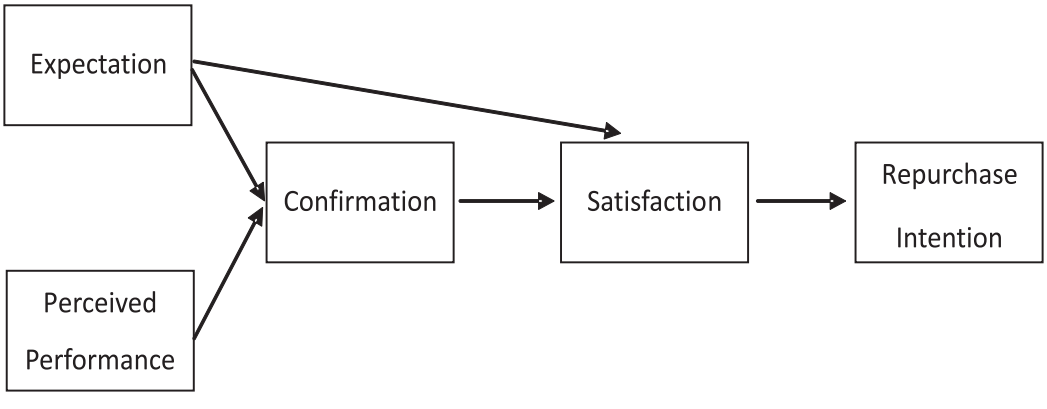

Figure 1: Expectation -Confirmation Theory (ECT).

Oliver (1980) believed that consumers would have expectations before product purchase, and would confirm it through the perceived performance of actual experience. The lower expectation and the higher perceived performance would lead to higher confirmation, and the higher confirmation resulted in higher satisfaction; thus the consumer's repurchase intention increased. In contrast, the higher expectation and the lower perceived performance would lead to lower confirmation; thereby reducing the consumer satisfaction and their repurchase intention decreased.

A Post-Acceptance Model of IS Continuance

Bhattacherjee (2001) amended the ECT in terms of the user behavior of continuous use of

information systems and proposed a Post-Acceptance Model of IS (Information System) Continuance.

Bhattacherjee (2001) believed that the ECT was controversial and irrational in some parts, for example, consumer's expectation before product purchase would change after actually experiencing the product. In addition, when the ECT applied in the user behavior of continuous use of information systems, it was confirmed that this aspect already contained the concept of expectation. Therefore, the theory of Bhattacherjee focused on the consumer's post-consumption expectation. He defined the consumer's post-consumption expectation as perceived usefulness, and proposed a Post- Acceptance Model of IS Continuance (Figure 2).

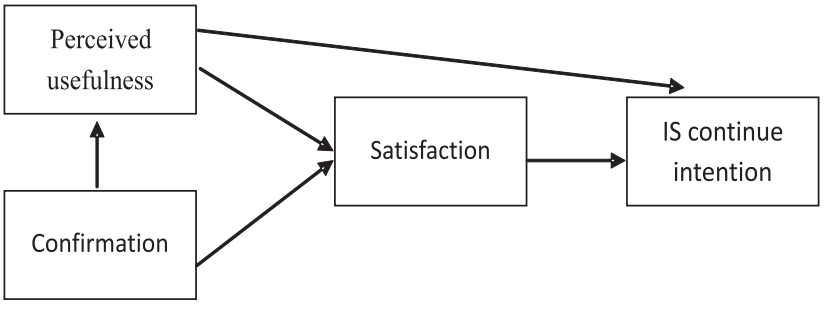

Figure 2: A Post-Acceptance Model of IS Continuance.

Bhattacherjee's study showed that in the factors of affecting the user's intention of continuous use of information systems, the impact of satisfaction was the highest followed by perceived usefulness. And the satisfaction was affected by perceived usefulness as well as confirmation; the confirmation also affected the perceived usefulness.

Technology Acceptance Model (TAM)

In 1989, Davis proposed the Technology Acceptance Model (TAM) (Figure 4) to predict and interpret the use of information technology. The perceived usefulness and the perceived ease of use are the two most important factors affecting the behavior of technology usage.

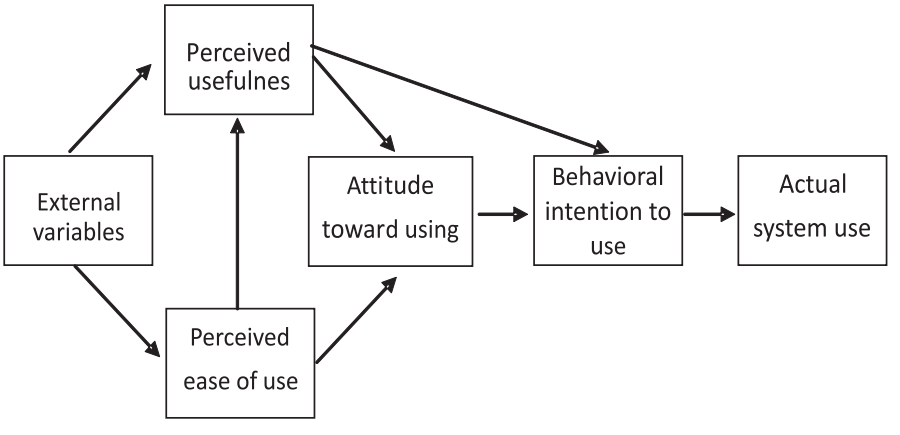

Figure 4: Technology Acceptance Model (TAM).

Davis proposed Technology Acceptance Model (TAM) according to the Theory of Reasoned Action (TRA) of Fishbein and Ajzen (1975) by simplifying the usage situation of information systems. TAM considered that the user's attitude toward using was a very important factor affecting user's behavioral

intention to use. And the user's attitude toward using was affected by perceived usefulness and perceived ease of use. When the user felt that the system had higher usefulness and higher ease of use, then the user's acceptance of the system was higher.

(1) Perceived Usefulness

Davis (1989) defined the perceived usefulness as the level of user perceiving that the system could improve the work performance. When the user thinks the system or product is more useful, then the user's intention of using it is higher.

(2) Perceived Ease of Use

The perceived ease of use means that the user feels the system or product is easy to use and is willing to spend more time learning the operation; thus the user will have a better understanding of the usage method and bring the system or product more into effect. Therefore, in the model, the perceived ease of use will reinforce the intent of perceived usefulness.

Playfulness

The Technology Acceptance Model (TAM) is a widely accepted intention model for predicting the information technology usage. However, it has been criticized for ignoring social influence and individual characteristics (Tony, Seewon & Ingoo, 2007). In some cases, the perceived usefulness and perceived ease of use can not completely explain the user's motivation. Moon & Kim (2001) pointed out that the perceived playfulness was internet user's intrinsic belief or driving force. When the perceived playfulness was higher, the internet interaction would be higher. Lin, Wu and Tasi (2005) added the playfulness based on the theoretical model proposed by Bhattacherjee into the exploration of the user behavior of continuous use of internet (Figure 3). The study pointed out that when the user felt delighted or enjoyable, means the user would probably visit this website again.

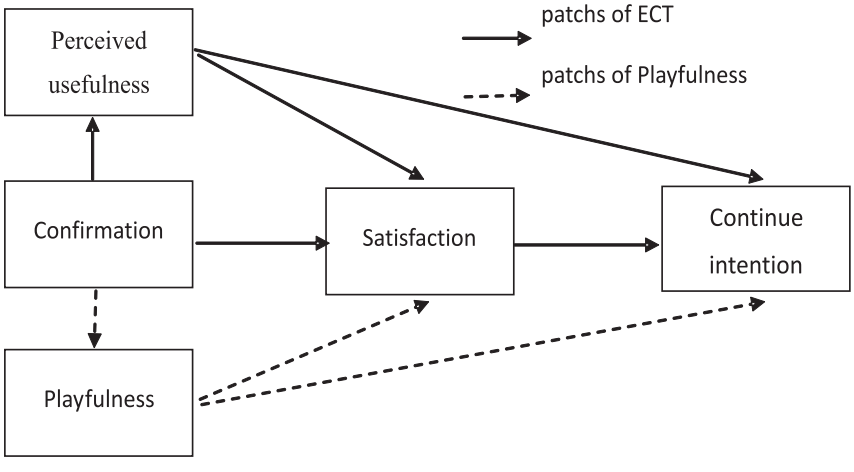

Figure 3: The model of Lin et al. (2005).

Moon and Kim (2001) defined three dimensions of perceived playfulness:
***Concentration**:* The degree of self-perceptibility when a person concentrates.
***Curiosity**:* The degree of a person's curiosity on interaction.
***Enjoyment**:* The degree of a person's interest and fun in interaction.

Learning Attitude and Effects

Manis (1985) considered that the attitude was the evaluation of entities associated with individuals, groups, things, and actions, etc. including positive or negative views of three aspects of emotion,

cognition and behavior. In general, the learning effects refer to the students' test scores after a period of teaching. When the score is higher means the learning effects are better; when the score is lower means the learning effects are lower. In addition, some scholars believed that the learning effects should also include student's own cognition and experience of learning (Brown et al., 1898; Bower & Hilgard, 1981). In other words, in addition to evaluate student's learning effects by scores, teachers should pay attention to student's own experience of learning.

Webb's research (1989) in the learning effects of geography for students at University of Cambridge integrated a number of factors including family background, cognitive ability, learning attitudes and school impacts, etc. It found that the learning attitudes affected most on the learning effects. From which it was noticed that the learning attitudes had a positive influence on learning effects.

Many studies show that the learner's attitudes and motivation are important indicators of predicting whether the learning effects are successful. The attitudes might be more important than in any other stages of learning; a positive attitude might be the necessary term for learning (Naiman, 1995).

Methodology of Research

Samples

The research samples are two classes of fifth-grade students at an elementary school in Pingtung County and the other two classes of fifth-grade at an elementary school in Kaohsiung City. The four classes are divided into an experimental group with a total of 53 students and a control group with a total of 49 students. The students in these four classes are through normal placement. The experimental group uses LEGO NXT as the teaching tool; and the control group uses a general way of teaching by integrating information technology into the courses. The two groups adopt the same teaching material that is the Aspects of Animal Life, the second section of Science and Life Technology, the textbook of fifth-grade second semester.

Design of Teaching

The experimental teaching activities were introduced in six sessions, and the aim is to allow students to take learning activities of exploration in a simulating situation by using LEGO Robotics based on the Situated Learning Theory. The teaching objectives of the unit are:

- Observing animals' ways of exercise, and understanding the construction of animals as well as its relation to doing exercise.
- Observing the ways animals seeking for food and their behaviors during food hunting.
- Understanding how animals protect themselves.
- Understanding the reproduction ways of animals such as oviparity and viviparity.
- Understanding the importance of habitat to animals.

The authenticity of learning activity:

For creating a realistic situation, it is first placed with the model of animals' habitat including a pond, woods, and a lawn (See the graph of the model in appendix). The model is lifted up by few tables to the height suitable for students' operation and observation; the model of habitat is placed with some animals made up of LEGO bricks and each animal is located in its appropriate environment. In class, students were divided into six groups with four to five people in each group. The table of each group is surrounded the table of habitat model which is placed in the center.

This teaching design is centered in the habitat environment, and most learning activities are carried out in the habitat model so that students can integrate the learned knowledge and situation.

The aspect of active exploration and operation:

Toys can always catch children's eyes and science toys with educational meanings not only can cause students' interests but also trigger their recognition and exploratory learning under the guidance of teachers.

Students of the experimental group have no experience about using LEGO Robotics, nor have they designed and edited programs of LEGO Robotics. Thus, the LEGO Robotics in teaching activities was designed by LEGO Robotics including programming and editing. However, in the teaching activities, researchers designed some projects for students' having some hand-on experiences to comply with the principle of situated learning theory which is the actively exploratory learning.

The aspect of teacher's role:

The relation between teachers and students in the process of situated learning is significant. During the process, students imitate teachers' behaviors and ask for teachers' help when encountering problems. Learning can be proceeded smoothly in this learning environment. In the teaching activity of this unit, teacher demonstrates all the procedures or provided positive or negative feedbacks to students' learning behaviors, and gradually reduces assistance for them to solve the problems by themselves so as to achieve the better learning effects.

The aspect of learning interaction:

Sharing knowledge is emphasized on both Situated Learning Theory and Constructionism. Thus, students learned in groups in class through discussing, creating and sharing each other's thoughts in groups.

Research Model

The research mode (Figure 5) is designed to explore the behavioral intentions of students towards the application of LEGO NXT in the Science and Life Technology course and the influence of which on their learning effects based on ECT (Oliver, 1980) and the research results of Bhattacherjee (2001) and Lin et al. (2005).

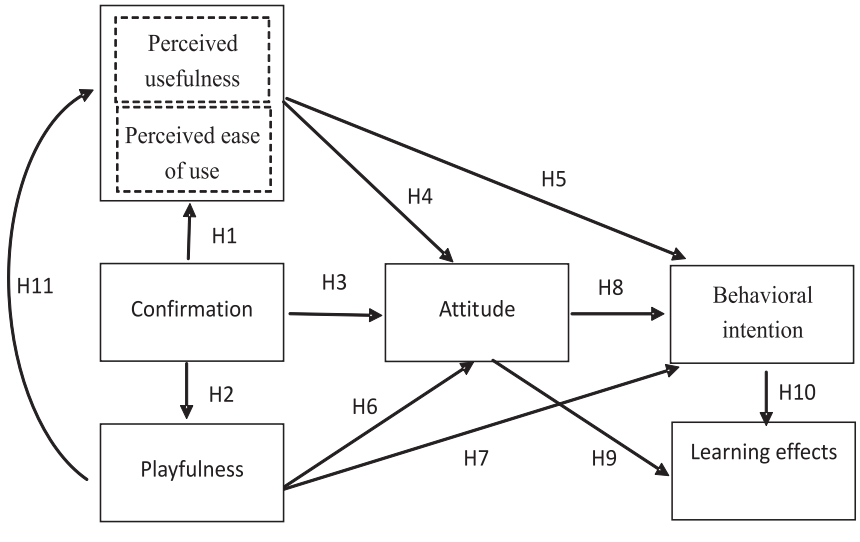

Figure 5: Research model.

As the satisfaction, attitude and emotion are of the same aspects; they are all personal emotional responses. But the learning attitude includes the preference towards courses; therefore, this research

model uses the attitude to replace the satisfaction.

The research model uses perceived usefulness, perceived ease of use and playfulness to replace the post-expectations (Bhattacherjee, 2001; Lin et al., 2005).

Since students are not in control of choosing the teaching tool, students' intentions of continuous use of the tool do not mean that teachers will use them in class. But students can express their ideas and provide teachers for references. Therefore, this research model uses the behavioral intention to replace the continue intention.

The LEGO NXT Robotics is still a big part of the feature of toys to students. In terms of the function of science toys giving students fun in learning, it had a meaningful value for teachers in teaching (Angier, 1981). Toys are always able to attract children's attention; and under appropriate guidance by teachers, toys with educational function can even trigger children's cognitive and explorative learning during the process of operating toys. Therefore, this research model will explore the impact of playfulness on attitudes and whether the playfulness will affect the perceived usefulness and perceived ease of use.

The main purpose of this study is to explore the learning effects. In the research model, the evaluation of learning effects is not only based on the scores from the tests of students' learning effects, but also uses the questionnaire survey to understand student's own perception of learning effects; and then integrating which in the research model in order to analyze the factors of affecting the learning effects.

Based on the above discussion and the theoretical contents of ECT in the second as well as the findings of Bhattacherjee (2001) and Lin et al. (2005), this study proposes hypotheses as below:

H_1: The confirmation of applying LEGO NXT in the teaching of Science and Life Technology has a significant positive effect on perceived usefulness and ease of use.

H_2: The confirmation of applying LEGO NXT in the teaching of Science and Life Technology has a significant positive effect on playfulness.

H_3: The confirmation of applying LEGO NXT in the teaching of Science and Life Technology has a significant positive effect on attitude

H_4: The perceived usefulness and ease of use of applying LEGO NXT in the teaching of Science and Life Technology has a significant positive effect on attitude.

H_5: The perceived usefulness and ease of use of applying LEGO NXT in the teaching of Science and Life Technology has a significant positive effect on behavioral intention.

H_6: The playfulness of applying LEGO NXT in the teaching of Science and Life Technology has a significant positive effect on attitude.

H_7: The playfulness of applying LEGO NXT in the teaching of Science and Life Technology has a significant positive effect on behavioral intention.

H_8: The attitude of applying LEGO NXT in the teaching of Science and Life Technology has a significant positive effect on behavioral intention.

H_9: The attitude of applying LEGO NXT in the teaching of Science and Life Technology has a significant positive impact on learning effects.

H_{10}: The behavioral intention of applying LEGO NXT in the teaching of Science and Life Technology has a significant positive effect on learning effects.

H_{11}: The playfulness of applying LEGO NXT in the teaching of Science and Life Technology has a significant positive effect on perceived usefulness and ease of use.

Questionnaire Design

This study designs the questionnaire focusing on various aspects of the model. The questions are amended by referring mainly to the related research so as to in line with the experimental situation. In order to allow the questionnaire effectively measure the features of each aspect as well as it also covers all the concepts that to be measured, the draft was revised by two professors and four teachers who have used Lego robotics in teaching so that the questionnaire can effectively measure students' views on each aspect. The questionnaire was filled out by students after the experimental program was ended. In this study, all variables are measured with questions presented using a five-point Likert item.

The complete questionnaire data are as below:

Table 1. Measurement of variables.

Latent variable	Measurement of variables	Reference
Confirmation (CONF)	I think the features of LEOG NXT are better than I imagined. I think that applying LEOG NXT in the science class, the curriculum is more copious than I expected. I think that applying LEOG NXT in the science class, the curriculum is about the same as I imagined before the class.	Bhattacherjee (2001)
Perceived ease of use (PE)	In the science class, the teacher taught us how to operate LEOG NXT; I think I understand how to operate it very fast. I did not encounter difficulties in the use of LEOG NXT in the science class. I feel it is very easy to learn the science class from the application of LEOG NXT.	Davis(1989)
Perceived usefulness (PU)	Applying LEOG NXT in the science class, I can easily understand the contents of the course. I think it is good to combine LEOG NXT with the science class. LEOG NXT is a very good learning aid.	Davis(1989)
Attitude (AT)	I like the class using LEOG NXT. I am very satisfied with the science class using LEOG NXT. I will be particularly serious when LEOG NXT is used in the science class.	Bhattacherjee(2001)
Behavioral intention (BI)	I would like the class using more LEOG NXT. I would want to learn other courses that using LEOG NXT. I am interested in learning other features of LEOG NXT.	Bhattacherjee(2001)
Playfulness (PF)	I feel that time flies quickly using LEOG NXT in the science class. I think it is more fun using LEOG NXT than other ways in the science class. I feel very happy when using LEOG NXT in the science class.	Moon & Kim(2001)
learning effects (LE)	I remember the lecture better in the science class using LEOG NXT. I learned more knowledge from the science class using LEOG NXT. I think I can understand the lecture better in the science class using LEOG NXT.	Sorted by the study

The Test of Learning Effects

The range of this learning effects test is based on Unit II of Science and Technology, "Aspects of animal life", the second semester of the fifth grade, Kang Hsuan Edition. The test was edited by the research and the questions were based on the teaching objectives of each section so as to investigate students' learning effects of this unit.

For getting the most accurate result of students' learning effects, the exam paper was viewed and commented by the researcher's advising professor as well as other senior teachers in the field of Science and Technology. The revised exam paper is used in both the experiment group and the control group at the end of the project.

Data Analysis Method

In the end of the experimental program, students in the experimental group and the control group were given tests of learning effects. After grading the tests, the scores were analyzed using SPSS

software for the analysis of covariance (ANCOVA) to test the differences of learning effects between the experimental group and the control group.

In the end of the experimental program, the questionnaires were distributed to students in the experimental group. The effective data from the collected questionnaires were tested by using VisualPLS to conduct research hypotheses.

Research Results

Analysis of Learning Effects

The tests of students' learning effects are analyzed after the experimental program is over; and evaluates whether there are differences of learning effects of the two groups through different teaching curricula. When students in the experimental group and the control group were at their fourth-grade and ready to enter into the fifth-grade, they were placed in different classes according to their scores at the fourth-grade, which is called the normal placement. Therefore, the initial capacities of students in these four classes are the same. In order to compare the differences of post-learning effects of the experimental group and the control group after implementing different teaching methods, this study uses the scores of the first regular performance assessment as the pre-test scores and the tests of learning effects as post-test scores to conduct ANCOVA.

From the above data, it shows that the average scores of learning effects of the experimental group are better than those of the control group; and the standard deviations of the experimental group are also less than those of the control group.

Followed by the ANCOVA, this study uses the scores of the first regular assessment of the science and life technology (pre-test) as covariates; test scores of learning effects (post-test) as the dependent variables; different teaching methods (different groups) as the independent variables. Before carrying out the ANCOVA, the check of the homogeneity of with-in regression coefficient in the group needs to be done to see if it reaches the significant criteria; the results are shown in Table 2.

Table 2. Descriptive Statistics of Pre-test & Post-test in EG and CG.

Group	N	Pre-test		Post-test	
		Mean	SD	Mean	SD
EG	53	84.00	10.981	89.81	8.573
CG	49	84.53	13.262	86.63	13.926

The results of homogeneity of with-in regression coefficient in Table 3 shows that the F=3.290 and sig=0.073 for Group*Pre-test are below the significant criteria of 0.05. Which means that the relationship between covariates (pre-test scores) and the dependent variables (post-test scores) will not have any differences because of the different management levels of the independent variables. It meets with the hypothesis of homogeneity of with-in regression coefficient for covariates, and then ANCOVA can be conducted. The results of ANCOVA are shown in Table 4.

Table 3. `Summary of checking the homogeneity of with-in regression coefficient.

Source	Type Sum of Squares	df	MS	F	Sig
Corrected Model	7627.499a	3	2542.500	43.248	0.000
Intercept	1884.370	1	1884.370	32.053	0.000
Group	264.835	1	264.835	4.505	0.036
Pre-test	6680.496	1	6680.496	113.636	0.000
Group * Pre-test	193.418	1	193.418	3.290	0.073
Error	5761.256	98	58.788		
Total	808389.000	102			
Corrected Total	13388.755	101			

From Table 4 we can see that when excluding the impact of covariates (pre-test scores) on the dependent variables (post-test scores), the effect of experimental treatment of independent variables (different teaching methods) on the dependent variables is significant. The F=5.330 and the significance is 0.023 smaller than 0.05 reaching a significant level; that is, the learning effects of students instructed with LEGO NXT in the teaching have significant differences from those of students instructed with information technology integrated in the teaching. The resutls reveal that the learning effects of experimental group of students are superior to those of the control group.

Table 4. ANCOVA for the test scores of learning effects.

Source	Type Sum of Squares	df	MS	F	Sig
Corrected Model	7434.081a	2	3717.041	61.798	0.000
Intercept	1751.382	1	1751.382	29.118	0.000
Pre-test	7176.827	1	7176.827	119.319	0.000
Group	320.581	1	320.581	5.330	0.023
Error	5954.674	99	60.148		
Total	808389.000	102			
Corrected Total	13388.755	101			

Questionnaire Validity and Reliability Analysis

In the end of the experimental program, the study distributed questionnaires to students. A total of 53 questionnaires were sent out and recovered the same; all questionnaires are valid. After the questionnaires were collected, the study analyzes and verifies the model hypotheses by the VisualPLS software. To make the questionnaire effectively measure the predicted results from the theory, the study conducts the factor analysis. According to the suggestion of Hair et al. (1998), the factor loading of a

question from each aspect should be at least higher than 0.5, then the validity of the question will be sufficient. If the validity is less than 0.5, then the question does not have enough validity for this aspect and it should be deleted. In the questionnaire, the factor loadings of the questions from all aspects are all higher than 0.5, which means that the question of each aspect can effectively measure the concept of the aspect. The analytical results are shown in Table 5.

Table 5. Original factor loadings, Residual, and Weight factors.

Construct	Indicator	Mean	Stdev	Loading	Residual	Weight
PE						
	pe1	3.792208	0.991247	0.8439	0.2879	0.5073
	pe2	3.298701	0.960605	0.5972	0.6434	0.2827
	pe3	3.623377	1.170233	0.7883	0.3786	0.5113
PU						
	pu1	3.961039	1.117346	0.8260	0.3176	0.5030
	pu2	3.753247	1.015095	0.7683	0.4097	0.4211
	pu3	4.168831	0.801357	0.7514	0.4355	0.3474
PF						
	pf1	4.155844	0.874567	0.8242	0.3207	0.4424
	pf2	4.064935	1.173587	0.6759	0.5432	0.3628
	pf3	4.129870	1.004603	0.8100	0.3439	0.4817
CONF						
	conf1	3.610390	1.137354	0.7307	0.4660	0.3697
	conf2	3.831169	1.031129	0.8389	0.2962	0.4861
	conf3	4.025974	0.931524	0.7159	0.4874	0.4497
AT						
	at1	4.064935	0.878660	0.6768	0.5420	0.3535
	at2	4.038961	1.005793	0.8804	0.2250	0.4939
	at3	3.883117	1.025645	0.7663	0.4128	0.4254
BI						
	bi1	4.207792	1.067925	0.8530	0.2724	0.4479
	bi2	3.987013	0.966457	0.8206	0.3267	0.4321
	bi3	3.844156	1.064560	0.6986	0.5119	0.3770
LE						
	le1	3.974026	0.986408	0.7642	0.4160	0.4162
	le2	3.974026	0.873198	0.8400	0.2943	0.4533
	le3	3.636364	0.985541	0.7989	0.3618	0.3770

The performance of reliability and validity from all aspects of the questionnaire are shown in Table 6 and Table 7. The composite reliability (CR) is to assess whether the questions of all aspects are consistent, means whether all the questions measure the same concept. If the CR is higher, means the questions

have high correlation and can more easily measure the latent variables (Fornell & Larcker, 1981); the variables of the questionnaire are all greater than the recommended value, meaning the questions of all aspects have good internal consistency. In this study, the AVE values of all aspects of the questionnaire are greater than 0.5, meaning that the research model has good convergent validity.

Table 6. Reliability and AVE.

Construct	Composite Reliability	AVE	Cronbach Alpha
PE	0.791421	0.563386	0.610527
PU	0.825539	0.612395	0.675637
PF	0.815444	0.597406	0.643666
CONF	0.806955	0.583437	0.643467
AT	0.820657	0.606757	0.673221
BI	0.835122	0.629671	0.699602
LE	0.843420	0.642627	0.718215

Data from: Visual PLS list systematically by the study.

Table 7. The square root of AVE, the correlation coefficient comparison table.

	AVE SQRT	PE	PU	PF	CONF	AT	BI
PE	0.75						
PU	0.78	0.71					
PF	0.77	0.67	0.70				
CONF	0.76	0.64	0.68	0.62			
AT	0.78	0.68	0.76	0.70	0.68		
BI	0.79	0.61	0.66	0.73	0.67	0.75	
LE	0.80	0.69	0.75	0.71	0.66	0.72	0.61

Data from: Visual PLS list systematically by the study.

According to the recommendation of Bollen & Stine (1992), the study uses BootStrap method to estimate the path coefficient; using the value "t" from which to verify the significance of the path. If the "T" value exceeds 1.96, it can be regarded as significant. Through the PLS analysis, there are four hypotheses of research model below the significance levels which would not be supported. The remaining hypotheses are of significance levels. The results of PLS analysis are shown in Table 8; The Bootstrap repeat sampling of Model path coefficients is shown in Figure 6.

Table 8. Standardized path coefficients and t-Statistic.

Entire Sample estimate		T-Statistic	R Square
CONF->PE (H1b)	0.356	3.8598***	0.532
PF->PE (H11b)	0.453	4.0513***	
CONF->PU (H1a)	0.403	4.4548***	0.593
PF->PU (H11a)	0.452	4.9573***	
CONF->PF (H2)	0.621	7.0299***	0.385
CONF->AT (H3)	0.192	2.0503*	0.664
PF->AT (H6)	0.226	1.9944*	
PU->AT (H4a)	0.360	3.1504**	
PE->AT (H4b)	0.152	1.3311	
AT->BI (H8)	0.419	2.8458**	0.646
PF->BI (H7)	0.384	2.9721**	
PU->BI (H5a)	0.054	0.5724	
PE->BI (H5b)	0.027	0.3992	
BI->LE (H10)	0.160	1.6789	0.529
AT->LE (H9)	0.600	6.3761***	

** : t-Value>1.96(P<0.05); ** : t-Value>2.58(P<0.01); *** : t-Value>3.29(P< 0.001)*

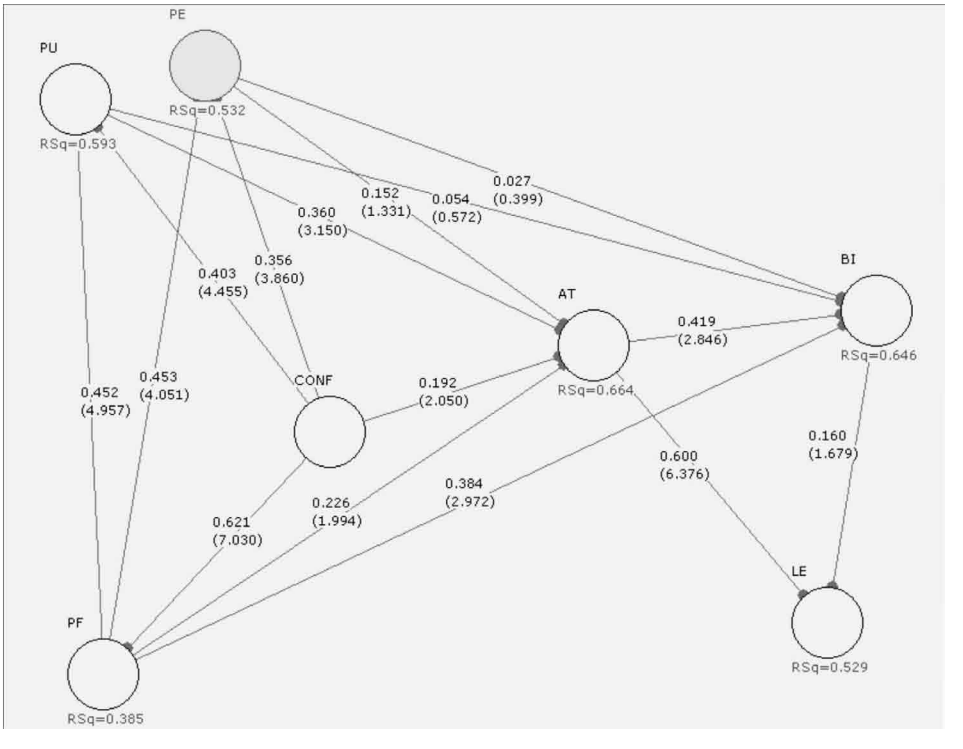

Figure 6. Bootstrap repeat sampling of Model path coefficients.

Discussion

Based on the above information, the study organizes the results of the research hypotheses as follows.

(1) Confirmation

In the research model, the hypotheses of the impacts of confirmation are all holding. In other words, the perceived ease of use, perceived usefulness, playfulness and attitude are subject to the significant influence by confirmation. Further reviewing the data, the study found that the impact of confirmation on playfulness is the highest (t=7.03), followed by the impact on the perceived usefulness (t=4.455), the third is the impact on the perceived ease of use (t=3.86), while the lowest impact is on the attitude (t=2.05).

(2) Perceived Ease of Use

In the research model, the hypotheses of perceived ease of use are all not holding. There are no significant impacts of perceived ease of use on attitude and behavioral intention; the "t" values are 1.331 and 0.339 respectively.

(3) Perceived Usefulness

In the research model, two hypotheses of perceived usefulness have significant impacts on attitude (t=3.150), while no significant impact on behavioral intention (t=0.572).

(4) Playfulness

In the research model, all the hypotheses regarding the impacts of playfulness are all holding. In other words, the ease of use, usefulness, attitude and behavioral intention are all impacted by playfulness. Further reviewing the data, the study found that the impact of playfulness on usefulness is the highest (t=4.957), followed by the impact on the ease of use (t=4.051), the third is the impact on behavioral intention (t=2.972), while the lowest is the impact on attitude (t=1.994).

(5) Attitude

In the research model, the impacts of attitude on behavioral intention and learning effects are significant, in which the impact on learning effects is higher (t=6.376) and less impact on behavioral intention (t=2.846).

(6) Behavioral Intention

In the research model, the impact of behavioral intention on learning effects does not reach significance (t=1.679), this hypothesis does not hold.

As described in the literature study of second in this study, the Lego robotics is a good learning aid for students to study science, technology, engineering, mathematics and other subjects. Through hands-on process, many teachers apply Lego robotics in the learning of scientific concepts, enabling students to actively build knowledge and help them understand problem and solve the problem.

In fact, in the current primary school education, the application of LEGO robotics in the teaching is not common. Not only the price is expensive, but the user also has to have the programming capabilities of using LEGO robotics. In the current curricula of primary school education, it is difficult to schedule time for learning LEGO Robotics. If students already learned the programming skills, a course unit of teaching will at least need two sessions to design and assemble robots. For teachers who try to make the best of their time, it is not possible to arrange such kind of teaching. Many of the LEGO robotics studies are done

outside of the normal teaching hours; and very little has been arranged in the usual school hours.

The development of a teaching aid often takes a long period of time of testing and researching for improvement. For instance, at the early stage when the information technology integrated into the teaching, the computer and audiovisual equipment were expensive, the quality of teaching software was rough, and teachers were not familiar with the operation of electronic equipment. After the past ten years of promotion, currently at primary school, every classroom has computer and audiovisual equipment, the teaching software has developed into fine quality electronic textbooks. It has become an essential capability for teachers to apply information technology into teaching.

Therefore, this study, as a beginning attempt, applies LEGO NXT into the normal teaching combining with situated learning theory to try to develop a viable teaching method, which can be the references for follow-up researchers and scholars to make further improvements.

The biggest challenge in this study is to compile a teaching project integrating LEGO NXT into the teaching. The experimental program must be coordinated with the normal course of teaching and proceeded in the normal school hours. Therefore, it is impossible that students can design and assemble their own robots. In reference to the research of Bers et al. (2002), this study suggests that teachers design and assemble the robots and students have hands-on operation.

After six sessions of teaching, the study uses the covariances to analyze the pre-scores and post-scores of the experimental and control groups and found that the learning effects of students who are in the situated learning with LEGO NXT has significant differences ($p=0.023<0.05$) from those of students in control group. In other words, in this study, the learning effects of applying LEGO NXT in the teaching are superior to those of integrating information technology into the teaching. Moreover, from the viewpoint of the standard deviation, after applying LEGO NXT in the teaching, the difference of performance scores among students in the experimental group is less than that of control group. Overall speaking, students in the experimental group made progress in learning.

The design of teaching uses the animal habitat as the pivot. Most of the teaching activities are carried out in the habitat so that the knowledge students learned can combine with the situated environment. For example, after students used Lego bricks to assemble into animals, teachers would guide students to place animals in the suitable habitat. Through hands-on process, it helps students understand the relationship between animals and their living environment. Bers et al.(2002) show that using robotics during classes as a bridge between concreteand and abstract explorations provides the chances of learning for students.

Although the building of LEGO NXT is a simulated situation, but many scholars also mentioned that as long as the learning is conducted in the simulated situation which helps in the cognition of the concept, it still can achieve meaningful learning (Brown et al., 1898; Vergnaud, 2009), which is the effect that this experimental program wants to achieve.

Conclusions

After the experiment and analysis, the study proposes the following conclusions as the future references for follow-up researchers.

(1) To students, LEGO NXT is a teaching aid with plentiful playfulness.

In the research model, the impact of confirmation on playfulness is the highest; indicating that students consider LEGO NXT is a very interesting teaching aid. In the average scores of questions of all aspects, the score of playfulness is the highest, students' perceptions are noticeable. LEGO NXT is originally a toy with educational meaning; and the playfulness is the major factor to attract children to a certain toy. The dynamic effect of LEGO NXT attracts the attention of school children, and which function of attracting students' attentions is strong.

In class, the playfulness of LEGO NXT enables students to enjoy it; the classroom atmosphere is pleasant. This is the same as what Sipitakiat (2000) emphasized on building an environment of convivial learning. As a learning tool, LEGO NXT indeed could strengthen conviviality. Many researchers also proved in his study that through the LEGO NXT's lessons, the motivation of students would be improved and above all, it is a

very important foctor that students can enjoy the process of learning(Goh & Aris, 2007; Benitti, 2012).

In the research model, the impacts of playfulness on usefulness and ease of use are significantly high. The playfulness also has significant impact on behavioral intention. It shows that the playfulness of a teaching tool plays a very important role in the teaching. The objects of this experimental teaching are children around eleven years old; they are still at the fun-loving age. If it is fun using LEGO NXT in class; then certainly, teachers will be willing to use LEGO NXT in class in the future.

(2) The ease of use of LEGO NXT is not sufficient.

When comparing playfulness with ease of use, LEGO NXT apparently lacks of ease of use. In the impact of confirmation on ease of use, although it reaches to a significant level, but it is the lowest. In the average scores of questions of all aspects, the ease of use is the lowest. It is obvious that students generally think that LEGO NXT is not easy to operate.

The study found that in the experimental teaching although students were very interested in LEGO NXT, but when teachers asked students operate the robot, at first, students did not dare to try. And the reasons are, first, students know LEGO NXT is an expensive toy and they are afraid of breaking the robot accidentally. Second, students did not assemble the robot themselves; and moreover, teachers only demonstrated the operation methods giving students no extra time for hands-on practice. Therefore, students are not familiar with the robot and not sure whether they can achieve the actions of robot that teachers required.

However, in this study, there are no impacts of ease of use on attitude and behavioral intention. The research of Karahanna et al. (1999) also pointed out that the influence of ease of use in the initial phase was significant, but over a period of time in use, the effect of ease of use was not obvious. This illustrates that although the ease of use of LEGO NXT is not sufficient, but its impacts on attitude and behavioral intention are not big. This point is the same as Tao et al. (2009) findings.

The satisfaction of student learning environment that the instructor's support is an important factor to encourage student participation in learning because the interaction of the instructor is seen as a motivating factor for the student and facilitates learner involvement (Bookout, 2010). Extending this idea, in class, teachers will teach what students do not understand; therefore, the ease of use of LEGO NXT is not what students concerned.

(3) Students wish the class can use more of LEGO NXT.

In this model, which uses ECT as the pivot, the behavioral intentions of students on the use of LEGO NXT in class reach a significant level. In other words, students recognize that LEGO NXT is playful, useful and easy to use after experiencing LEGO NXT applied in the teaching; and therefore, they are happy to have LEGO NXT used in class. The results of this study confirm the same results as the original model of ECT. However, it is worth noticing that although the impact of confirmation on attitude and the impact of attitude on behavioral intention all achieve the level of significance, but they are not the highest, which does not meet with the research of Bhattacherjee (2001). Presumably, it is because students have no dominance in teaching aids. When students have high expectancy on certain teaching aid, it does not mean that teachers will use it. After all, in the teaching, the leaning effect is the main issue. And LEGO NXT can reach an acceptable level; it is not required to be significantly higher than expected. In terms of influence, the perceived usefulness has higher influence, indicating that the application of teaching aid is mainly to achieve the learning effect. As for the new teaching strageaies, teachers can use them often in classes and students can accumulate good experiences, students will like them and think they are helpful (Lam et al., 2011).

Overall, students believe that the usefulness of LEGO NXT is sufficient and the class is fun and joyful, thus students are willing to have LEGO NXT used more in class.

(4) Applying LEGO NXT in teaching has a positive impact on learning effects.

After the analysis of learning effects, the study found that the use of LEGO NXT in teaching could really improve students' learning effects. In addition, this study added the aspect of learning effects into the expectation-confirmation model to explore students' ideas of learning effects after the use of LEGO NXT.

After the analysis of the model, it shows that the influence of students' attitudes towards learning effects is significant; this is the same result as the research of Webb(1989). However, the behavioral intention has no influence on learning effects.

The study believes that the attitude is impacted by the confirmation, and the usefulness and playfulness is also affecting the attitude. Students felt that using LEGO NXT in class, they would have a better understanding of teacher's lecture. In coordination with the situated learning, students can memorize the lecture even more firmly. Because of the usefulness and playfulness of LEGO NXT, students believe that it is helpful for learning effects. And there is no influence of intention on using it, maybe simply because LEGO NXT has a lot of fun, but it does not necessarily mean it has learning effects.

Lui, Ng, Cheung, and Gurung (2010) pointed in their researches on acilitating independent learning effects by using Lego Mindstorms robots through questionnaires that the evaluation was generally positive. The participants found that the course could improve their knowledge and skills. In summary, there is a positive impact on learning effects by applying LEGO NXT in the teaching.

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Bih-Yaw Shih	Ph.D., Professor, Department and Graduate School of Computer Science, National Pingtung University of Education, No. 4-18, Ming Shen Rd., Pingtung 90003, Taiwan.
Tsung-Hao Chen	Ph.D., Director, Department of Business Administration, Shu-Te University, Yen Chau, Kaohsiung 82445, Taiwan, ROC
Sun-Ming Wang	Department and Graduate School of Computer Science, National Pingtung University of Education, No. 4-18, Ming Shen Rd., Pingtung 90003, Taiwan.
Chen-Yuan Chen	Ph.D., Professor, Department and Graduate School of Computer Science, National Pingtung University of Education, No. 4-18, Ming Shen Rd., Pingtung 90003, Taiwan. Corresponding author (CY Chen). E-mail: cyc@mail.npue.edu.tw