Toward a Highly Interactive Model of Flipped Learning

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Abstract. This study proposes a highly interactive model with the new technology of wireless projector to provide an ideal environment for presenting and discussing by multiple users including the teacher and students during lecture hour of flipped classroom. This model can definitely reduce the transition time and the presentation burden switching among a variety of learning activities to achieve a seamless learning. The TAM statistical analysis method is then exploited in the assessment for ease of use and usefulness for the proposed model. Finally, the experimental results demonstrated that the proposed model could readily support highly interactive learning activities for the flipped learning and have high acceptance of intent of use and usage behavior.

Keywords: Wireless projector · Flipped learning · Seamless learning · TAM

1 Introduction

The effective use of modern technology can let teachers easily organize their instructional materials and teaching activities simultaneously to enrich the classroom in full of the interesting and aggressive situation [1]. With the advantage of new functions of projector including the high resolution and wireless projection, the visual display by the teacher and students have more attractive and vivid such that the traditional PPT presentation can be improved [2, 3]. In addition, teachers can use a digital broadcast teaching system on their classroom to deliver teacher-side visual information to their students' PCs, notebooks or mobile devices [4]. This typical system highly focuses on delivering information from teacher side to student side. In order to achieve remarkable result to increase students' presentation capability, the delivering function from student

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side to teacher side is needed. That is, students can easily deliver their visual information to the classroom projector. Recently, the fast progress of wireless projection hints us to improve the function of digital broadcast teaching system so that students can directly send their content to projector instead of finding VGA cable to connect their PC or notebook to the input port of projector [5, 6].

As we know, the flipped classroom more emphasizes on interactive activities. This student-centered learning model allows students having more opportunities to present their opinions. Moreover, in a collaborative group, each member perhaps scramble to raise his/her voice. In this case, one presenting channel is not enough to satisfy their highly requirement. This motivates us to integrate the standards of wireless presentation including Airplay and Miracast together to let students who can hold different device to show their visual information to the classroom projector at same time and on their own seat position. In this researcher, we proposed a wireless projector server, called Airboard, to realize the above requirement [7–10].

In cognitive apprenticeship teaching, the interaction between a teacher and students is also considered as one of important activities applied in the flipped classroom. The teacher can handle the Airboard to invite or reject students' visual information to the classroom projector. Therefore, the teacher-led strategies can be realized more easily.

Finally, we apply the method of TAM statistical analysis to evaluate the contribution of highly interactive environment assisted by Airboard for realizing cooperative learning and seamless learning. The experimental results demonstrated that the proposed model could readily support highly interactive learning activities for the flipped learning and have high acceptance of intent of use and usage behavior. We believe we catch the developing trend to establish the highly interactive model that still has more fruitful research issues to deal with in the future.

2 Related Concept

2.1 Flipped Learning

Flipped classroom is a form of blended learning in which students learn content online by watching video lectures usually at home and do homework in class with teachers and students discussing and solving questions. The teacher interacting with students is more personalized with guiding instead of lecturing [11, 12].

Flipped learning strongly excludes to read videos inside lessons that is a self-learning model. It emphasizes about how to best use in-class time with students that is a student-centered model. Actually, flipped learning helps teachers move away from direct instruction as their primary teaching approach toward a more student-centered approach [13, 14].

2.2 Collaboration Learning

Students are collaborating with each other through a media to learn more about specific subjects, to test out ideas and theories, to learn facts, and to gauge each other's opinions [15–17]. In most cases, the collaboration process boosts everyone's interactive frequency.

According to Jones and Issroff (2005) research on collaborative learning and educational technologies, some key concepts is needed to take into account the interaction between cognitive, social and affective/emotional factors [15, 16]. Some highlights are summarized as follows:

- Social affinity between partners: some studies suggest that friend relationships facilitate the communication processes and interaction regulation that in turn increase motivation and collaboration.
- Actual and perceived cognitive abilities of the partners: this factor draws the attention to possible difficulties managing asymmetries in collaboration.
- Distribution of control: the way about the different members of a learning group are able to control their learning pace and how available tools enable this process during collaboration.
- Nature of the task: the nature of the task also influences the way a group 'decides' to collaborate. The difficulties of being able to collaborate synchronously might lead to losses in the activities, which increase the chance of demotivation towards group work.
- Time: socio-affective relationships evolve in time. Thus, it is important to conduct longitudinal studies in order to reveal how the different elements of a group are able to appropriate the technologies at their disposal.

2.3 Seamless Learning

Seamless learning refers to the seamless integration of the learning experiences across various dimensions including formal and informal learning contexts, individual and social learning, and physical world and cyberspace [18].

A ubiquitous learning environment is a pervasive and persistent setting allowing students to access learning materials flexibly and seamlessly in any location at any time, both from the physical environment and from the Internet [19]. All echelons will integrate the collectors, thus creating a seamless collaborative environment [18].

In e-Learning or c-Learning (classroom-Learning), we need more efficiency and to focus on teaching and learning activities or peer perform interactive learning. From the seamless-learning perspective, learners are given the opportunity to collaborate and interact in new ways within their peers and the physical world, as well as the physical world can be augmented through the using of digital technologies.

Learners would be encouraged to externalize their learning experiences and increase their awareness of the underlying connections between abstract representations and concrete experiences.

Inspired by the discussions by Chan et al. (2006) on the seamless learning model supported by the setting of one mobile device or more per learner, Looi et al. (2009) propose that seamless learning can be framed according to the guiding principles of distributed cognition theory [20, 21].

Through a thorough review of recent academic paper on seamless learning, Wong & Looi (2011) identify ten dimensions that characterize seamless learning as follows [21]:

- (MSL1) Encompassing formal and informal learning;
- (MSL2) Encompassing personalized and social learning;
- (MSL3) Across time;
- (MSL4) Across locations;
- (MSL5) Ubiquitous knowledge access (a combination of context-aware learning, augmented reality learning, and ubiquitous Internet access);
- (MSL6) Encompassing physical and digital worlds;
- (MSL7) Combined use of multiple device types (including "stable" technologies such as desktop computers, interactive whiteboards);
- (MSL8) Seamless switching between multiple learning tasks (such as data collection t analysis t communication);
- (MSL9) Knowledge synthesis (a combination of prior + new knowledge, multiple levels of thinking skills, and multi-disciplinary learning);
- (MSL10) Encompassing multiple pedagogical or learning activity models.

2.4 Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) is a statistic method based on information systems theory to collect and analyze users' acceptance and use of a technology. This model suggests that when users are trying to use a new technology, at least two factors, perceived usefulness and perceived ease of use, to influence their decision:

1. Perceived usefulness (PU) - Fred Davis defined it as "the degree to which a person believes that using a particular system would enhance his or her job performance".
2. Perceived ease of use (PEOU) - Davis defined it as "the degree to which a person believes that using a particular system would be free from effort" [22].

3 Implementation of Flipped Learning

3.1 Instructional Design

We selected the lecture of distant learning, "I-Number Logic", to implement this experiment. This lecture supported by the MOOCs project of Taiwan Ministry of Education during 5/2014 $\sim$ 4/2015 was run by two styles of course. One was on TaiwanLife which is a MOOCs web platform during 10/27/2014 $\sim$ 01/18/2015 as 18 h lecture of pure distant learnng. Another was on CyberCCU which is the distant learning platform of National Chung Cheng University in Taiwan during 9/2014 $\sim$ 1/2015 as 36 h blended learning lecture. Both lectures used the same 18-hour high quality e-Learnng content with full HD resolution and mp4 media format.

Based on the Bishop and Verleger (2013) analysis, "an ability to communicate effectively," "an ability to identify, formulate, and solve engineering problems," and "an ability to function on multidisciplinary teams" are important training outcomes of an engineering unversity student [14]. Many of these criterion for better outcome are generally difficult to teach and assess effectively with informative lectures and closed form questions. The lecture offered in TaiwanLife was a 100 % self-learning and informative lecture. Even we tried to design more attractive problems, we were hard to face our students to let problem more open. Therefore, the second style lecture offered in our university was increased 18 h to run the flipped learning.

This lecture is related to the I-Ching so called the Book of Changes, a mystery kwonledge from ancient china. It is very difficult to fully comprehend the knowledge base and inference rules of the core book. Therefore, we rewrite the part of prediction as the main content of our lecture to satisfy the modern lecture format. We translate the old concept of knowledge to be a knowlege rule base. Students can learn the specific rule to understand the deep idea instead of ambiguous concept of original I-Ching. Also, we apply the inference structure of fuzzy system to rewrite the prediction rule as a well-form inference mechanism. Students can understand how to manipulate a set of rules picked up from knowledge rule base to progress a sequence of inference steps and finally give a perfect consultation.

There were 33 students whose majors are in Engineering or Managment to take the I-Number Logic in our university. Mathematical Logic is one of the key foundations related to their major areas. Therefore, we design two kinds of open form questions to let students construct their I-Ching knowledge and prediction inference abiliy.

Type I Problem: Ask students to explain an old phrase or several correlated old phrases with a new knowledge rule. For example,請以生尅之法則解釋“兄動刻財,子動能解”。(Fig. 1).

A lot of phrases can be found from old books. This kind of treasure knowledge can be appropriately selected to let students discuss outside the classroom and then present their opinion inside the classroom.

Type II Problem: Ask students to rewrite old predication cases with new inference mechanism (Fig. 2).

Aslo, a lot of old cases are avaliable without worrying about the copyright. Most of the old cases were concept-based writing style with uncertainty conclusion. Let each completely discuss the assigned cases outside the classroom and then present their new results inside the classroom.

In this class, 33 students are divided into 11 groups. Each student can discuss the problem in their group, but must return the answer and result by oneself. In this study,

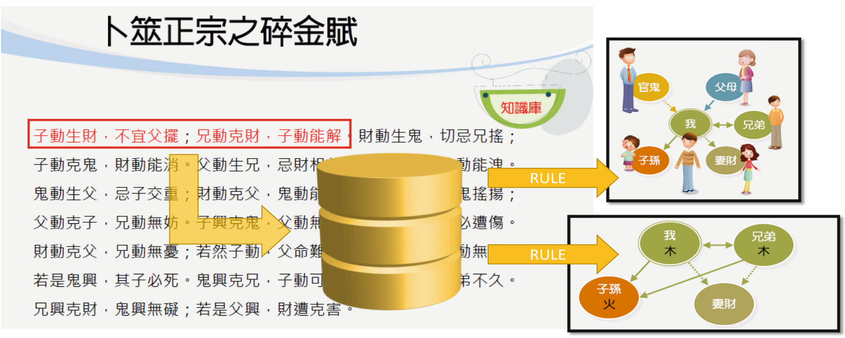

Fig. 1. A new knowledge rule

Fig. 2. Some new inference mechanisms

we just concentrated on analyzing the final report of each group on their activity gap and technology acceptance. Each group was assigned a project with two Type II problems and one self-design problem. Each problem has one member in charge of it. This member is called as the major member and another two members are called minor members. Each one has a chance as the major member and two chances as minor members. The mission of major member was in charge of preparing the PPT and reporting the main result. Another two were to assist the major member to report the supplementary data from knowlege rule base and inference mechanism while the major member mentioned them.

Inside the flipped classroom, each group has three times to report their final project. Students not in the active group were encouraged to discuss with the reporting group for realizing the concept of peer learning.

3.2 Multiple Channel Presentation

At most, four persons want to present including one teacher and three students. In Fig. 3, the traditional projector configuration was suggested. The teacher handled the VGA switch box to decide whose content can be shown on the screen. At same time, only one person can display his/her content under this solution. This style of presentation is called

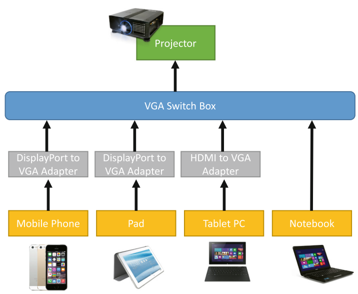

Fig. 3. Switching presentation

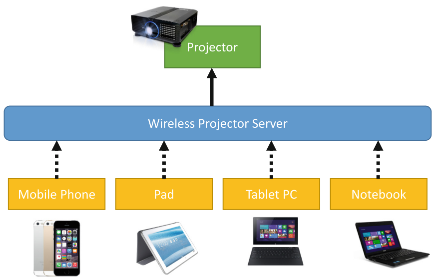

Fig. 4. Parallel presentation

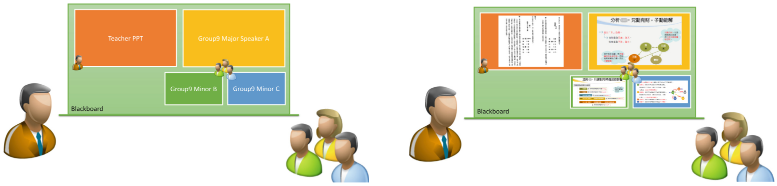

Fig. 5. A highly interactive scenario

as switching or sequential presentation. In Fig. 4, the wireless projector server was proposed. The wireless projector server allows four contents display on screen at same time. The teacher and students can use the wireless environment to connect to wireless projector server. This server can receive four inputs and then display them on one screen. This style of presentation is called as parallel presentation. Under this presentation style, the highly interactive scenario can be easily realized as shown in Fig. 5.

4 Analysis of Seamless Learning

This experiment is to test whether the parallel presentation can reduce the activity gap in contrast to the switching presentation. The first run of 11 groups was asked to use the approach of switching presentaton to present their first Type II problem. Then, the second

Fig. 6. The scenario of parallel presentation

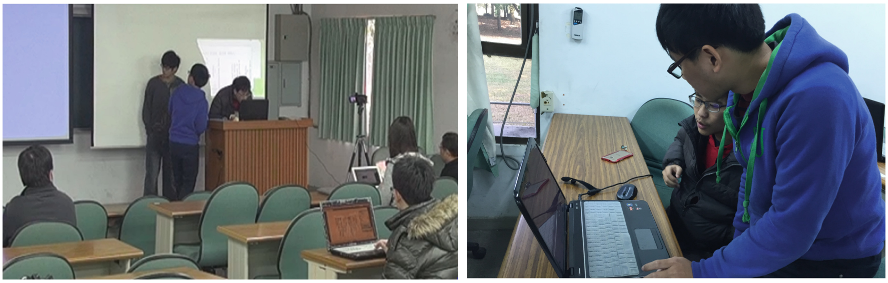

Fig. 7. The difference scenario bewteen squential and parallel presentations

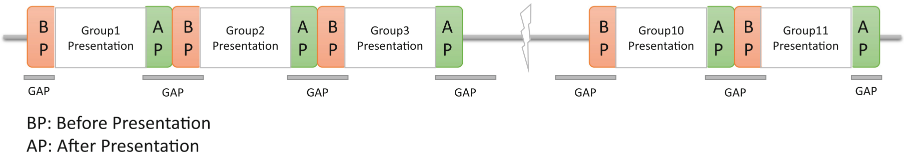

Fig. 8. A learning gap bewteen two consecutive presentations

run was asked to use the approach of parallel presentation to present their second Type II problem. The presentation time of each problem is not over 10 min (Figs. 6 and 7).

We used two digital video recorders to record the whole learning activities occured inside the classroom. We found that the activity gap occurred between two consecutive presenations. In Fig. 8, we can find that before and after 11 presentations totally have 12 gaps.

Basically, the duration time before presentation probably was occured by

(1) walking from seat position to presentation position;
(2) setting up the VGA connection to project;
(3) setting up the resolution and mirror projection.

Also, the duration time after presentation probably was occured by

(1) taking off the VGA connection;
(2) picking up their notebook and handout and going back to their seat.

With the ideal consideration of seamless learning, we should spend whole lecture time on presentation. Actually, it is impossible to reach this ideal goal. The only effort is to reduce the gap. From our statistical data, we found that average time spent on each group on the 1st and 2nd runs were 15.81 and 10.03 min, respectively.

In Table 1, we can find a significant differences of presentation time spent by each group in the 1st and 2nd runs. By switching presentation, each member probably used different brands of notebook to connect to projector so that it always caused a connection failure. The Groups 5 and 11 in the 1st run can not connect to projector, and tried a couple of times finally to conncet to the projector. This caused a big gap before their presentation.

Table 1. The presentation time tabulation

Group	Before presentation(min)		In presentation (min)		After presentation(min)		Overall(min)	
	1st run	2nd run	1st run	2nd run	1st run	2nd run	1st run	2nd run
01	4.5	2	6.2	7	2	0.5	12.7	9.5
02	5	1.2	8	7.8	2	0.4	15	9.4
03	5.2	1	7.5	7.6	2.2	0.5	14.9	9.1
04	4	1	9	9.2	1.5	0.4	17.5	10.6
05	13	1.2	10	9	2	0.5	25	10.7
06	4	1.1	8	8.5	1.5	0.5	13.5	10.1
07	3	1	7	8.5	1.6	0.4	11.6	9.9
08	4	2	7.5	8	1.4	0.5	12.9	10.5
09	5	1	8.2	9	1.5	0.5	14.7	10.5
10	6	1	8	8.2	1.5	0.4	15.5	9.6
11	12	1.4	7.2	8.5	1.4	0.5	20.6	10.4
Average	5.97	1.26	8.15	8.30	1.69	0.46	15.81	10.03
Percentage	37.78 %	12.60 %	51.52 %	82.77 %	10.70 %	4.62 %	100 %	100 %

In the 2nd run, students didn't need to walk to platform or inforamtion desk. They can present their result on their seats, and cooperate with another members via Wi-Fi by using the wireless projector APP to show their reports on the projector screen. Therefore, they had more time to explain his/her study report with comfortable mood. In the 1st run, each group almost wasted almost half time (48.28 %) in preparing for presentation. However, in the 2nd run, the preparation time was highly reduced and students spent 82.77 % time on their presentation.

5 TAM Analysis of Highly Interactive Environment

Although much research supports the Technology Acceptance Model (TAM) as an excellent model to explain the acceptance of IS/IT, it is questionable whether the model can be applied to analyze every instance of IS/IT adoption and implementation [23].

Many empirical studies recommend integrating TAM with other theories (e.g. IDT, or DeLone & McLean's IS success model) to cope with rapid changes in IS/IT, and improve specificity and explanatory power (Carter & Be´langer, 2005; Legris, Ingham, & Colerette, 2003) [24, 25].

According to the TAM, it is derived to apply to any specific domain of human–computer interactions (Davis et al., 1989) [22]. The TAM attitude toward using, in turn, is a function of two major beliefs: perceived usefulness and perceived ease of use. Perceived ease of use has a causal effect on perceived usefulness. Design features directly influence perceived usefulness and perceived ease of use [26].

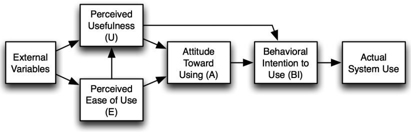

Fig. 9. The Technology Acceptance Model, version 1. (Davis 1989)

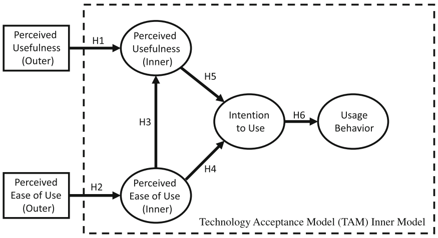

Fig. 10. The Highly Interactive TAM Model

5.1 Research Model and Hypotheses

Study Architecture: This study is based on Davis (1989) the Technology Acceptance Model (TAM), which follows the original mode of "perceived usefulness, perceived ease of use, the intention to use and the usage behavior" as facets of inner model variables [22]. On the external variables, we selected the Venkatesh, V. and H. Bala, (2008) proposed Technology Acceptance Model as an external variables and design questionnaires for the outer model of TAM. The outer model questionnaires require to explore usage intention of students' acceptance to use the system in perceived usefulness and perceived ease of use [23] as shown in Fig. 9.

This study was based on Fig. 10 that delimits the relationship in the various facets of TAM architecture. According to this model, we proposed six hypothesis to investigate the effects of TAM. The definition and rationale for each of research hypothesis variables are detailed below:

"The External factors" (In SmartPLS known as "Outer Model") refers to the quality of their information systems function measure. It contains the system's reliability, usefulness, ease of use, friendly and reaction time [27]. This study was based on the above theory and hence we developed following research hypothesis:

H1: External factors will positively influence perceived usefulness.
H2: External factors will positively influence perceived ease forward.

According to the Davis (1993) and Igbaria et al. (1997) pointed out, the Perceived ease of use will positively affect the perceived usefulness and intention to use [26, 28].

The perceived usefulness follows the above theory document to develop the H4 and H5 research hypothesis. In addition, according to the Sørebø and Eikebrokk (2008) point out, if information technology can allow the user spend less time to learn how to use, in a better way it can be easily intuitional to use, so that it will indirectly improve user interaction with the application of information technology [29]. Therefore, we designed hypothesis as follows:

H4: perceived ease of use will positively influence perceived usefulness.

About "Perceived usefulness", Davis (1993) and Igbaria et al. (1997) found that if the user thinks the information system can effectively improve work efficiency, the user will have a higher intention to use this system. This study was based on the theory of this document, the following research hypothesis [26, 28].

H5: The cognitive using perceive usefulness will positively influence the system.

"Interaction with the system" refers to the interaction between users and information systems. If the user more frequent to use the system, which represents that a user will have a higher intention to use the system [26, 28]. The following research hypothesis is based on the theory of this document:

H6: interactive with the system will positively affect the willingness to use the system.

5.2 Questionnaire Design and Operational Definition

This study used questionnaires to predict and investigate the system of student acceptance the ease of use and usefulness. All the questionnaires were designed by refering to some research experts [18, 30]. In this study, the questionnaire content was: Perceived Usefulness Outer model, Perceived Ease of Use Outer model, Perceived Usefulness Inner mode, Perceived Easy of Use Inner model, Intention to Use and Usage Behavior. A totally is 36 ask items.

5.3 Development of Instruments

Data Collection: The samples were collected from the lecture, I-Number Logic, in our university, Chung Cheng Univrsity. Therefore, this study actually used the college students to carry out a questionnaire administer test. We used the concept of TAM, and designed 70 questions for questionnaire. After that, we discussed with seven professors and doctoral students and left 36 questions for final experiment. It was enough to reveal both inner and outer model of TAM dimensions. The questionnaire experimented from January 5, 2014 to January 15, 2014. Total investigations sent out were 80 questionnaires and took back 65 samples. After the deduction of 13 invalid questionnaires, 52 valid questionnaires were obtained. The effective rate was 65 % for reflecting this study results for the wireless projector environment.

5.4 Reliability Validity Analysis

This study analyzed the results of the program in accordance with SmartPLS. It was determined where the reliability index factor loading and a Composite Reliability (CR) and Average Variance Extracted (AVE). If the CR higher values can be measured, the latent variables (Bagozzi 1981) would show the recommended value of 0.6 or more [31].

The Average Variance Extracted (AVE) values were calculated for each potential variables. If the average variance was extracted the higher amount of potential variables, it showed that there were more potential variables. Concerning about high

Table 2. Test results of each facet

	Composite Reliability (CR)	AVE	Cronbach's Alpha
Perceived usefulness (Outer)	0.932	0.505	0.919
Perceived ease of use (Outer)	0.914	0.545	0.895
Perceived usefulness (Inner)	0.891	0.673	0.836
Perceived ease of use (Inner)	0.958	0.852	0.942
Intention to use	0.878	0.705	0.793
Usage behavior	0.888	0.727	0.809

convergent validity and discriminant validity, Fornell and Larcker (1981) suggested that the average variance extracted should be greater than 0.5. The table shown below reflected the average variance extracted from all constructs of all amounts greater than 0.5. Thus, this study confirmed the measurement of this experiment and had some convergent validity [32].

The reliabilities of each variable were shown in Table 2. In this study, Cronbach's Alpha coefficient value on reliability analysis tested the internal variables to measure each of the question items from the table consistency between Cronbach's Alpha value of each variable between 0.793 to 0.942. According that Cronbach's Alpha value was greater than 0.6 and the CA value was greater than 0.7, the reliability of the questionnaire can meet the eligibility criteria and then the use of this research scale had good reliability. In Table 2, Composite Reliability and Cronbach Alpha were higher than the recommended value. It explained that the internal consistency of this study indicated that all facets of the project were good.

Overall for the questionnaire, most of users who used Airboard in flipped classroom learning activities were perceived and interesting. Some of them expressed the hope that can continue and will recommend it to other students to use. Not only that, some of students hoped to using courses in the future, but also to apply relevant information technology for learning activities.

6 Conclusion

In this study, we have employed the technique of wireless projector to improve the interactive ability of a group of students while they are presenting simultaneously. This improvement can make more freedom of interaction inside the flipped classroom so that students can present on their seat instead of working to the platform or information desk.

We found that the *t* values collected from the hypothesis of H1, H2, H3, H4, H5, and H6 all reached the standard level of significant. This shows that the Wireless Projector Server System possesses high satisfaction and positive effect.

Therefore, the experimental results demonstrated that the proposed model could readily support highly interactive learning activities for the flipped learning and have high acceptance of intent of use and usage behavior. We believe we catch the developing trend to establish the highly interactive model that still has more fruitful research issues to deal with in the future.

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