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The Adoption of TAM for Investigating Intention Usage in a Simulation for Teaching Assistance of Computer Graphics

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Abstract: This research investigates student acceptance of teaching assistance simulation for a computer graphics (CG) course. The study proposes the Technology Acceptance Model (TAM) to assess the impact of perceived variables and extended variable on intention usage. The perceived variables consist of perceived ease of use and perceived usefulness and the extended variable consists of interface design. The proposed methodology was then employed in a study using students enrolled in the CG course. A teaching assistance simulator for the CG course was developed using Microsoft Visual C++ and OpenGL. The simulator helps students understand the fundamentals of computer graphics such as the setting of material and lighting of objects, learning the viewport and understanding 3D transformations. In addition, we also used the tools to teach OpenGL commands in the CG course. The results from the study support the hypotheses. The outcomes indicate that both the perceived and extended variables can effectively predict whether users will adopt a simulation program. Moreover, this research also provides insight into various simulation tools that may be a useful reference for students.

Keywords: Technology Acceptance Model (TAM), Computer Graphics, User Interface Design, Intention Usage

1. Introduction

Computer Graphics (CG) is the most important prerequisite course for further studies in advanced Computer Graphics such as Computer Animation, Image Processing, Game Programming, and so on. This is because it provides the fundamental concepts of CG such as creating viewport, understanding 3D transformations, setting colors, and adding lighting of materials. Certainly, learning concepts of CG inevitably involves programming languages and graphics application programming interface (API). The students who chose to study CG should have a very good skill in programming. One method to assist students to understand the CG principles is to apply theory to practice. For example, Michael B. Gousie (2000) encouraged his students in CG course to code large CG projects and to interact via CG project. The result showed that students paid more attentions and truly understood the concepts. There are many research studying the assistant teaching in computer graphics, for example, Gerald Shultz (2006) developed an application consisting of model objects, setting light and a camera, and 3D transformations by using a sample pedagogic 3D graphics API. However, it did not include the setting color of objects which is an essential property of material. Rance D. Necaise (2006) developed an interactive graphics tool used in an introductory computer graphics course of computer science department at Washington and Lee University. The tool is developed by using OpenGL and the graphix windowing toolkit. To the best of author's knowledge, we found that the existing research in computer graphic assistant teaching ignored the students' acceptance of

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the assistant tools. Therefore, this research focuses on investigating students' acceptance of a simulation for teaching assistance in a CG course.

The current trend in education is to apply information technology (IT) in the learning process. As more teachers adopt information technology to assist instruction, more researchers will investigate the issue of technology-integrated education (Liu et al., 2010)

TAM is widely accepted as a powerful tool to represent the determinants of users' adoption and usage decision across a variety of IT. TAM has been applied to studies on the adoption intention usage of various IT and systems (e.g. Albert, Donna, Mark & Youlong 2000; Juan Carlos Roca, Chao-Min Chiu, & Franciso Jose Martinez 2006; Dong-Hee Shin 2007)

This research attempts to investigate the students' acceptance of a simulation for teaching assistance of a CG course. It was argued that the findings of this study provide a good basis for lecturer considering the potential adoption of the teaching assistance.

2. Background and Related work

Technology Acceptance Model (TAM) was derived from the Theory of Reasoned Acton (TRA, Ajzen&Fishbein, 1980) which describes how users' beliefs and attitudes relate to individuals' intentions to perform. TAM was developed by Davis (1986) who aimed to explore the impact of technology on user behavior. The model is composed of two factors: Perceived Usefulness (PU) and Perceived Ease of Use (PEU) both of which have impact on individual's Intention Usage (IU). The relationship between PU, PEU, and IU is described in Figure 1. PU refers to "the degree to which an individual believes that using a particular system would enhance his/her job performance" and (PEU) refers to "the degree to which an individual believes that using a particular system would be free of physical and mental efforts" (Davis 1989).

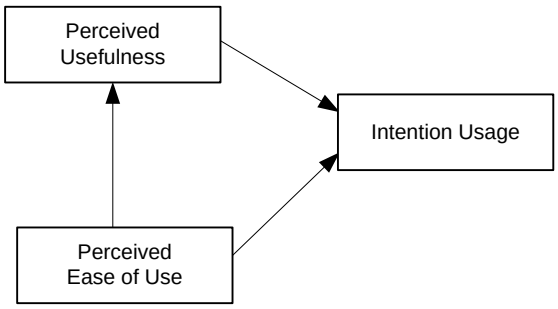

Figure 1: Technology Acceptance Model (Davis 1989).

User Interface Design (UID) is one of the critical factors that should be considered (McKnight, Dillon & Richardson, 1996). Many user interface features of an information system such as menus and icons are specially intended to enhance the usefulness and ease of use of different

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functions of the system (Cho V.,Cheng T.C.E., Lai &W.M.J.,2009). A well designed user interface can help user to operate a system more easily (Jones, Farquhar, & Surry, 1995), Moreover an interactive interface design should quickly guide users to the correct way of learning (Liu, Chen, & Sun, 2006).

3. Research Design

The major objective of this research is to investigate the perceived factors and an extended factor that affect the intention usage by adoption TAM. The minor objective is to find the relationship between the independent variables, which are PU, PEU, and UID. In this section, we first discuss the research model used in the relationship analysis. Then, we present the research's hypotheses, followed by the research data collection.

The research model is presented in Figure. 2.

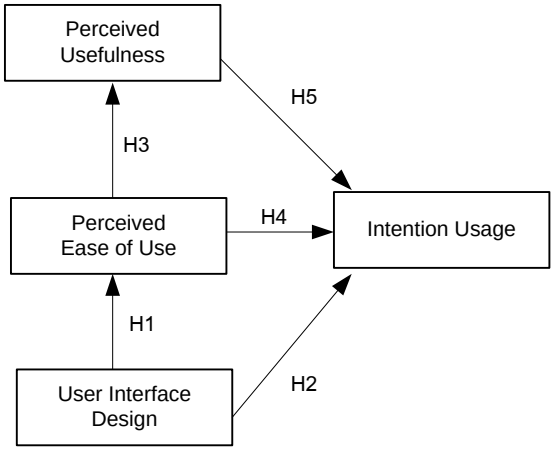

Figure 2: The proposed research model.

From the Figure 2, we have the following hypotheses:

H1: User Interface Design will have a direct effect on Perceived Ease of Use.

H2: User Interface Design will have a direct effect on Intention Usage.

H3: Perceived Ease of Use will have a direct effect on Perceived Usefulness.

H4: Perceived Ease of Use will have a direct effect on Intention Usage.

H5: Perceived Usefulness will have a direct effect on Intention Usage.

A summary of the research variables and related hypotheses is presented in Table1

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Table 1

Research hypotheses

Variable	Related Hypotheses
User Interface Design (UID)	H1: User Interface Design will have a direct effect on Perceived Ease of Use.
	H2: User Interface Design will have a direct effect on Intention Usage.
Perceived Ease of Use (PEU)	H3: Perceived Ease of Use will have a direct effect on Perceived Usefulness.
	H4: Perceived Ease of Use will have a direct effect on Intention Usage.
Perceived Usefulness (PU)	H5: Perceived Usefulness will have a direct effect on Intention Usage.

The research design was a kind of questionnaire quantitative approach, mainly informed by Liu et al., 2010 questionnaire for their study of extending the TAM to explore the factors that affect intention to use an online learning community, as well as the questions used by Davis (1989) for identifying factors that influence technology adoption. It was then employed in a study using 57 students enrolled in the CG course in school of science at University of the Thai Chamber of Commerce. A teaching assistance simulator for the CG course was developed using Microsoft Visual C++ and OpenGL.

The researchers collected data from the survey questionnaire and used SPSS for windows program to examine the inference statistics. The study was tested by descriptive and correlation. Simple Linear Correlation (Pearson's r) was used to determine the extent to which values of the variables are proportional to each other. A summary of the result is demonstrated in the next section.

4. The simulator development

We developed a simulator for the teaching assistance of CG course by using Microsoft visual C++ and graphics API such as OpenGL, GLUT and AntTweakBar. The simulator aims to assist students in understanding the fundamental concepts of CG such as setting color of material and lighting of object, creating the viewport and understanding 3D transformations. For the development, we first designed a class diagram that consists of 11 classes, as shown in Figure 3. From the class diagram, we can explain that classes in the bottom line of the diagram, consisting of CGSCone, CGSCube, CGSSphere and CGSTeapot, are subtype of a class CGSGLU3D. In

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addition, the class CSSGLU3D and a class CGS3DModel are inherited form a class CGSObject. The class CGSObject and a class CGSLight are parts of a class CGSWorld. Furthermore, a class CGSViewport makes relationship both a class CSGCamera and the class CGS World.

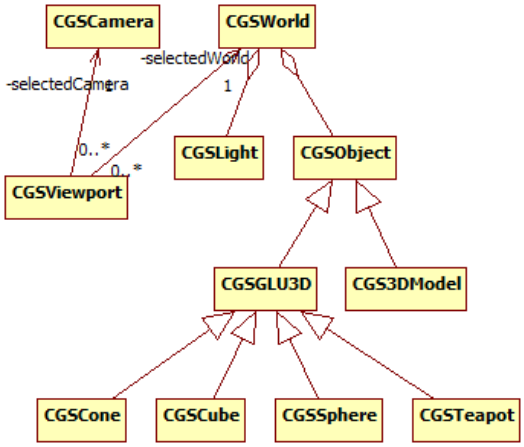

Figure 3: The class diagram of the simulator

Next, the class diagram can be converted into coding to implement class of the simulator. The example of the implementation to the class "CGSLight" is shown in Figure 4. The Class "CGSLight" is generally used for setting light on the objects.

```
class CGSLight
{
public:
        int lightID;
        float ambient[3];
        float diffuse[3];
        float specular[3];
public :
        CGSLight();
        void setAmbient(float red,float green,float blue);
        void setDiffuse(float red,float green,float blue);
        void setSpecular(float red,float green,float blue);
        const float* getAmbient();
        const float* getDiffuse();
        const float* getSpecular();
        void setID(int id);
        int getID();
};
```

Figure 4: An example of class CGSLight

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The simulator interface is subdivided into three main parts, a Main Window, a Control Center, and a Properties Box, as presented in Figure 5. Firstly, the Main Window displays a 3D model in the viewports which can be added or removed by users. Secondly, the Control Center is used for creating a new viewport and a new camera, setting new light and choosing the new model. Lastly, the Properties Box is used for setting value of the object's properties, setting the objects' colors, lighting the object, and 3D transformations. In addition, we used the simulator for teaching OpenGL commands and properties in CG course by learning from parameters of each command in the properties box.

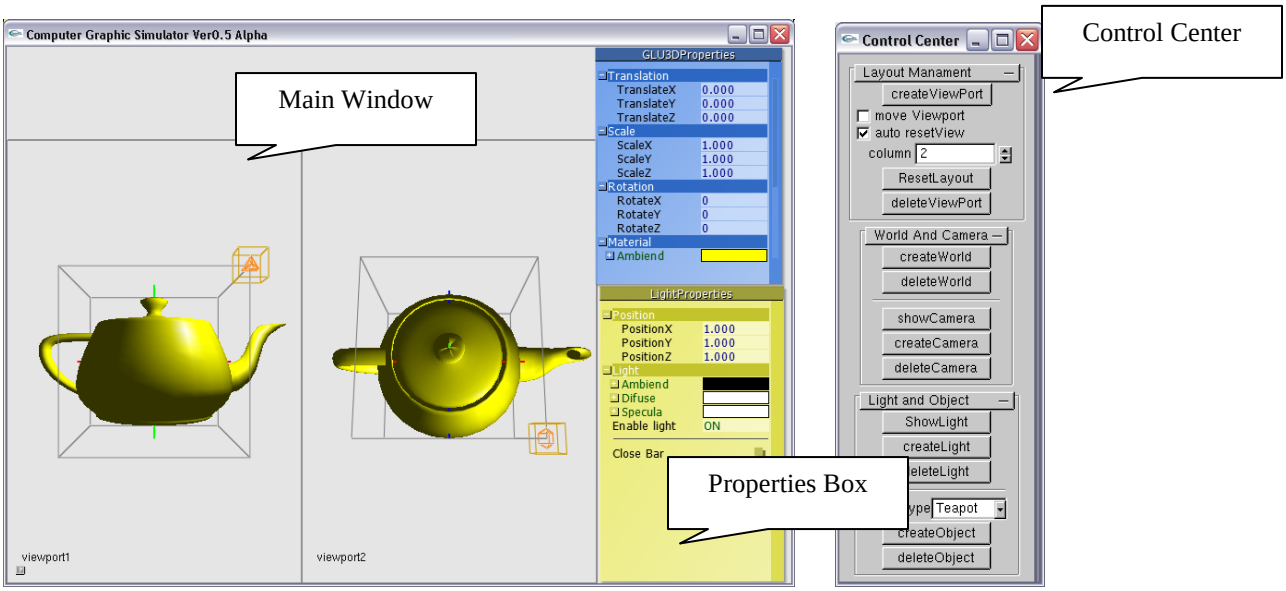

Figure 5: The Main Window, the Properties Box and the Control Center

5. Results and discussions

The Cronbach's alpha coefficient for internal consistency reliability was first assessed. As shown in Table 2, it was shown that each construct exhibited strong internal reliability.

Table 2. Validity and Reliability

Reliability assessment Variable	N of Items	Cronbach's Alpha	Mean	Std. Deviation
UID	4	.679	15.54	2.027
PEU	3	.824	11.37	2.135
PU	4	.771	15.40	2.060
IU	2	.770	8.12	1.324

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The descriptive statistics of the constructs are presented in table 3. It shows the mean scores of UID, PEU, PU and IU. All mean scores were greater than 3.0, ranging from a low 3.7895 to a high of 4.0614. This indicates an overall positive response to the constructs. The standard deviations for all variables were less than one and this indicates that the item scores were around the mean scores.

Table 3. Descriptive statistics of the constructs.

Variable	Overall Sample (N = 57)	
	Mean	S.D.
UID	3.8860	0.5068
PEU	3.7895	0.7117
PU	3.8494	0.5068
IU	4.0614	0.6619

The study examined the correlations among the study variables. The correlations are presented in Table 4. Regarding the relationships between the concerned variables, it was found that IU had a relationship with the UID, PEU, and PU (r=.680**,.603**,and .536**). PU had a relationship with UID and PEU (r=.643**, and .572**) Moreover, PEU had a relationship with UID (r=.712**).

Table 4. Correlations among the study variables

Variable	UID	PEU	PU	IU
UID	1	-	-	-
PEU	.712**	1	-	-
PU	.643**	.572**	1	-
IU	.680**	.603**	.536**	1

All correlations are significant at the 0.01 level (2-tailed).

The result of the correlation test indicates that PEU, PU and UID exhibited equally strong impacts on IU. Therefore all hypotheses are supported.

6. Conclusion

The result of this research shows that all hypotheses were confirmed. The user interface design of the simulator has a significant impact on intention usage of students. From the result, we conclude that the instructors who plan to develop the teaching assistance of the simulator should make a special effort to properly design its user interface. This is because the interface design directly affects the simulator's ease of use. In other words, if the design of the interface is not complicated, the students will perceive the simulator as easy to use. Moreover, this study provides valuable information related to an understanding of the relative efficacy of perceived usefulness, perceived ease of use, and user interface design in the context of an education setting. Finally, this study provides information useful for the development of an effective a simulation for teaching assistance of computer graphics.

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