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Collaborative Learning for Packaging Technology using Virtual Reality

[1]Ratchadawan Nimnual and [2]Surachai Suksakulchai
[1]Learning Innovation in Technology Program, [2]Department of Electrical Technology Education,
Faculty of Industrial Education and Technology
King Mongkut's University of Technology Thonburi, Bangkok, Thailand

Abstract: This study presents an application of Collaborative learning for Packaging technology using Virtual Reality (COPVR). The COPVR was divided into two steps, Pattern Packaging (PP) and Material Packaging (MP). The PP was designed to let students to practice their thinking by finding and matching a Pattern model of an unknown package with a set of 3D packages with which are randomly selected from the system. If they cannot choose correctly, the score will be deducted from their total scores. In addition, the system also provides material and pattern packaging tutorial such as a material selecting and other information and for second game, the MP, students are selected an appropriate material of packages for each products from program randomly and the selecting steps were controlled by the system in which students must selected a correct material of each product. If they can select correctly, the system will show the result and score increase. On the other hand, if students select a wrong material, the system will give the students a warning and their scores will be deducted. After students pass the COPVR system, they can understand in material packaging and can design the good pattern of packaging. Then this system was evaluated by five experts. The index of Item Objective Congruence (IOC) is 0.82. The program was corrected and improved before trial with a target group. The target groups of this study consisted of 24 packaging students and they were selected by simple random sampling. This study describes some approaches to provide the VR game-based learning system discusses problems, experiences and presents an outlook for the virtual game and collaborative learning of packaging technology for students in the future. However, the result showed that students can select the good packaging material and design the pattern in a good level. Finally, the assessments of the performance of the program are presented.

Key words: Collaborative learning, virtual reality, game-based learning, packaging technology, COPVR, Thailand

INTRODUCTION

Packaging technology is a course related to the design and the application of the designed package to make the product. Therefore, the course must focus on the design and the package production in team. However, the practice cannot be achieved due to the limitations in budget for non-renewable materials, especially paper resulting in the students lacking enough materials for practice. Moreover because of insufficient time in class, the students have to continue their work at home. Other problems also arise such as some students do not work at all whereas other students must work very hard to finish the assignments on time. This is partly because the students live in different locations far away from one another and their free time is not the same due to their selection of different courses. These problems are crucial for the students' learning skills. Therefore, innovation should be used in the instruction so that every learner could work together at the time, they are ready such as after dinner time. In other cases like somebody is not free, the system is still ready for other people in the group to use it. According to research results in the past, it was found that collaborative learning which requires all members to work together to find solutions to the assigned problems is an approach suitable for the globalization era when everybody needs to participate in creating something in the modern world.

Moreover, the focus is now on the relationship between the persons of different skills to work together in different issues. If 3D virtual reality technology is applied to facilitate the presentation, the lesson may be interesting due to it is interactive every learner could work together at the time, they are ready such as after dinner

Corresponding Author: Ratchadawan Nimnual, Learning Innovation in Technology Program, Faculty of Industrial Education and Technology, King Mongkut's University of Technology Thonburi, Bangkok, Thailand

time. In other cases like somebody is not free, the system is still ready for other a game is a system in which players engage in artificial conflict defined by rules that results in a quantifiable outcome. The goal of successful game design is the creation of meaningful play which is achieved by creating game-play that enables discernable and integrated interaction by the player.

The concept of collaborative learning, the grouping and pairing of students for the purpose of achieving an academic goal has been widely researched and advocated throughout the professional literature. The term collaborative learning refers to an instruction method in which students at various performance levels work together in small groups toward a common goal. The students are responsible for one another's learning as well as their own. Thus, the success of one student helps other students to be successful.

Proponents of collaborative learning claim that the active exchange of ideas within small groups not only increases interest among the participants but also promotes critical thinking. According to Johnson and Johnson (1986), there is persuasive evidence that cooperative teams achieve at higher levels of thought and retain information longer than students who work quietly as individuals. The shared learning gives students an opportunity to engage in discussion, take responsibility for their own learning and thus become critical thinkers (Totten *et al*., 1991). In spite of these advantages, most of the research studies on collaborative learning have been done at the primary and secondary levels. As yet, there is little empirical evidence on its effectiveness at the college level. However, the need for non-competitive, collaborative group work is emphasized in much of the higher education literature. Also, majority of the research in collaborative learning has been done in non-technical disciplines. The advances in technology and changes in the organizational infrastructure put an increased emphasis on teamwork within the workforce. Workers need to be able to think creatively, solve problems and make decisions.

LITERATURE REVIEW

Game based learning: Wolfe and Crookall (1998) indicate that computer game-based learning is emerging as a hot topic in education. In recent years, there has been increasing interest both in the potential of computer games as learning and teaching tools and in research into their use. The inception of educational gaming dates back to the 1950's with the integration of war gaming, computer science and operations research, coupled with the emergence of constructivist educational theories that emphasis active, experiential learning and reflection. The first computer games were developed in the late 1960's and it was not long before computer games were also being used and developed for educational purposes. There are many examples of different and innovative ways in which computer gaming has been used to support learning and teaching in recent years both with children and in higher education. For example, recent research with school children includes the use of bespoke science games, off-the-shelf historical games and multi-user gaming environments. Examples of recent research in higher education include the use of games to support the learning and practice of civil engineering concepts (Ebner and Holzinger, 2007), a competitive game to teach programming and virtual reality games used with geography students (Virvou *et al*., 2004).

Virtual reality: Virtual Reality (VR) is a term that applies to computer-simulated environments that can simulate physical presence in places in the real world. Cronin (1997) indicate that there are basically three different kinds of VR, categorized by the quality of the immersion that is being provided. The 1st is desktop VR which is by far the most common and least expensive form of VR there are which typically consists of a standard desktop computer. This form of VR completely lacks any feelings of immersion on the part of the user. The 2nd, a semi-immersive VR system attempts to give the users a feeling of being at least slightly immersed by a virtual environment which is often achieved by different types of so called workbenches and reach-in displays. The 3rd form of VR isusually referred to as being fully immersed. It typically consists of head mounted visual display units that allow users to be completely isolated from thephysical world outside. Recently, a growing interest in building so-called caves has been noted. A cave is a room in which the walls surrounding the user produce the images and thus deliver a sense of immersion. Not surprisingly, fully immersive VR is generally considered the best option for several reasons including the ability to almost completely filter out interference from the outside world and thus allowing oneself to focus entirely on the virtual environment. However, even reasonable VR hardware and software designed to support full immersion is quite expensive and application development in this area is generally more difficult and time-consuming.

Learning skills: The approach was inspired by literature that uses Bloom's taxonomy (Bloom, 1956) identify skills to be practiced, it is also necessary to identify the best methods to teach the students according to their individual learning styles.

Level 1 (Knowledge): The basic ability to recall information without requiring any understanding of the material being recalled.

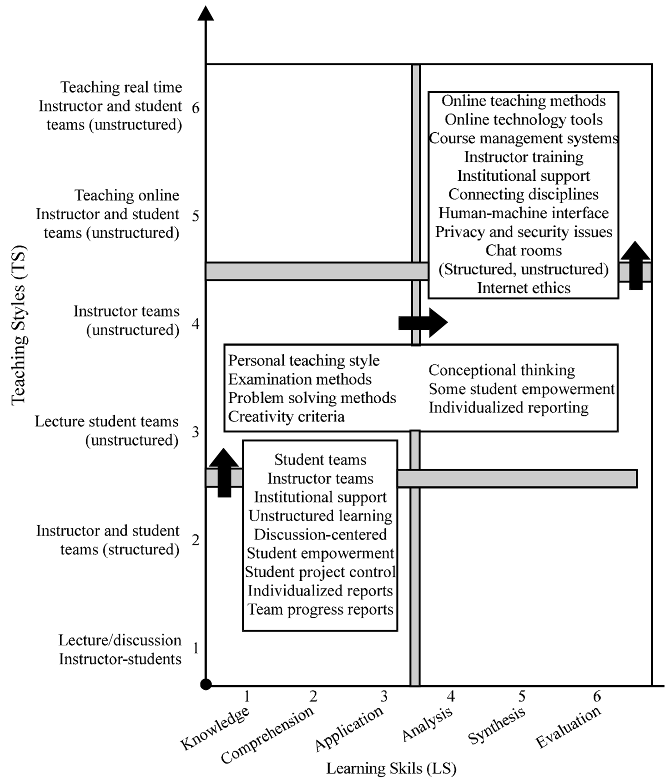

Fig. 1: The six main categories of Bloom's taxonomy

Level 2 (Comprehension): The ability to understand and interpret material or situations and to extrapolate that understanding to areas not covered by the original input.

Level 3 (Application): The ability to determine which knowledge is relevant to a particular situation and to correctly apply that knowledge to produce a correct solution to the problem at hand.

Level 4 (Analysis): The ability to break a complex problem or situation into parts and to recognize the relationships between the parts and the organization of the parts.

Level 5 (Synthesis): The ability to create a unique new entity by drawing on different aspects of knowledge and understanding such that the result is more than simply the sum of its component parts.

Level 6 (Evaluation): The ability to judge the value of ideas, solutions and methods, etc. This level is considered to be the top of the cognitive hierarchy because the student must employ all five of the lower levels, plus appropriate evaluation criteria in order to determine the overall value of the subject being examined (Fig. 1).

MATERIALS AND METHODS

Purpose of study: This study examined the effectiveness of individual learning versus collaborative learning in packaging design.

Research questions: The research questions examined in this study were; will there be a significant difference in achievement on a test comprised of packaging design items between students learning individually and students learning collaboratively?

Limitations: An initial pilot study was conducted at Department of Printing and Packaging Technology. The population is Packaging technology student in Thailand and the sample groups consisted of 24 students, the system was evaluated by five experts.

VR classroom design: COPVR was divided into two steps, Material Packaging (MP) and Pattern Packaging (PP). In the MP, students are selected an appropriate material of packages for each products from program randomly and the selecting steps were controlled by the system in which students must selected a correct material of each product. If they can select correctly, the system will show the result and score increase. On the other hand if students select a wrong material, the system will give the students a warning and their scores will be deducted. For the 2nd game, the PP was designed to let students to practice their thinking by finding and matching a pattern model of an unknown package with a set of 3D packages with which are randomly selected packaging tutorial from the system. If they cannot choose correctly, the score will be deducted from their total scores. In addition, the system also provides material and pattern students select a wrong material, the system will give the students a warning and their scores will be deducted.

For the 2nd game, the PP was designed to let students to practice their thinking by finding and matching a pattern model of an unknown package with a set of 3D packages with which are randomly selected from the system.

If they cannot choose correctly, the score will be deducted from their total scores. In addition, the system also provides material and pattern packaging tutorial such as a material selecting and other information. After students pass the COPVR game, they can understand in material packaging and can design.

Tool for collect data: The target group consisted of 24 packaging students and they were selected by simple random sampling and survey was on a 5-point Likert-scale (1 = strongly disagree, 5 = strongly agree). The system was evaluated by five experts and the Index of item Objective Congruence (IOC) (Fig. 2).

Procedure: The procedure comprised of two parts; lecture and worksheet. Initially, the researcher delivered a common lecture to both treatment groups. The lecture occurred simultaneously to both groups to prevent the effect of any extraneous variables such as time of day, day of week, lighting of room and others. The lecture was 50 min in length.

It was based on packaging design and material. Next, one section was randomly assigned to the individual learning group while the other section was assigned to the collaborative learning group. The two sections worked in separate classrooms. The same worksheet was given to both treatment groups. It was comprised of virtual reality game.

The full ranges of cognitive operations were called into play in that single worksheet. It began with factual questions asking for the units of packaging design. Next, the questions involved simple applications of material packaging. The factual questions and the simple application questions were analogous to the drill-and-practice items on the posttest. The questions that followed required analysis of the information, synthesis of concepts and evaluation of the solution. Both sections had the same treatment time.

Fig. 2: Try out with 24 students in COPVR system

System design

Project architectural: In this architectural diagram, the process is started at client browser by access to the Collaborative learning for Packaging technology using Virtual Reality (COPVR). The COPVR works by using VRML, XML and 3D model for display game environment and sent data to processing at server site. The COPVR up-loader application uses the HTTP protocol for transferring all related files to the servers and it also stores the information in the database server. In the meantime, the web server which hosts the COPVR homepage is responding all requests from the user including browsing and interactive functions.

Once a user selects the preferred game, the web server will redirect that user to the COPVR web-player, a VRML web application integrated with the XML and 3D model. With this COPVR web-player, users can play VR game with other player via collaborative from the beginning to the end. However at client site, system works by encoding, compressing a data and breaking it into small packets which are sent to server over the internet. When the packets reach destination server, they are decompressed data, decoder algorithms and then saved in storage devices and then processed by the application system consist of database, VRML, XML to interactive and send data back to client site for run game-based application (Fig. 3).

Technology descriptions: As in the Project architecture, this study was made of several technologies integrated together. From the client to the server, the technologies used in this study are totally different. This study will describe in detail about each technology and how it work

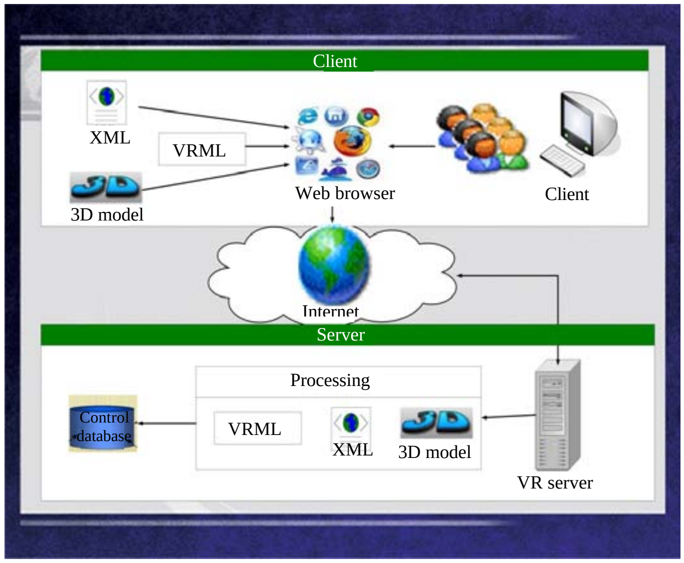

Fig. 3: System architectural diagrams

Fig. 4: Technology descriptions (client/server)

with the other technologies in the project by separating into two layers including client and server (Fig. 4).

Client side technologies: The Client-tier technologies are the group of components that running at the user side. The clients have no need to install any client software. However because the client side has taken advantage of a web browser to access media on demand, it needs to setup a plug-in in order to make the flash player work properly. It is the one time setup. All supported web-browser can acknowledge this plug-in setup at the same time. Therefore, users will not need to setup this plug-in for other web-browsers, they use in that computer again. All of the client-side components will be distributed to the clients by downloading of web-browsers from the web-server. The some components like HTML, VRML, JavaScript and CSS will be automatically run on the web-browser. However with the latest technology of VRML both class and interface are also saved in the client side as cookie. There are four web technologies used in the client tier including HTML (Hypertext Markup Language), DHTML (Dynamic HTML), JavaScript and VRML (Virtual Reality Modeling Language). The HTML, the basic web language is used in the Client-tier as the major integrator to fasten other technology together. On top of the HTML page, this study has used JavaScript language for the communication between technologies like a computer bus. As my research, JavaScript is the most effective language that can be used to connect other web client technologies together. Since, it has the web-client framework which is combined between HTML and JavaScript, the next technology that has been integrated is the VRML. This study uses the VRML to be the main interface for displaying the content, the model and the user interactive. The significant reason that selected VRML technology is that the display page is the multimedia web application which has a lot of components embedded in same page.

Server-side technologies: Although, most of the technologies are running at the Client-side, it also still needs the server side to serve the content and provide some multimedia that required in the Client-side. The components that are combined at the server-side including web server, VRML and database server. In order to be compatible with the application developed by using HTML extension interface and VRML at the Client-tier, web server technology has to be the product in the same solution which is Microsoft Internet Information Services (MIIS) and MySQL database. Moreover, the web server has to be integrated to the VRML and data compression software. The purpose of this integration is to convert a user's short-note to the media file. However, the database is the most important component in this tier. MySQL which is the most popular open source database is used. It is a Relational Database Management System (RDBMS) that is based on Structured Query Language (SQL). MySQL has a small size and fast speed so many small and medium websites choose it for their website databases to reduce costs. Because of its advantages, MySQL was chosen to manage the database system in this research.

The system approach: This study presents the instructional media of VR game-based learning for packaging technology. This instructional media were divided into two parts, Material Packaging (MP) and Pattern Packaging (PP). In the MP, students are selected an appropriate material of packages for each products from program randomly and the selecting steps were controlled by the system in which students must selected a correct material of each product. If they can select correctly, the system will show the result and score increase. On the other hand, if students select a wrong material, the system will give the students a warning and their scores will be deducted (Fig. 5). For the 2nd game, the PP was designed to let students to practice their thinking by finding and matching a Pattern model of an unknown package with a set of 3D packages with which are randomly selected from the system.

Fig. 5: Material Packaging (MP)

Fig. 6: Pattern Packaging (PP)

If they cannot choose correctly, the score will be deducted from their total scores. In addition, the system also provides material and pattern packaging tutorial such as a material selecting and other information (Fig. 6).

RESULTS

An initial pilot study was conducted at Department of Printing and Packaging Technology. The population is Packaging technology student in Thailand and the sample groups consisted of forty students and five experts. However, this research used the four step of evaluation consists of:

- First expert review
- Try out evaluation
- Second expert review
- Classroom experiment

The surveys used a 5-point Likert-type scale (1 = Strongly disagree, 5 = Strongly agree).

First experts review phase: Five experts with a high level of expertise in this research field reviewed the prototype version of COPVR to identify any deficiencies or problems and provided recommendations for improvement. The evaluation criteria determined the overall quality of the usability software testing and the experts' estimation provided a recommended design for the modification of the system. The overall quality of the system was determined according to concepts framework, effectiveness, efficiency and satisfaction followed ISO 9241-11 (1998). The level of quality was determined through four categories of concepts framework, effectiveness, efficiency and satisfaction. These showed means of 4.28 (SD = 0.37), 4.08 (SD = 0.46), 4.15 (SD = 0.55) and 4.20 (SD = 0.53), respectively. Moreover, this phase also summarized and changed the main design in order to solve the usability problems that had been identified in the quality of the VR graphics and the user interface (Table 1).

Try out evaluation phase: In this process, representative users identified and removed more prominent errors from the COPVR prototype. Three groups of students consist of 2, 4 and 6 students.

Table 1: Mean and standard deviations for COPVR prototype by the 1st expert review

Categories	M	SD
Concepts framework	4.28	0.37
Effectiveness	4.08	0.46
Efficiency	4.15	0.55
Satisfaction	4.20	0.53

Table 2: Means and standard deviations for COPVR prototype by the try out evaluation phase

Categories	M	SD
Concepts framework	4.40	0.37
Effectiveness	4.00	0.49
Efficiency	4.30	0.28
Satisfaction	4.10	0.38

Table 3: Means and standard deviations for COPVR prototype by the second expert review

Categories	M	SD
Concepts framework	4.60	0.36
Effectiveness	4.35	0.40
Efficiency	4.19	0.45
Satisfaction	4.40	0.47

Table 4: Differences pre and post-test score of control and experimental groups

Categories	Testing	Mean	df	S	t-values
Control group (classroom)	Pre-test	12.57	3.54	7.92	2.644*
	Post-test	16.80			
Experimental group (classroom+COPVR)	Pre-test	12.49	7.57	5.24	8.546*
	Post-test	19.49			

Table 5: Comparison of the achievement between classroom environment and classroom+COPVR environment

Teaching methods	Mean	S	t-value
Classroom	16.80	5.53	2.20*
Classroom+COPVR	19.49	4.51	-

*p<0.05

This phase focused on the suitability of the system for learning. The overall satisfaction of the system design was good. The degree of clarity of system was rated higher than target levels. The suitability for the concepts framework a mean of 4.40 (SD = 0.37), effectiveness a mean of 4.00 (SD = 0.49), efficiency a mean of 4.30 (SD = 0.28) and satisfaction a mean of 4.10 (SD = 0.38) (Table 2).

Second experts review phase: In this process, the COPVR prototype was finally reviewed by five experts who exhibited a high level of expertise in these fields of interest. Their task was to identify any deficiencies or problems and provide recommendations for the improvement of the prototype.

The evaluation criteria for determining the overall quality of the usability software testing, its clarity and impact were defined by ISO 9241-11 (1998). The evaluation criteria were determined in four areas, concepts framework, effectiveness, efficiency and satisfaction. These had means of 4.60 (SD = 0.36), 4.35 (SD = 0.40), 4.19 (SD = 0.45) and 4.40 (SD = 0.47), respectively. The overall quality of the system design was good (Table 3).

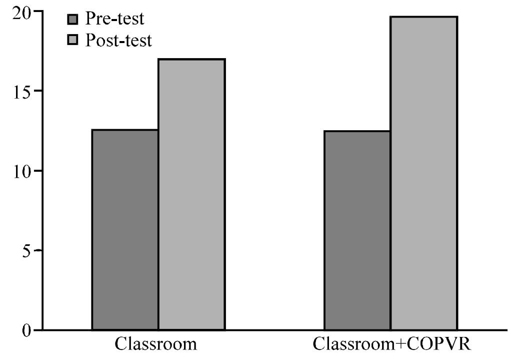

Fig. 7: The difference between classroom environment and classroom+COPVR environment

Class room evaluation phase: In this process, the evaluation separate control group and experimental group for pre- and post-test scores. The control group consist of 24 printing and packaging technology students. The experimental group consist of 24 printing and packaging technology students (Table 4 and 5).

As Table 4 shown the result of differences pre- and post-test score of control and experimental groups. The differences score of control group was 3.54, S score was 7.92 and t-value was 2.644*. For the experimental group, the differences score was 7.57, S score was 5.24 and t-value was 8.546*. It mean that the classroom+COPVR gave the better result in learning more than the classroom at 0.5 levels.

As Table 5 shows the difference in the learning achievement of the two groups by using a t-test statistics. The finding revealed that the achievement of the control group taught with classroom was statistically significantly different from the classroom+COPVR at 0.5 levels.

As in Fig. 7, the difference in the learning achievement of the two groups by using a t-test statistics. The finding revealed that the achievement of the control group taught with classroom was statistically significantly different from the classroom+COPVR.

CONCLUSION

Game-based learning has been widely adopted for children's learning. Pedagogically highly valued products are on the market and have a proven success in the improvement of learning as well as in children's acceptance. Recently, game based learning has also been proposed for adult education. Gaming is becoming a new form of interactive content, worthy of exploration for learning purposes. Universities are also looking for a new positioning in the changing setting of lifelong learning. Universities need to develop innovative forms of learning in order to provide concepts for lifelong learning to their prime customers students. Modern technology needs employees proficient in effective communication, teamwork, project management and other soft skills such as responsibility, creativity, corporate culture, etc. COPVR is an approach to tackle the issues.

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