Situated Learning in a Course of Augmented Reality Technology and Application Design

[Chun-Tsai Wu, Chun-Hsiung Huang]

Abstract—**An application design of augmented reality (AR) technology is used as a learning objective in the interactive design course. The teacher creates an AR development situation through activities such as case analysis, group discussions, planning proposals, project development, performance presentation, and peer review. Students are challenged and motivated with the development process of AR projects. This study analyzes the contents of learning effectiveness which is based on students' accomplished AR projects and interviewed results of student subjects. The study found that, through a collaborative situated learning of AR project, most students can integrate new AR technologies with their prior knowledge and technology to develop their AR interactive projects.**

Keywords—**augmented reality, situated learning theory, experiential learning theory**

I. Introduction

Dewey advocated "learning by doing", learning from practical action is the best learning (Dewey, 1938). The learner's perception of the situation is closely related to the

Chun-Tsai Wu/ Department of Digital Content Design

Ling Tung University
Taiwan, R.O.C

Chun-Hsiung Huang / Department of Digital Content Design

A. Situated learning theory

Situated learning theory emphasizes that learning should be carried out in real situations (Brown, Collins, & Duguid, 1989; McLellan, 1996), and should use materials or things that can be accessed in life, and use the situational problems of real life as the starting point of learning. Situated activities enable learners to learn knowledge and skills in real situations, and to establish rational and meaningful interpretations of knowledge. The situated teaching method is a way for teachers to create a close-to-real situation, so that students have a sensible insight in order to produce meaningful learning. Situational learning is a process of two-way interaction between people and situations. Learners adapt themselves to the "target situation" based on the "demand conditions" and "restrictions" of the situation to adapt to the "target situation" and develop an effective model of participating in the operation. McLellan (1994) analyzed the situational learning success cases and found that the common characteristics are six key factors: apprenticeship, collaboration, reflection, coaching, multiple practice, and Articulation. Herrington and Oliver (1995) added three additional features to situational

actions he /she can perform. Learners construct knowledge through interacting with real-world learning situations, and they are influenced by activities and cultural context (Brown, Collins et al. 1989). In order to gain the knowledge and skills of designing augmented reality applications, and provide the context of the practical field. This course guides students to explore the topic of practical applications by old case analysis. Learning activities include planning proposals, project development, performance presentations and peer review. Byrge and Tang (2015) believe that providing personal training opportunities and grouping them by their self-perceived enthusiasm and interest can stimulate their creativity. We allow students to collaborate learning, engage them in project planning, to enhance knowledge and skills through developmental process, to cultivate their ability of independent learning and reflection, and to achieve application implementation.

II. Theories applications in course design

learning as: providing authentic context, authentic activities and integrated assessment of learning.

Lee and Caffarella (1994) summarized the methods and techniques of applying experiential learning theory in teaching situations, such as group discussions, hands-on exercises, case studies, games, debates, storytelling, role-playing and visits. Their common characteristics are based on the existing experience of the learner oneself. The teaching design in the classroom focuses on providing and creating new experiences through connecting with the old experience.

B. Experiential learning theory

Experiencing the process of creating a project is the best link between theory and practice. Kolb's experiential learning theory claims that knowledge is transferred from the experience. People improve their concrete experiences through reflection and realizing abstract concepts. The new concepts are actively practicing and applied to new situations, and new concrete experiences are created to form a cyclic process (Kolb, Boyatzis et al. 2001). Learning occurs in the process of constructing knowledge and knowledge learning can happen under learning context and learning activities.

III. Methodology

62 junior students are divided into 17 groups to design and develop augmented reality applications. The researcher uses the content analysis method to analyze students' project development and learning effectiveness and interview the students. At the end of the semester, students ought to take an assessment questionnaire to assess their learning satisfaction.

A. Instructional Design

The significance of situated learning is that teachers can design a diversified teaching situation and environment complied with multifaceted learning characteristics of learners. Learners can obtain intellectual and perceptual knowledge, learning through participation in learning. The instructional design considers learning, motivation and conducts experiential learning. In order to simulate the situation of AR project design and development, the teacher introduces AR application cases and allows students to experience first-hand AR works, to motivate students' learning intention and decide their learning goals. The teacher clearly states learning objectives, evaluation criteria, and teaching activities to complete learning step by step. This course intends to provide cooperative learning, team support and time management to increase effectiveness, efficiency and productivity. Students have to propose a project plan before the midterm. Teachers guide students to find equilibrium between creativity and productivity through cross-inquiries. The teacher provides concepts and techniques to ensure students' achievement of their learning goals. The teacher develops adjustable teaching materials responding to students' learning difficulties. The final goals of this course requires students to be able to complete posters, Apps and AR work videos as a team effort. At the final presentation, students display their works, demonstrate app operations, provide peers to experience and respond to post-experience questions. Peer reviews are conducted as group review. Final presentations have set scoring rubrics as in Table I.

TABLE I.   EVALUATION CRITERIA

Criteria (Weights)	Poor 4	Fair 6	Good 8	Excellent 10
Innovation concept (2.5)	Concepts and interaction mechanisms are not innovative	Changes in concepts and general interaction	Changes in concepts and interaction mechanisms	Concepts and interaction mechanisms are innovative and closely integrated
Interface performance and integrity (2)	Interface is too simple	Basic interface combined with text design	Visualization and consistency	Interface design and theme tightly integrated

Application of technology (2)	Operates with a normal input interface without considering the user's operating habits	Operate with normal keyboard and mouse	Combined with joystick or other operating device, such as Webcam, sensor	Shen immersion experience, VR / the MR
Business value and feasibility (2)	Insufficient theme	For users, demand is average	Have specific ethnic needs	Many users with commercial distribution value
Cross-border integration and planning (1)	Limitations of a single field	Interdisciplinary integration in general	Cross-domain integration with some results	Close cross-domain integration, clear and complete planning

Assessment methods include 30% of the learning portfolios (assignments, worksheet, participation and attendance); 30% of midterm proposals (proposals, presentations, and individual performance); 40% of the final performances (project works and presentations). Peer assessment is not used in grading.

B. Contents Analysis Coding Instruction

This study analyzes the contents of learning effectiveness based on students' AR projects, including the detecting methods, rendering results, interactive forms, integration techniques, completeness, and consistency of proposals and completed AR works. The coding instructions used to analyze students' projects are shown in Table II.

TABLE II.   CODING INSTRUCTION

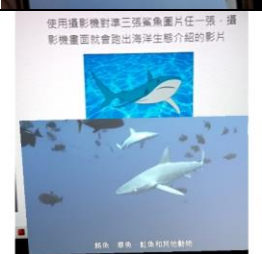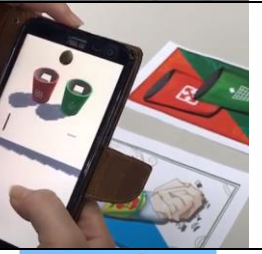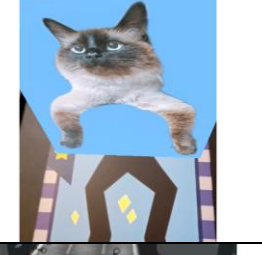| Project Work Analysis	Coding Description
Detecting methods	1:Single pattern recognition; 2:Multiple pattern recognition; 3:Positioning
AR rendering results	1:2D graphics; 2:3D models; 3:Movies; 4:2D animations; 5:3D animations
Interactive form	1:Graphic recognition; 2:2D game; 3:3D game; 4:Card interaction; 5:Positioning interaction
The consistency	1:Low; 2:Medium; 3:High
Integrated technology	1:2D art; 2:3D art; 3:2D animation; 4:3D animation; 5:Programming; 6:Movie editing
Completeness	1: Low 2: Medium 3: High

IV. Research Results and Analysis
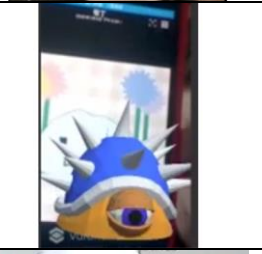
Among the 17 groups of projects, two groups (13 and 14) with incompetent knowledge and skills failed to complete the AR project. The rest of 15 groups perform different learning outcomes. The related links are shown in Table III.
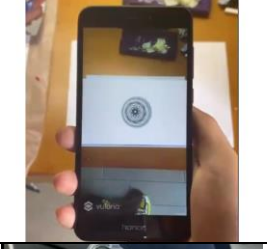
A. *Course Objective and Evaluation*

The course objective is that students should learn how to develop AR applications, and producing interactive effects between real and virtual objects. It permits students to freely innovate their own AR applications. The class objectives, project that they accomplished productions include picky eating, marine ecology, environmental protection and emoji. The interactivity design combines various interactive forms and AR rendering methods. Their finished productions are displayed in the Table III.

TABLE III.   CODING INSTRUCTION

Ideation	Interactivity	Application
Prevent children from picky eatings https://youtu.be/1J4wcx_b9p0	Multiple pattern recognition → 3D models rendering.: Card interaction	
A 2D electronic pet game https://youtu.be/8FfO31kQYt0	Multiple pattern recognition → 2D animations : Card interactioninteraction	
An Introduction to Marine Ecology	Single pattern recognition → MovieClips : Graphic recognition	
A foodie board game https://youtu.be/j8bUHTcQx4g	Multiple pattern recognition → 3D modelsc.: Card interaction	
Sushi AR menu https://www.youtube.com/watch?v=Y7VQnexYGwc&feature=youtu.be	Multiple pattern recognition → 3D models rendering.: Graphic recognition	
A memes AR APP https://youtu.be/MKjRlFKdA7s	Single pattern recognition → 2D graphics rendering : Graphic recognition	
A slime rancher game https://youtu.be/fHGewbwda9o	Single pattern recognition →3D animation rendering : Graphic recognition	
An app to heal the body and soul https://youtu.be/Y6Ge0TEEi9c	Single pattern recognition →3D models rendering : Graphic recognition	
An emoji positionin game https://youtu.be/_p2PBezeN40	Positioning recognition →3D models rendering : Positioning interaction	
A 3D environmental protection games -- Garbage classification https://youtu.be/_ITD68hnZJ4	Multiple pattern recognition →3D models rendering : 3D game	
A silhouette pattern guessing game	Multiple pattern recognition →2D graphics rendering : Card interaction	
A 3D racing games https://youtu.be/C56fg2iJnBY	Single pattern recognition →3D models rendering : 3D game	

Introduce the Chess Rules— A card breakthrough games https://youtu.be /UhGmxJsfdao	Single pattern recognition →3D animation rendering ：Graphic recognition	
The relationship between cigarette and religion https://youtu.be /xiIqx7lI9LQ	Single pattern recognition →2D animation rendering ：Graphic recognition	
The celebrities accompany you for dinner https://youtu.be /0Q5jlLRkX58	Single pattern recognition →2D graphics rendering ：Graphic recognition	

B. *Contents Analysis on AR Projects*

1) Detecting Methods

Students create AR Content with Vuforia in Unity. The detecting method is image targeted and positional tracking. Through analyzing finished projects, single image targets are found many, multi-image targets the next and positional tracking the least (Table IV). Students mainly choose to create projects with methods that can complete assignments, and single object tracking is the most basic method.

TABLE IV. DETECT METHODS

Detect Methods	Number of Groups	Percentage
Single Image Tracking	8	53
Multiple Images Tracking	6	40
Positional Tracking	1	7

2) AR Rendering

With students finished projects, the AR rendering results used by 3D models the most, 2D graphics, movie clips, 2D animation, and 3D animation the next (Table V). The form of AR Rendering involves the students' prior knowledge and ability. Students will choose the form of performance, according to their own abilities.

TABLE V. AR RENDERING

AR Rendering	Number of Groups	Percentage
2D graphics	3	20

AR Rendering	Number of Groups	Percentage
3D models	8	53
Movieclips	2	13
2D animations	1	7
3D animations	1	7

3) Interactive Form

The most interactive form uses graphic recognition, followed by card interaction, 3D games, 2D games, and positioning (Table VI). Graphic recognition is the most basic form of AR interaction. No additional programming is required. For example, students design sushi menus, and 3D models of sushi can be presented through AR. Some groups take the challenge to write interactive programs, such as card breakthrough games, 3D environmental protection games, 3D racing games, 2D electronic pet games and emoji positioning games.

TABLE VI. INTERACTIVE FORM

Interactive Form	Number of Groups	Percentage
Graphic recognition	8	53
2D game	1	7
3D game	2	13
Card interaction	3	20
Positioning interaction	1	7

4) The Consistency

Students express their creativity in the proposal. Whether creativity can be implemented in final projects depends on the learners' knowledge, skills and attitude. In Table VII, there are 11 groups with a high degree of implementation of their project proposal and 2 groups with a medium degree. Two groups with low degrees of implementation have been found with poor learning attitudes, low class attendance and poor performance.

TABLE VII. THE CONSISTENCY

The Consistency	Number of Groups	Percentage
Low	2	13
Medium	2	27
High	11	73

5) Integrated Technology

Implementing a project requires different techniques. Some students can integrate the techniques learned from other classes to optimize their implementation. It can be seen in Table VIII. Each of them integrates various technologies to establish versatile works.

TABLE VIII.   INTEGRATED TECHNOLOGY

Numbers of Integrated Technologies	Number of Groups	Percentage
1	3	20
2	3	20
3	3	20
4	4	27
5	2	13

6) The Completeness

The work has to be published as an App as a completion. The project poster must be displayed with a QR Code for others to download, review and evaluate. An operation process video also is required for reviewing and peer evaluation in the Cloud (Table IX).

TABLE IX.   THE COMPLETENESS

The Completeness	Number of Groups	Percentage
Low	1	7
Medium	5	33
High	9	60

C. Students Interviews

From the students' learning results, out of the 17 groups of works, 13, 14 groups failed to meet the teaching goals. For realizing the difficulties encountered by the students, we interview the students.

1) Student grouping

Student grouping is an important factor for learning effectiveness. Group 13 only has one member who is a night school student. Because he is not familiar with his classmates and lacks the help of peers, coupled with himself personal factors, he is unable to devote time to schoolwork. So that the assignment cannot be completed successfully.

Sorry, my current progress is only for modeling completion. Because I have to go to the mainland to handle some things, I have no time to complete this homework (group 13).

Group 12 has a good division of labor and can apply new technologies to the work.

Assignment of work is based on everyone's ability, because the game is actually not difficult, so I did not encounter too many difficulties, but I really learned something new, that is, how to add the game to the AR function, and use AR Scan the specified object (Group 12).

2) Active learning

When students encounter problems, they are not active enough to ask questions and affect subsequent learning.

I encountered some problems and didn't know how to continue ... Sorry, we didn't ask you to solve the problem in time. We will accept with any humility anyway. Thank you (group 14).

3) Learning scaffold

Digital teaching material can enhance self-learning, and high-level learning requires teachers to provide a scaffold to promote learning.

The biggest problem is the lack of technology. Sometimes I really can't find out what went wrong? Later, I changed to the simpler method given by the teacher, which just met, the effect we wanted to achieve (Group 9).

Concerning course learning and personal learning, I think the teacher's teaching method is very good because there is a PDF to refer to, so you cannot be so nervous and afraid to keep up. However, since this course hopes that students can use their imagination and make it, it may still require more assistance from the teacher in the application (Group 10).

D. Student Evaluation of Teaching

The average score of teaching evaluation is 4.32 and students have scored higher satisfaction. The items 3 and 5 have scored lower than 4.2 (Table X). The teacher adjusts teaching materials for learning difficulties, according to students' ability.

TABLE X.   STUDENT EVALUATION OF TEACHING

Question item	Mean	SD
1. Teachers have clearly provided teaching plans.	4.33	0.77
2. The teacher's curriculum content is consistent with the teaching plan.	4.33	0.77
3. Teaching content of undergraduate programs is of moderate difficulty.	4.17	0.87
4. Experiment / practice / exercise content and teaching materials can cooperate with classroom teaching.	4.32	0.79
5. Teachers explain clearly in class.	4.18	0.87
6. Teacher teaching can enhance students' interest in learning.	4.2	0.86
7. Teachers can give feedback and guidance according to the learning situation of students in teaching.	4.32	0.79
8. Experimental / implementation / exercise content can be clearly explained or demonstrated.	4.25	0.79
9. Teachers' teaching attitude is serious.	4.33	0.77
10. Good interaction between teachers and students.	4.27	0.8
11. Teachers can teach on time. Except for special reasons, do not be late, leave early, or miss classes.	4.37	0.76
12. Teachers' assessment of students can meet the teaching content.	4.32	0.77
13. Teachers 'assessment of students' learning is fair and reasonable.	4.35	0.76
14. Teachers can feedback the results of learning assessment to students.	4.28	0.8
15. Teachers will make safety announcements, reminding them to pay attention to the safety of internship experiments.	4.33	0.8
16. Overall satisfaction of undergraduate programs	4.25	0.82

v. **Conclusion**

In conclusion, this course design provides students with the following learning benefits. A Motivational process of experiential learning that affects students' acquisition, transfer and use of knowledge and skills (Dweck, 1986). Students with different prior knowledge and skills can benefit from the cooperative learning method and increase their success rate of learning through peer observation and individual workload. This course centers on technology, assignments, open themes and forms, and can offer students opportunities to think creatively. Experiential learning combines spontaneity, feeling, and deep individual insights with the possibility of rational thought and reaction (Miettinen, 2000). Through hands-on experience, students learn to modify their planning based on their abilities. Teachers should adopt various teaching strategies to cope with different learning needs. Students with high self-efficacy will take challenges and solve problems. Peer assessment can stimulate students 'motivation for learning, as well as to observe, ask, and learn from others' perspectives and develop the ability to evaluate and communicate. In this course, students have learned to integrate their prior learned technologies, completed works with newly learned techniques, and fulfill personal learning achievements. The diverse topics and interactive forms of student accomplished projects can prove that engaging learners in real situations and participating in active learning, reflective exploring and feedbacking can advance their knowledge and capabilities.

References

[1] Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational researcher*, *18*(1), 32-42.

[2] Byrge, C., & Tang, C. (2015). Embodied creativity training: Effects on creative self-efficacy and creative production. *Thinking Skills and Creativity*, *16*, 51-61.

[3] .Dewey, J. (1938). Experience and education: The 60th anniversary edition, Kappa Delta Pi West Lafayette, IN.

[4] Dweck, C. S. (1986). Motivational processes affecting learning. *American psychologist*, *41*(10), 1040.

[5] .Herrington, J., & Oliver, R. (1995). Critical characteristics of situated learning: Implications for the instructional design of multimedia.

[6] Kolb, D. A., Boyatzis, R. E., & Mainemelis, C. (2001). Experiential learning theory: Previous research and new directions. *Perspectives on thinking, learning, and cognitive styles*, *1*(8), 227-247.

[7] .Lee, P., & Caffarella, R. (1994). Methods and techniques for engaging learners in experiential learning activities. AUTHOR Jackson, Lewis, Ed.; And Others TITLE Applying Experiential Learning in College Teaching and Assessment: A Process Model. INSTITUTION University of Northern Colorado, Greeley. PUB DATE (Oct 92, 28.

[8] McLellan, H. (1994). Situated Learning: Continuing the Conversation. *Educational Technology*, *34*(8), 7-8.

[9] Miettinen, R. (2000). The concept of experiential learning and John Dewey's theory of reflective thought and action. *International Journal of Lifelong Education*, *19*(1), 54-72.