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Original Research Article

A Preliminary Study on Problem-Solving and Virtual Learning

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Abstract: Students have to practically face numerous hard and ill-structured problems when they go to work. However, the separation of theory and practice in traditional instruction makes knowledge be inert and provides no opportunity for students to personally experience the ill-structured problem solving procedure. In order to provide students with an experiential learning experience and understand the effect of a 3D virtual learning environment in students' ill-structured problem-solving ability, the present study designed a 3D virtual company (3DVC) for the participants to be a general manager to solve the complex problems for different departments. In order to confirm that the instruments used in the present study are reliable and valid in understanding students' problem-solving ability and attitude toward the learning system, the present study selected twenty business students to participate in the pilot study. The entire procedure contains pretest, 3DVC training plus questionnaire, and posttest. The materials used in the tests are three complicated, difficult and open-ended questions for the participants to fix. Two management professionals graded each participant's answer and the participant's final score was averaged by the two graders' total score after confirming that the inter-rater reliability coefficient is above acceptable level. The results indicate that the participants performed significantly better in the posttest after the 3DVC training system, which reflects that the learning system is with reliability and validity and the questionnaire results also presented with good reliability and validity

Keywords: Problem solving, virtual learning, 3D virtual learning environment.

INTRODUCTION

Students have to face numerous cases or different problems when they go to work. These problems are usually difficult and complex and make novices very hard to reach the answer. Therefore, educators have been trying different ways to enhance students' problem-solving ability. On the other hand, the advanced computer technology in the modern era has been widely applied to different areas of different level education. Especially, it is notable that the highly developed 3D modeling technique in the recent decade has been proved to be effective in enhancing students' professional cognition or skills. Therefore, the present study utilized 3D technology to help students' problem solving, and the purpose of the study is to conduct a pilot study to ensure that if a 3D virtual learning system is effective in improving students' problem solving through a pilot study.

LITERATURE REVIEW

The environment and experiential learning

One of the most undeniable features of VR is that is creates an artificial environment, which sometimes make users very difficult to distinguish the simulated one from the real situation. Meanwhile, the authenticity of learning environment is supposed to be closely related with knowledge transference [1]. Past research [2] reported that the key point to influence a learning environment's success depends that if the environment is designed in a meaningful, usable, and appropriate manner to the users. Constructivists [3] also stressed that providing learners with a hands-on experiential environment would be the key point to have students transfer class knowledge to the real world. In other words, the interaction that students have personally experienced (the so-called first-person experience) with others is more effective in helping them to transfer class knowledge to the real world than other person's depiction.

In our opinion, paper knowledge remains inert if only it can be applied to the real world. If students can be trained with a situated learning environment to get first-person learning experiences, then, hopefully, their cost to become a person with rich experience would be highly reduced. Moreover, a safe and closed learning environment allows learners for repeated learning, which makes them be more confident and with higher self-efficacy to deal with the related problems in the future.

Based on Dewey's interest theories of leaning [4], the learning environment with more multi-modal feedback will provide learners with stronger sense of presence and immersion, which thereby makes the learning experience more transferable to the real world. Additionally, according to situation and performance theory [5], "People too often fail or behave below expectation due to the anxious feelings caused by the unfamiliar situations, if people have been well trained in a similar situation before they confront the real one, mostly they'll be skilled because they will have a firmer grasp of the situation". Therefore, we are trying to construct a 3DVC to expose students to a real-like environment and provide them with an opportunity to experience how to fix the ill-structured problems of the real world.

Supporting students' learning with VR technology

Learning is not merely the communicative process between learners and instructors of the classroom but the meaningful process about how to make knowledge be more transferable. The instruction media thus become the pivotal to implement the objective. In the recent decade, the advanced computer technology has made learning contents more abundant and flexible. From learners' viewpoint, technology plays the role of an important conveyor; it is to deliver the related learning information to the students, just like trucks pass goods to the stores [6]. Students learn from the delivery as the way customers buy goods from stores. However, learning is not merely memorizing, but a meaningful knowledge construction process supported by technology. Recently, modern computer technology has transformed learners' role from passive to be active with learner-initiated and learner-controlled functions by engaging learners in an active, constructive, intentional, authentic, and cooperative learning environment [7]. In this regard, a virtual learning environment (VLE) that constructed by VR technology would be the most proper alternative to support learning.

In the past decade, researchers from different areas have utilized VR technology to build various learning interfaces to facilitate students' learning. For example: medical educators [8-12] utilized VR's manipulatability and tangibility to provide learners with repeatable learning to make them be more skillful to operate the related facilitation when facing the patients. Science educators [13-15] applied VR's visualizability and tangibility to enhance students' learning, it is approved that some of the concepts are easily understood through the 3D learning interface. On the other hand, VR is also contributive on vocational training [16], for the environment constructed from VR technology owns the feature of vividness; learners can acquire personal experiences through the real-like situations. This is why VR technology is widely applied to different application. Notably, VR is also helpful in special education [17, 18], educators have utilized a 3D VLE to enhance autistic children's social interaction ability, and the outcomes indicated that the results are satisfactory. Recently, VR has been integrated with game-based learning concepts [19, 20] because of its real-time interaction with learners, their learning motivation are highly increased.

Based on the above cases, thanks to VR's help, learning has been transformed from the traditional lecture-centered procedure to be learner-centered activity and the related knowledge transference and application has become more expectable and possible. However, regretfully, VR remained play the role of a learning interface. From the perspective of business education, VR can do more on learning; it could be integrated with part of our daily life so that class learning would be more possible to be transferred to be the real world's problem-solving ability.

METHODOLOGY

System development

The present study utilized VR technology to construct a 3Dvirtual company (3DVC), in the 3DVC, there are three departments, which includes Finance, Marketing, and Production departments. The participants have to play the role of a general manager to solve different problems for the departments based on the pre-designed scenario. The layouts, sound effects, and situation of the 3DVC simulate the scenes of the real life. For example, the general manager has firstly come to the Finance department, when s/he knocks the door through clicking the mouse, the door opens automatically and the department manager comes to the face the lens to report the problem to the general manager. In order to make the participants understand the problem contents, the wordings of the problems are shown on the screen so that the participants would have time to consider how to figure solution alternatives for the department. There are text input areas on the screen for the participants to input their answers. All of the answers input by the participants are stores in the database system for future grading. Meanwhile, in order to make the participants understand that many cases or problems in the real world are often urgent and time-limited, the system allows thirty minutes for solving each problem.

The participants

The present study selected ten students with business management background to participate in the pilot study. They have taken the prerequisite course--- management so that the experiment validity is ensured.

Measurement

In order to make the items as lifelike as possible so that it would be more helpful for the students' future business career, the items used in the experiment were firstly developed by the researcher based on the features of ill-structured defined by the prior study [21], then send to be confirmed by two management professionals. Therefore, the content validity and face validity of the items are ensured.

Pilot study procedure

The present study then conducted the pilot study through pretest, 3DVC test, and posttest. The participants had to fill out a questionnaire after they finished the test. The purpose is to understand the reliability and validity of the system and questionnaire.

RESULTS AND DISCUSSION

The results and discussion of the test and questionnaire is reported as the following:

3DVC system

In order to confirm the validity and reliability of the 3DVC system, the present study processed as follows:

System reliability

Reliability refers to the stability and consistency of an instrument. The test results of a reliable instrument will not be influenced by external factors such as weather or test location. However, it is because ill-structured problems usually happen in the real world, each one has its different background or scenario. People would be hard to expect that two problems occur in totally the same situation; therefore, requesting the participants to repeatedly log into the system to confirm its reliability would lead to the doubts of maturation effect. Moreover, even the same subject face the same problem twice, s/he may not generate the same solution results at different times. Hence, the present study selected twenty business students, who had taken the prerequisite course, management, to participate in the pilot study. Notably, the participants of the pilot study were isolated from that of the formal experiment so that the experiment validity is out of question. After that, the two prior-noted management professionals were invited to evaluate the students' performance and then conducted inter-rater reliability analysis to understand if the system is reliable in improving their problem-solving ability.

Table-1: Paired sample t-test in the pilot study: Pretest vs. 3DVC

Test	n	Mean	SD	t-Value	df	p
Pretest	20	41.03	8.74	-3.605	19	0.002**
3DVC	20	50.75	7.91			

Note: The p value is rounded off to the third decimal place
*p< 0.05; **p<0.01; ***p<0.001

Table-2: Paired sample t-test in the pilot study: Pretest vs. Posttest

Test	n	Mean	SD	t-Value	df	p
Pretest	20	41.03	8.74	-2.198	19	0.041*
Posttest	20	46.35	7.30			

Note: The p value is rounded off to the third decimal place
*p< 0.05; **p<0.01; ***p<0.001

In order to reflect the pilot study results as object as possible, the present study invited the two prior-stated management professionals to conduct the grading. The researcher had meeting and discussion with the professionals about how to reach grading consensus. However, because the participant number of the pilot study is less than that of the formal experiment; the grading load was relatively lighter. Sequentially, the present study conducted inter-rater reliability analysis to confirm if the grading results are acceptable. The results indicated that the inter-rater reliability coefficients in the pretest, 3DVC, and posttest stages are .788, .799, and .793, which imply that the results are fairly acceptable. Therefore, the present study went further to conduct paired sample t-test to understand if the participants' performance is improved after the 3DVC training.

Based on the results reported in Table 1, we can see that the mean in the pretest is 41.03 (SD= 8.74); the mean in the 3DVC is 50.75 (SD= 7.91), it is encouraging that the results indicate that the participants improved significantly in the 3DVC training. Moreover, though the participants' performance in the posttest ($Mean_{posttest}$ = 46.35) (see Table 2) is slightly lower than that of the 3DVC ($Mean_{3DVC}$ = 50.75), it still significantly outperformed pretest ($Mean_{pretest}$ = 41.03). Accordingly, the preliminary results showed that different students had better performances; this implies that the system has acceptable reliability.

System validity

Validity refers to the extent that a tool can really describe the fact or feature of the subject. In order to understand if the system validity is trustable, the researcher briefly asked the twenty students' thinking about the system after they had finished the

3DVC system. It is notable that all of them expressed that the system is with good learnability even though they had different comments or thoughts. This implies that the system validity is satisfactory.

On the other hand, the researcher also invited the two management professionals and two system designers (one is a licensed multimedia designer and the other is a animation and programming professor) to evaluate the system validity. The researcher had intensive discussion with the four experts and the system was revised for several times based on the experts' suggestions (for example: one of the management professional provided comments for adapting the scenarios of the problems of the problems and the two system designers revised the front and back end of the system for several times based on their theoretical and practical background). Therefore, in general, the system validity is acceptable from learners' and experts' standpoint.

One point very important is that ill-structured problems usually happen in our daily life, each problem may have unique background or scenario, it is not adequate to confirm the system reliability and validity through repeated testing, moreover, once the contents of the system is exposed to the students, there would rise the doubts of "maturation effect". Therefore, the present study employed the way that has been stated as the above.

Questionnaire

The present study is now reporting the pilot study results of the questionnaire:

Item analysis

The purpose of conducting item analysis is to understand each item's critical ratio (CR) of the questionnaire. The present study firstly calculated each respondent's total scores from the items and then analyzed the percentile of the data by sorting out the top 27% and the lower 27% of the total scores. This is followed by conducting independent sample t-test of the two groups. If the t value (CR value) of the item is not significant, this item should be eliminated because it implies that the item is not with discrimination capability. Those who are with significant CR value should be kept for sequential investigation.

Table-3: Independent t test of the items in the pilot study

Items	CR value
1.The layouts of the VLE fully reflected the real world's situation.	-3.087*
2.The virtual objects of the VLE presented vividly.	-4.017**
3. The background sound effects of the VLE played naturally.	-3.838**
4. The interaction of the VLE was interesting.	-4.919***
5.The problems of the VLE mirrored the real life's condition.	-3.536**
6.I think the VLE is helpful in enhancing me to solve the complex problems in the future.	-2.596*
7.I think the VLE is helpful in enhancing my ill-structured problem-solving ability.	-2.846*
8.I think the role-playing of the VLE gave me sense of achievements.	-3.578*
9.I think the role-playing of the VLE provided me an important experience of solving ill-structured problems.	-3.651**
10.I think the question prompt of the system is beneficial in helping me to judge the problems.	-3.182*
11.I think the question prompt of the system helped me to systematically solve the ill-structured problems.	-4.017**
12.I think the question prompt of the system helped me to simplify the complex problems.	-4.690**
13.I think the expert model of the system helped me to clarify the logic of the ill-structured problems.	-3.578**
14.I think the expert model of the system was helpful in my ill-structured problem-solving ability.	-3.111*
15.I think my problem-solving ability has been improved after training by the system.	-5.715***
16.I think my knowledge application ability could be enhanced through the related learning system.	-4.690**
17.I think the VLE is helpful in shortening the gap between theory and practice.	-5.196***
18.I think the VLE is easy to use.	-4.536**
19.I think the VLE is interesting.	-4.264**
20.I hope I can have another opportunity to use the similar system.	-4.919***
21.I hope my teachers can teach us by the way that is different from the traditional one as possible as they can.	-4.264**

Note: *p<.05; **p<.01; ***p<.001.

The results of Table 3 indicate that the CR value of each item is significant, which implies that all of the items are worthy to be maintained for future analysis. Additionally, the manuscript of the questionnaire was sent to a professional for ensuring the wording. After discussion, the wording was slightly revised based on the expert's suggestion. Moreover, the researcher specifically and briefly noted the definition of ill-structured problem at the end of the close-ended items for the participants' better understanding.

Reliability analysis

In order to understand if the items are stable and reliable, the present study sequentially conducted questionnaire reliability analysis through testing the coefficients of Cronbachα for each item. The higher the coefficients, the better the internal consistency of the items. The results are revealed as the following:

Table-4: Reliability analysis results of the questionnaire in the pilot study

Construct 1	Alpha if item deleted	Construct 2	Alpha if item deleted
Q1	.9056	Q18	.7986
Q2	.9032	Q19	.7687
Q3	.9010	Q20	.8982
Q4	.9008	Q21	.7813
Q5	.9034	Alpha	.8555
Q6	.9065		
Q7	.9048		
Q8	.9039		
Q9	.9007		
Q10	.9080		
Q11	.9002		
Q12	.8975		
Q13	.9037		
Q14	.9012		
Q15	.8995		
Q16	.8997		
Q17	.8988		
Alpha	.9075		

In the reliability analysis, if the item coefficient is greater than the construct coefficient, this reflects that the construct reliability will be better when the item is eliminated, then the item should be removed.

Based on the results reported in Table 4, we can see that the αvalue of each item is lower than that of the construct; this implies that the items are with good internal consistency. In addition, it is generally accepted that the item is with high reliability if theαvalue is greater than 0.8 [4] or 0.7 [21]. The results indicate that the items are all with internal consistency. Accordingly, all of the items should be kept for the future formal investigation.

CONCLUSION

The results above indicated that the system developed in the study is with reliability and validity in terms of students' ill-structured problem solving. The questionnaire also presented with acceptable reliability and validity It is suggested that future research adopt VR technology in different areas of education so that VR function in education could be explored more deeply.

REFERENCES

1. Winn, W. (2002). Current trends in educational technology research: The study of learning environments. *Educational psychology review*, *14*(3), 331-351.
2. Nilan, M. S. (1992). Cognitive space: Using virtual reality for large information resource management problems. *Journal of Communication*, *42*(4), 115-135.
3. Vygotsky, L. (1978). Mind in society. Cambridge, MA: Harvard University Press.
4. Dewey, J. (1913). Interest and effort in education, Cambridge, MA: Houghton Mifflin.
5. Cheng, Y. & Wang, S.-H. (2011). Applying a 3D virtual learning environment to enhance student's application ability, *Computers in human behavior*, 27(1), 576-584.
6. Clark, R. (1983). Mere vehicles. *Review of Educational Research*, *53*(4), 445-459.
7. Jonassen, D., Howland, J., Marra, R.M., & Crismond, D. (2008). Meaningful learning with technology, 3rd Ed., Pearson Education Inc., Upper Saddle River, New Jersey.
8. Brenton, H., Hernandez, J., Bello, F., Strutton, P., Purkayastha, S., Firth, T., & Darzi, A. (2007). Using multimedia and Web3D to enhance anatomy teaching. *Computers & Education*, *49*(1), 32-53.
9. Engum, S. A., JeVries, P., & Fisher, L. (2003). Intravenous catheter training system: computer-based education versus traditional learning methods. *American Journal of Surgery*, 186, 1, 67–74.
10. John, N. W. (2007). The impact of Web3D technologies on medical education and training. *Computers & Education*, *49*(1), 19-31.
11. Markush, J. P., Grimes, G. J., & Merril, J. R. (2000). Investigations toward using VRML for distributed medical collaboration. Presence: *Teleoperators and Virtual Environments*, *9*(4), 383–393.
12. Phillips, N., & John, N. W. (2000). Web-based surgical simulation for ventricular catheterisation. *Neurosurgery*, *46*(4), 933–937.
13. Limniou, M., Roberts, D., Papadopoulos, N. (2008). Full immersive virtual environment CAVE™ in chemistry education. *Computers & Education*, *51*(2), 584-593.
14. Ramasundaram, V., Grunwald, S., Mangeot, A., Comerford, N.B., Bliss, C.M. (2005). Development of an environmental virtual field laboratory, *Computers & Education*, *45*(1), 21-34.
15. Kartiko, I., Kavakli, M., & Cheng, K. (2010). Learning science in a virtual reality application: The impacts of animated-virtual actors' visual complexity. *Computers & Education*, *55*(2), 881-891.

16. Al-Awar Smither, J., Mouloua, M., & Kennedy, R. (2008). Reducing symptoms of visually induced motion sickness through perceptual training. *International journal of aviation psychology*, *18*(4), 326-339.
17. Cheng, Y. & Chen, S. (2010). Improving social understanding of individuals of intellectual and developmental disabilities through a 3D-facail expression intervention program. *Research in Developmental Disabilities*, *31*(6), 1434-1442.
18. Cheng, Y., Chiang, H.-C., Ye, J., & Cheng, L.-H. (2010). Enhancing empathy instruction using a collaborative virtual learning environment for children with autistic spectrum conditions. *Computers & Education*, *55*(4), 1449-1458.
19. Price, S., Rogers, Y., Scaife, M., Stanton, D., & Neale, H. (2003). Using tangibles to promote novel forms of playful learning. *Interacting with Computers*, *15*, 169–185.
20. Yalon-Chamovitz, S., Weiss, P. L. (Tamar). (2008). Virtual reality as a leisure activity for young adults with physical and intellectual disabilities. *Research in Developmental Disabilities*, *29*(3), 273-287.
21. Chi, M.T.H., & Glaser, R. (1985). Problem solving ability. In R. J. Stemberg (Ed.), Human abilities: An information processing approaches. New York: W. H. Freeman and Company, 227-250.