# DOES INFORMATION TECHNOLOGY BENEFIT STUDENTS' CREATIVE THINKING? A CASE OF 3D MODELING

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Abstract

*Most current research focus on the courses that particularly emphasize one's ability of logic, language or analytical thinking. However, there are other courses that require students' cognitive abilities other than logic, language or analytical thinking. Creative thinking, the other way of thinking style, is less emphasized in most lectures and is seldom studied in prior research. This study would like to investigate if students could benefit from e-learning in the courses concerning training of creative way of thinking. A pilot study was conducted and 12 participants were invited to join the experiment. A lecture teaching the participants how to do 3D modeling was the experimental course. A LED with 3D vision supported was provide for the participants to brainstorm and generate new ideas. Results of this study indicated that the participants had positive perceptions toward the pedagogical activity. Based on the results shown in this pilot study, it seems that customization of the equipment been provided is an important feature when offering information technology for students to enhance their ability of creative thinking.*

Keywords: Creative thinking, 3D modeling, e-Learning, 3D vision

## 1. Introduction

In our education system, courses such like science (Limniou *et al*., 2008; Sato *et al*., 2008; Trindade *et al*., 2002), laser physics (Mikropoulos & Bellou, 2006), astronomy (Barnett et al., 2005; Keating et al., 2002), biology (Shim *et al*., 2003), linguistics (Dörnyei, 2003) and mathematics (Rittle-Johnson, & Siegler, 1998) were frequently studied. Briefly speaking, these courses emphasize one's ability of logic, language or analytical thinking. The reason that many academics put much of their effort on the courses might be that the relatively ease of assessing one's performance. Because almost of the courses have definitely wrong and right answers, instructors are easy to give proper scores to students according to their responses. Results of this kind of research have contributed the literature and extends our knowledge of how to exploiting technologies to benefit students' learning.

However, there are other courses that need researchers' attention and, most importantly, require students' cognitive abilities other than logic, language or analytical thinking. In general, media art, music, and dancing are such courses that especially need one's imagination. Students having well logic of reasoning might not perform as well, when they are asked to express themselves in such courses. This is because these courses, media art, music, and so on, require distinct competences, such like artistic, creative and visual abilities. In essence, these abilities are quite different from the competencies usually emphasized in science, mathematics, and so on. Maybe one of the most different characteristics is no absolutely right and wrong answer for media art, music, or dancing.

In current education system, analytical thinking is regarded as the most important cognitive ability. Creative thinking, the other way of thinking style, is less emphasized in most lectures and is seldom studied in prior research. Although instructors might have signaled the importance of creative thinking in the courses that especially require the way of analytical thinking, the chapters included is usually insufficient. This phenomenon is particularly obvious when many researchers in educational field devote their efforts to enhance students' achievements. To our knowledge, there are little education studies that focus on the courses that are creative thinking in nature.

This study considers the phenomenon urgent and then requires the researchers' much attention. In our daily life, an individual needs not only analytical way of thinking, but also creative way of thinking. For example, any architect could create a building, which follows all the rules he have learnt from architecture. Nevertheless, the knowledge of architecture does not guarantee the creature of an astonishing building. What an architect would learn from the courses is to analyze the structure of the building in a systematic framework in order to prevent foreseeable collapse. This kind of training is quite important. However, as the knowledge of architecture becomes more and more complete and robust, people would like to see more identifiable buildings. This expectation not only helps us to easily find out the right direction in the modern city, but it makes the street view of our society a better outlook.

Unlike previous studies focusing on the training of analytical way of thinking, this study would like to investigate if students could benefit from e-learning in the courses concerning training of creative way of thinking. This study exploited "3D Modeling" as the experimental course because there is limited number of research focusing on 3D media art and Design education. Given that the content of this course requires students' creative thinking in nature, a pilot study was conceived to better understand how instructors could use current technology to help students enhance their abilities.

## 2. Literature review

### 2.1 Theoretical background

Generally, researchers of educational field have borrowed many theories from psychology to sustain their opinions and then suggest feasible pedagogical activities. One of the theories that is widely used by researchers to underpin the plausibility of information technology to enhance students' learning is Piaget's theory of cognitive development (Piaget, 2013). Briefly speaking, Piaget considered that it is cognitive conflict inside one's brain that leads to the acceptance and modification of knowledge. In this point of view, learning occurs only when an individual perceives what he already knows is unable to explain the fact he has experienced. In this case, educational technology has to equip with the capability for students to learn by try and error. Computer-based test could be another example because it can analyze students' answer and then find out the concepts that the students might not understand.

Another theoretical basis that is opposite to Piaget's perspective is the work by Vygotsky (1978). Vygotsky considered that an individual acquires new knowledge through looking for the similar information that has been stored in the cognitive resources, and then linking what he has known to the new knowledge. Accordingly, educational technology invented based on this theoretical perspective focus on how to organize and display the information relevant to the knowledge to be learnt by students. Adaptive material is the typical case of this line of research.

Collaborative learning, conceptually, has its roots from Vygotsky's perspective. A large body of literature has acknowledged its positive impact on students' achievement (e.g., Altinay & Paraskevas, 2007; Ellis, 2001; Joiner, 2004; Rourke & Anderson, 2002; Salovaara, 2005). Briefly speaking, these studies suggested that for encouraging students to share information, problem solving, and giving feedback, collaborative learning seems to be a useful pedagogical activity. Research in this strand considers it as the main objective to construct an online environment for students that allows them to express and exchange ideas. Although an online discussion board requires simple technique, its effectiveness seems much important and has significant meaning in education. Expressing idea leads the student to reflect oneself. Thorough thinking around students organize their ideas, which in turn might have caused cognitive conflicts among their counterparts. When the cognitive conflicts occur, students would discuss, explore and justify which statements are right. This process indeed is what Vygotsky had proposed.

2.2 Creative way of thinking

Media art, music, or dancing are the courses which usually has no only one answer. Essentially, this is one of the main features that constitute creativity. Prior research has identified that brainstorming is the critical factor which leads to better creative products (Howe, 1997; Firestien & Treffinger, 1983; Canady, 1982; Parker, 1978; Osborn, 1953). Although many different opinions about what to do to make students creative, most of the researchers agree that the following steps are useful:

- Defer judgment when looking for ideas
- Generate as many ideas as possible
- List ideas as they occur and keep a written record
- Constantly elaborate or improve on ideas

Essentially, these steps are proposed to make sure it would happen among the individuals to think around. Furthermore, it is encouraged to combine various ideas from other people together to generate thoughts that have not proposed before. In this regard, students could be benefited from the information technology that allows them to brainstorming and generating ideas, when studying the courses that focus on the training of creative thinking. More specifically, this study supposes that the extent to which a students could benefit from the information technology is varied with the degree of fit among the features of the technology being used and the courses being studied.

In order to examine if students would have better outcomes when appropriate technology is supported in the course, an experiment was conceived in this pilot study. In the Media Arts & Animation program, 3D modeling is an important course that most students have to pass. Extensive creative work has currently been done in the area of 3D visualization and modeling using CAD applications. A typical task performed in a 3D application is the direct manipulation of graphical objects (Hutchins, Hollan, & Norman, 1986; Shneiderman, 1993), including selecting, scaling, rotating, creating, editing and so on. Although many task of these manipulations similar to the actions in our daily life (for example, translation, movement, rotation), some of which would be impossible in real world but are required to accomplish the tasks through the 3D application (for instance, extruding, scaling, deleting).

Accordingly, for students to be creative when they are learning to build 3D models, the information technology could be potential if it allows students to brainstorm and generate ideas from gathering various perspectives. In this regard, this study considered that LED with 3D vision supported might be an appropriate equipment. First, with a large scale of LED monitor, students could easily exchange their ideas, which provides an opportunity for them to think around. Second, the capability of 3D vision allows students to watch a virtual 3D object in real life so that many of the tasks required to accomplish 3D modeling could be performed. For example, students might watch the result of a 3D object when it is scaled, extruded, or modified. Although this work could be done in a flat 2D monitor, 3D vision gives students a better appearance of the 3D product in a nearly real world, which in turn would stimulate the emergence of new idea.

## 3. Research methodology

In this study 12 students voluntarily participated. All of them were majored in Information Science. Each week they joined an informal lecture teaching how to use 3D MAX to establish 3D models. The lecture lasted for three months and approximately 150 minutes each time. When the lecture began, the instructors introduced the theoretical basis of 3D modeling and then demonstrated the usage of 3D MAX to the participants. After the demonstration had finished, participants were asked to practice the techniques. When all the participants were familiar with the operation of 3D MAX, they were then told to establish a 3D model that was creative and novel.

In order to help the participants think creatively, a LED monitor, which supported 3D visions, was provided in this pilot study. Before the participants had actually created their own 3D objects, the instructors played several videos demonstrating 3D creatures by using the 3D LED. These videos displayed 3D objects in wireframe view and were collected from YouTube. An example of the screenshot of 3D wireframe is shown as Figure 1. Briefly speaking, camera of the video moves around the 3D model. This is a general video and were created for displaying in a 2D fashion. However, this pilot study provided a LED monitor, which has 3D converter to turn 2D viewing into 3D. Although sounds amazing, this is no longer a big deal in current LED productions. In fact, many companies have similar productions in the market. This study exploited CHIMEI LED with 3D converter so that the participants could see how the 3D creatures looked like by wearing 3D glasses. Figure 2 shows the 3D vision that the participants had watched on the LED. This process made the participants understand the best way of making wireframe when they were establishing 3D objects in 3D MAX.

Not only was convenient for the instructor, but also this way of demonstration was easy for the participants. Because of 3D converter supported by the LED monitor, the participants could easily export their video and then quickly watch their objects in a 3D manner. As a result, all of them could explore the self-created 3D objects in a holistic view. In addition, the technology established an opportunity for the participants to discuss their creative productions together.

After all the experiment had finished, the participants were asked to fill out a questionnaire concerning their perceptions and attitude toward the pedagogical activity. The questionnaire measured four constructs, including easy to use, usefulness, satisfaction, and creative self-efficacy. Items measuring the constructs concerning easy to use, usefulness, and satisfaction were revised based on the work by TAM (Davis, 1986). Creative self-efficacy were measured by seven items, which were adopted and revised from Yu (2013) and Tierney and Farmer's (2002) study. Each of all the item contained in the questionnaire was 5-point Likert scale.

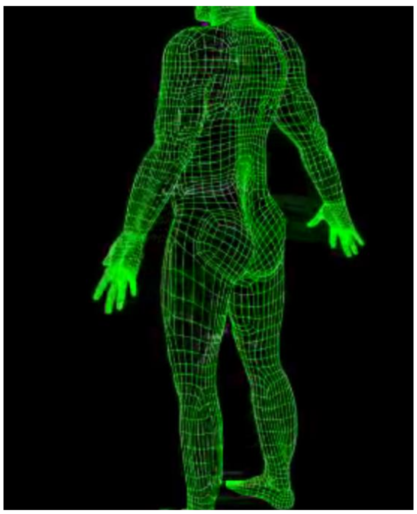

Figure 1. Screenshot of 3D wireframe

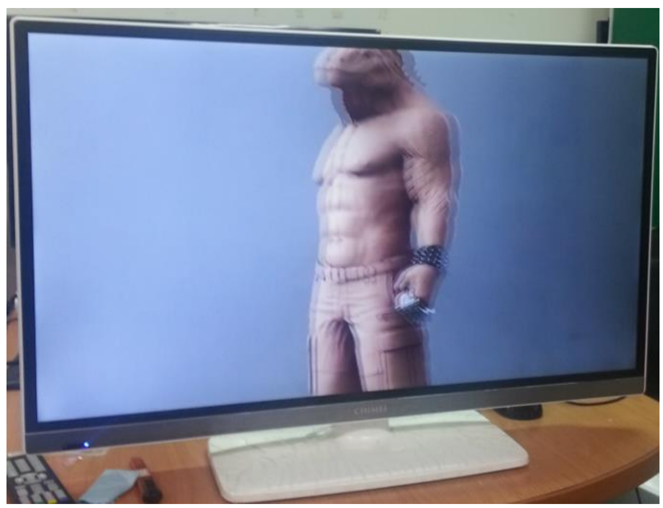

Figure 2. 3D vision shown on the LED

4. Results and discussions

Table 1 shows the participants' perceptions that were collected by the questionnaire, where "1" stands for "strongly disagree" and "5" stands for "strongly agree". Mathematically, if the mean value is larger than 3.5, it could be interpreted as that the participants had positive perception toward the pedagogical activity. Overall, participants responded positively to using the 3D technology in the lecture. Regarding the construct of easy to use, participants consistently considered that displaying 3D vision was flexible and easy. As the third question in this construct, a value of 0.6 standard deviation indicated that not every participants constantly thought they could displayed the 3D objects by using 3D vision as what they want. This message reveals that although 3D convert has the advantage of flexibility, it suffers from the shortcoming of lacking in-depth capability allowing students to display the 3D products in any angle, zoom, or detail.

The participants believed that allowing them to review the 3D objects in a 3D vision way was useful, while learning 3D modeling. The empirical evidence was found in Table 1, where all of the value were larger than 3.5. Noteworthy, the second question of the items has a standard deviation of 0.8, indicating that the participants had slightly various perspectives. Obviously, there were a few participants considering that their effectiveness of modeling a 3D object were not enhanced. While combing the results from previous construct, easy to use, this study postulated that it seems important for students to customize the workplace to satisfy various needs.

Finally, most participants found that using 3D vision to help them modeling a 3D object was satisfied and then lead them to a higher creative self-efficacy. Briefly speaking, the participants considered that displaying an object in 3D manner was beneficial and satisfied. While the participants' perceptions were all above-average, this study noticed that the item related to resolving problems when modeling a creative 3D object was not as high as the other items on measuring the participants' creative self-efficacy. It appeared that although the participants had positive perceptions on 3D visions to enhance their skills of modeling 3D objects, many of them considered that their confidences to solving problems were not significantly increased. In this regard, establishing the environment where the participants could review the objects in 3D vision was helpful on creative 3D modeling. However, this might not be the effective way to foster the participants' skills of exerting 3D applications.

Table 1. Statistics of the participants' perceptions

| Items | Mean | S.D |
|---|---|---|
| Easy to use | | |
| I find it flexible to interact with the converted 3D objects | 3.86 | 0.39 |
| Learning to display 3D vision is easy for me | 3.70 | 0.33 |
| It is easy to get my 3D objects displayed on the LED as what I want it to do | 3.76 | 0.60 |
| Usefulness | | |
| Using 3D visions would enable me to accomplish 3D modeling more quickly | 3.99 | 0.57 |
| Using 3D visions would enhance my effectiveness on the job | 3.89 | 0.80 |
| Using 3D visions in my job would increase my productivity | 4.02 | 0.54 |
| Satisfaction | | |
| I agree that 3D visions can enhance my understanding of the 3D modeling | 3.97 | 0.57 |
| I think displaying 3D visions can help me identify the structure of the wireframe | 3.95 | 0.50 |
| Overall, interacting with the objects in 3D visions is beneficial for us while brainstorming | 4.29 | 0.41 |
| Creative self-efficacy | | |
| I feel that I am good at generating 3D objects | 3.90 | 0.50 |
| I have confidence in my ability to modeling 3D objects creatively | 4.13 | 0.57 |
| I feel I can resolve some problems when modeling a creative 3D object | 3.76 | 0.56 |
| I have a knack for further 3D modeling | 4.05 | 0.43 |
| I am good at finding creative ways to do 3D modeling | 4.08 | 0.38 |
| I have the talent or expertise to do 3D modeling | 4.14 | 0.25 |
| I feel comfortable trying out 3D objects | 4.08 | 0.29 |

## 5. Conclusion

This study was attempted to explore the research question whether and how information technology could benefit students' achievement when they are studying courses that particularly require creative way of thinking. In this pilot study 3D modeling was the experimental course. The participants of this study were taught in the pedagogical activity by which all the videos were transformed and displayed in a 3D vision. Not only could the participants watch the prepared 3D videos, but they could export the 3D objects they created and then displayed the objects in 3D vision. There was no complicated work for the participants to do to show their production in 3D vision because the LED monitor supported 3D convert. All the participants had to do was saving their files in video format, like AVI.

Results of this study indicated that the participants had positive perceptions toward the pedagogical activity. Briefly speaking, the participants considered that using 3D vision to enhance their learning achievement in 3D modeling was useful and easy to use. All of them believed this way of learning 3D modeling was satisfied and then led them to a better perceptions of creative self-efficacy. According to the empirical evidence it seems that information technology could benefit students' achievements even in the course where creative thinking is the center of the focus. However, how the information technology benefits students when they are learning courses such like media art, dance, music, and so on. Based on the results shown in this pilot study, it seems that customization of the equipment been provided is an important feature when offering information technology for students to enhance their ability of creative thinking. Synthesizing the results in Table 1, this study found that it was not an effective way of modeling a 3D object. In addition, some of the participants considered they could not show the 3D objects in certain angle, zoom, or size as what they want to display. In this regard, this study suggests that for an information technology to truly benefit students' ability of creative thinking, customization of the information technology seems the critical feature that has to be supported by educators and developers.

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Biographies

JUNG-LUNG HSU has various research interests, including e-learning, virtual group dynamics, and text mining.

KUO-MING HUNG studies the topics such like pattern recognition, computer vision, and multimedia.

HUEY-WEN CHOU focuses her research on group dynamics, collaborative learning, and psychology.

WU-YUIN HWANG has various research interests, including e-learning, linguistic learning, and so on.

References

Altinay, L., & Paraskevas, A. (2007). A computer-supported collaborative learning (CSCL) approach in teaching research methods. *International Journal of Hospitality Management, 26* (3), 623-644.

Barnett, M., Yamagata-Lynch, L., Keating, T., Barab, S. A., & Hay, E. K. (2005). Using virtual reality computer models to support student understanding of astronomical concepts. *Journal of Computers in Mathematics and Science Teaching*, 24(4), 333-356.

Canady, J. E. (1982). CPS for the Educational Administrator. *The Journal of Creative Behavior*. 16(2), 132-149.

Davis Jr, F. D. (1986). *A technology acceptance model for empirically testing new end-user information systems: Theory and results* (Doctoral dissertation, Massachusetts Institute of Technology).

Dörnyei, Z. (2003). Attitudes, orientations, and motivations in language learning: Advances in theory, research, and applications. In Z. Dörnyei (Ed.), *Attitudes, orientations and motivations in language learning* (pp. 3-32). Oxford: Blackwell.

Edwin L. Hutchins, James D. H., & Donald, A. N. (1986). Direct manipulation interfaces. In D. A. Norman and S Draper, (Eds.), *User-centered system design* (pp. 87-124). Lawrence Erlbaum Associates.

Ellis, A. (2001). Student-centred collaborative learning via face-to-face and asynchronous online communication: What's the difference? *Paper presented at the Meeting of the Eighteenth Annual Conference of the Australasian Society for Computers in Learning in Tertiary Education*, December 9-12, 2001, Melbourne, Australia.

Firestien, R. L. & Treffinger, D. J. (1983). Creative Problem Solving: Guidelines and Resources for Effective Facilitation. *Gifted Child Today*. January/February, 2-10.

Hutchins, E., Hollan, J., & Norman, D. (1986). Direct manipulation interfaces. In D. Norman & S. Draper (Eds.), *User-centered system design*. Lawrence Erlbaum Associates, Hillsdale, New Jersey.

Joiner, R. (2004). Supporting collaboration in virtual learning environments. *CyberPsychology & Behaviour*, *7* (2), 197-200.

Keating, T., Barnett, M., Barab, S. A., & Hay, K. E. (2002). The virtual solar system project: developing conceptual understanding of astronomical concepts through building three-dimensional computational models. *Journal of Science Education and Technology*, 11(3), 261-275.

Limniou, M., Roberts, D., & Papadopoulos, N. (2008). Full immersive virtual environment CAVE in chemistry education. *Computers & Education*, 51(2), 584-593.

Mikropoulos, T. A., & Bellou, J. (2006). The unique features of educational virtual environments. In P. Isaias, M. McPherson, & F. Banister (Eds.), *Proceedings e-society 2006, International Association for Development of the Information Society*, Vol. 1 (pp. 122-128). IADIS.

Osborn, A.F. (1953). Applied Imagination. New York: Scribner's.

Parker, J. P. (1978). We All Have Problems...Who doesn't ? But Can They All Be Solved. *Gifted Child Today*. March/April, 61-63.

Piaget, J. (2013). *The construction of reality in the child* (Vol. 82). Routledge.

Rittle-Johnson, B., & Siegler, R. S. (1998). The relation between conceptual and procedural knowledge in learning mathematics: A review. In C. Donlan (Ed.), *The development of mathematical skills* (pp. 75-110).

Rourke, L., & Anderson, T. (2002). Using web-based, group communication systems to support case study learning at a distance. *The International Review of Research in Open and Distance Learning, 3* (2), 1-13.

Salovaara, H. (2005). An exploration of students' strategy use in inquiry-based computer supported collaborative learning. *Journal of Computer Assisted Learning, 21* (1), 39-52.

Sato, M., Liu, X., Murayama, J., Akahane, K., Isshiki, M., et al. (2008). A haptic virtual environment for molecular chemistry education. In Z. Pan (Ed.), *Transactions on edutainment I* (pp. 28-39). Berlin Heidelberg: Springer-Verlag.

Shneiderman, B. (1993). Direct manipulation: A step beyond programming languages. *Sparks of Innovation in Human-Computer Interaction*, 17, 57-62.

Shim, K. C., Park, J. S., Kim, H. S., Kim, J. H., Park, Y. C., & Ryul, H. I. (2003). Application of virtual reality technology in biology education. *Journal of Biological Education*, 37(2), 71-73.

Tierney, P., & Farmer, S. M. (2002). Creative self-efficacy: its potential antecedents and relationship to creative performance. *Academy of Management Journal*, 45(6), 1137-1148.

Trindade, J., Fiolhais, C., & Almeida, L. (2002). Science learning in virtual environments: A descriptive study. *British Journal of Educational Technology*, 33(4), 471-488.

Vygotsky, L. S. (1978). *Mind in society*, Cambridge, MA: Harvard University Press.

Yu, C. (2013). The relationship between undergraduate students' creative self-efficacy, creative ability and career self-management. *International Journal of Academic Research in Progressive Education and Development*, 2(2), 181-193.