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Virtual-Based Training and Creative Thinking in Higher-Level Education

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ABSTRACT

The purpose of the study reported on in this paper was to determine if Virtual-Based Training (VBT) could be used to develop students' abilities in creative thinking (CT). The sample was 26 second year undergraduate students from four different faculties at King Mongkut's University of Technology, Thonburi, Thailand selected by simple random sampling technique. Participants were divided into two groups: an experimental group consisting of 13 students (11 engineering students, and 2 architect students); a control group composed of 13 students (5 engineering students, 1 science student, and 7 industrial education and technology students). Both groups had similar background knowledge but differed in terms of their disciplines. The experimental group studied 24 CT lessons through VBT, and they had to submit their exercises by e-mail, by post, or in person. The tools used in this study were VBT in CT skills, students' assignments, a pre-test and a post-test using the Test for CT-Drawing Production (TCT-DP). Data was analysed using descriptive statistics and ANCOVA. The results of the study were as follows: (1) There was no significant difference on the pre-test scores of CT skills (TCTDP) between the experimental group and the control group. (2) There was a significant difference on the post-test scores of CT skills (TCTDP) between the experimental group and the control group. Results showed that VBT can enhance CT skills in these students in Thailand. In terms of implications, the development of VBT requires an investment of time, expertise and money. Therefore, institutions wishing to promote CT through use of such techniques will need to provide the funding and resources necessary to make possible VBT.

Keywords: Virtual-Based Training, Creative Thinking

INTRODUCTION

Definitions of creative thinking (CT) vary. Cornog (2008) defines it as the capacity to produce through thought or imagination and the capacity for original work. Kendall (1985) defines CT as a process by which something new is produced - an idea or an object including a new form or arrangement of old elements. The new creation must be useful to the solution of some problems (Harmon 1956). Creative people act differently. They face criticism with understanding. The creative

thinker has the mindset of the artist - that is, the ability to stretch his imaginative powers and see things from unusual perspectives. The meaning of CT includes components from both the cognitive and affective domains (Passi 2002). Creativity is a multi-dimensional attribute and can be both verbal and nonverbal. It includes the factors of seeing problems, fluency, flexibility, originality, inquisitiveness, and persistency.

There have been many studies of CT in face-to-face contexts but far fewer in virtual contexts. Karwowski and Soszynski (2008) studied an approach to develop creative abilities, especially creative imagination using Role Play Training in Creativity (RPTC) and the use of role playing games. Forty-seven undergraduate education students (mainly women) voluntarily participated in their study. Hsiao, Liang and Lin (2004) developed CT teaching strategies after perceiving common teaching problems for the cultivation of students' CT abilities in a computer network course. While there have been many studies of CT, few of these have studied CT in contexts of VBT at the post-secondary level and in a Thai context.

VBT is a form of e-learning that involves a formal online and offline training environment. It resembles a workshop environment but without face-to-face interaction. Trainees, trainers and co-workers use computers and software that enable them to send and receive message, interact with trainers and co-workers, read and comment on training materials, take tests, and receive feedback without having to attend scheduled workshops (Dabbagh & Bannan-Ritland 2005).

As use of computers and the Internet continues to grow, we will need to know more about how CT may occur with virtual tools. This paper attempts to fill an important gap in the research on CT as it may be practiced in virtual contexts. The objectives of the study reported on in this paper were to investigate if VBT could improve the CT skills of students at the post-secondary level in Thailand. The study was conducted with 26 second year undergraduate students from different faculties at King Mongkut's University of Technology, Thonburi, Thailand.

THEORETICAL FRAMEWORK

Sternberg and Lubart (1999) define CT as "The ability to produce work that is both novel (i.e., original, unexpected) and appropriate (i.e., useful, adaptive concerning task constraints)" (p. 3). Weisberg (1999) explains that "creative thinking by definition goes beyond knowledge" (p. 226). This argument is supported by some researchers who assert that too much knowledge may restrain creativity (Dietrich, 2004, p.10). Creativity is not simply innovation. Amabile et al. (1996) explain the difference between the two concepts by arguing that creativity represents a starting point for innovation. According to Torrance (1966) creativity is:

> A process of becoming sensitive to a problem, deficiencies, gaps in knowledge, missing elements, disharmonies, and so on; identifying the difficulty; searching for solutions, making guesses, or formulating hypothesis about these deficiencies; testing and retesting these hypotheses and possibly modifying and retesting them; and finally communicating the results (p. 6) .

Torrance (1974) developed a test of CT which he based on four categories of responses of fluency (number of responses) flexibility of responses, originality of responses and elaboration (detail in the responses). Davis (1992) refers to four 'Ps' in relation to creativity. These are the person; product; process and press or environment/climate.

In terms of the development of thinking skills such as CT, at the age of five, our capacity for original thinking is at 90%, but by adulthood, the capacity for original thinking is only 2% (Flynn 2000). The capacities of the human brain are not fixed at birth (Deveci 2008) but actually grow and mature partly in relation to the degree to which the person exists within a stimulating physical and social environment. However, the development of CT skills is not simply a matter or developing (Klenz

1987; Marzona et al. 1988) technical skills. In fact, according to Rheingold (1984) the development of CT skills requires tolerance of ambiguity, freedom and safety as well as openness. It is intrinsic rewards and not examinations, grades or competition that are likely to produce gains in CT skills (Hennessey & Amabile 1998).

METHODOLOGY

Phase 1: The Development of the VBT Module

In the first phase the authors developed a VBT module for CT. The module relied on use of CDROM and video tapes. The trainer/instructor would be recorded in a room as shown in Figure 1. The module featured three different instructors. It consisted of 24 lessons. Each lesson had the following components: 1) aim, 2) introduction, 3) concepts, 4) operational steps, 5) examples, and 6) exercises The trainer/instructor could use a PowerPoint™ presentation and/or any other forms of teaching materials such as image, animation, textbook etc. The VBT would allow learners to obtain course-related materials online via the Internet on the university's website and offline using a CDROM.

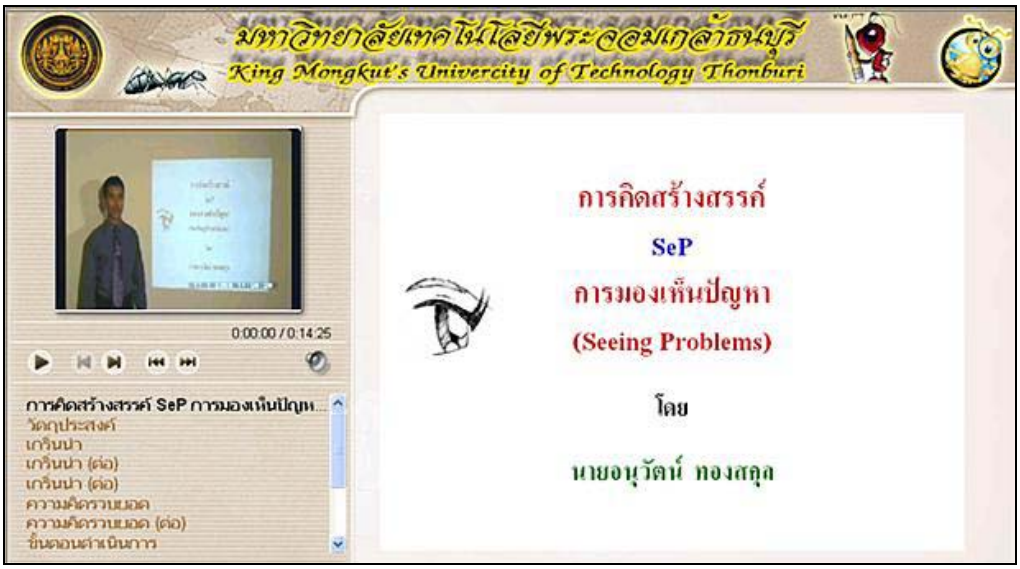

Figure 1: VBT module with trainer using a presentation

The steps involved in developing VBT were as follows:

1. Record video of trainers/instructors in the classroom and convert video to MPEG file.
2. Import the MPEG file into presentation software (e.g. Microsoft Producer for PowerPoint™.)
3. Import video, PowerPoint, sound etc. Microsoft Producer for PowerPoint™.
4. Cut video and presentation file to become synchronous.
5. Create menu for a learner to select the content that he or she would like to learn.
6. Link Microsoft Producer to PowerPoint™ with the WWW.
7. Design homepage using software such as Macromedia Dreamweaver MX.
8. Link homepage to Microsoft Producer for PowerPoint™, one file at a time.
9. Upload all files to the web if being used online.
10. For offline use, export all files; for example, flash, html, image, and others to CD.

One can develop learners' understanding for a given thinking skill in four different ways (Passi et al. 2003) through VBT. These are:

1. The structural approach (whole-part) would mean that the learners will understand a given thinking skill by breaking the 'whole into parts' i.e., breaking a concept into its attributes. Let us take the concrete example of a bicycle where the learner divides the bicycle into wheels, handle etc. In our lessons, we have done this by giving a section called the component-concepts of the skill.
2. The functional approach (uses) would mean that the learners will identify the ascribed functions, purposes and uses of a given thinking skill. For example, a bicycle can be used for movement, carrying etc.
3. The process approach can be divided into two parts: definitional description and component processes: (a) Definitional description would mean that the learner uses the art of arriving at output from the given input. For example, in the cycling process this would mean the use of a tool called cycle to cover a distance by using the principles of machines (b) In addition, the learner can also identify the component processes and their artful integration to form the complete process, e.g., the learner is busy in the process of cycling while he/she is engaged in balancing, paddling, using breaks etc.
4. Lastly, according to the operational approach (steps), learners gain awareness of the steps involved in sequential stages. For example, in the case of cycling, the operational steps would be pushing, balancing, sitting, paddling, handling, and others like using breaks. In our development of the VBT module, we have primarily used the operational approach. In our module, the steps were broken down by the teacher who explains, demonstrates, and tests the steps and stages.

The VBT module involved 24 lessons based on de Bono (2008) as follows: SeP (seeing problems), DeP (defining problems), EDI (escaping dominant idea), MaR (making rules), ReF (removing faults), EnP (enhancing persistency), APC (alternatives, possibilities, choices), C&S (consequences and sequel), CAF (consider all factors), CoC (concept challenge), COM (combination), MaD (making decisions), FOC (focusing), GoS (goal setting), IMA (imaging), OPV (other people's views), PLA (planning), PMI (plus, minus, interesting), RaI (random input), StS (stepping stone), UsA (using analogies), YNP (yes-no-po), FiR (finding requirements), ELA (elaborating).

Participants

The sample of 26 students from King Mongkut's University of Technology, Thonburi was divided into two groups as follows:

1. An experimental group: 11 engineering students and 2 architect students for a total of 13.
2. A control group: 5 engineering students, 1 science student, and 7 industrial education and technology students for a total of 13.

Instruments

We used the Test for CT-Drawing Production (TCT-DP) developed by Urban (2005) composed of 72 items with both the experimental group and the control group. The test sheets were collected after completion, lasting 15 minutes for each drawing. The test asks the testee to complete a drawing on the basis of some given figural fragments. These six figure fragments were designed with the following points in mind. They are (1) different in design, (2) geometric and non-geometric, (3) round and straight, (4) singular and compositional, (5) broken and unbroken, (6) within and outside a (seemingly) given frame, (7) placed irregularly on the space provided, and (8) incomplete.

The conceptual deliberations led to the following set of 14 key criteria that constitute as a whole the TCT-DP construct, and also serve as evaluation criteria: (1) Continuations: Any use, continuation or extension of the six given figure fragment. (2) Completion: Any addition, completions, complements, supplements made to the used, continued or extended figural fragments. (3) New elements: Any new figure, symbol or element. (4) Connections made with a line: between one figural fragment or figure

or another. (5) Connections made to produce a theme: Any figure contributing to a compositional theme or "gestalt". (6) Boundary breaking that is fragment dependent: Any use, continuation or extension of the "small open square" located outside the square frame. (7) Boundary breaking that is fragment independent. (8) Perspective: Any breaking away from two-dimensionality. (9) Humour and affectivity: Any drawing which elicits a humorous response shows affection, emotion, or strong expressive power. (10) Unconventionality: Any manipulation of the material. (11) Unconventionality: Any surrealistic, fictional and/or abstract elements or drawings. (12) Unconventionality: Any usage of symbols or signs. (13) Unconventionality: Unconventional use of given fragments, and (14) Speed: A breakdown of points, beyond a certain score-limit, according to the time spent on the drawing production.

Procedures

1. A pre-test using the TCT-DP was administered with both groups in person. There were no time limits on the pre-test. However, the more time spent, the fewer points awarded as shown in Table 1 as follows:

Time spent to complete the test	Points awarded
below 2 minutes	6
approximately 2-4 minutes	5
approximately 4-6 minutes	4
approximately 6-8 minutes	3
approximately 8-10 minutes	2
approximately 10-12 minutes	1
More than 12 minutes	0

Table 1 Time spent to complete the test and points awarded using the TCT-DP criteria

2. There are 11 criteria for scoring creativity (Jellen, H.G. & Urban, K.K. 1989) as follows: (1) Completion is for completing 6 parts of the incomplete picture outside the frame as follows: half circle, dot, right angle, curve, dotted line, and rectangle. The highest score is 6 points. (2) Addition is for adding parts of the picture so that it has meaning. The highest score is 6 points. (3) New element is for a picture or symbol independent from the specified parts of the picture. One new element is one point. The highest score is 6 points. (4) Connection made with a line is for any line which connects two elements in the picture. Each connection stands for one point. The highest score is 6 points. (5) Connection made to produce theme is for a picture or parts of the picture which show story or overall picture. Each theme is one point. The highest score is 6 points. (6) Boundary – breaking being Fragment Dependent is for any line or completion from inside towards outside the rectangular box. The score is 6 points. (7) Boundary – breaking being Fragment Independent is for any object outside the rectangular box. The score is 6 points. (8) Perspective is for any picture with 3 dimensions or depth and near-far perspective. Each perspective is one point. The highest score is 6 points. (9) Humor is for any humor by funny pictures or funny language or funny title for the picture. The highest score is 6 points. (10) Unconventionality is for any abnormal picture. (11) Speed (Sp) is time spent for completion (see more details in Table 1).
3. The experimental group of students was trained in CT skills through VBT with 24 CT lessons, for two terms during the 2007-2008 academic year. Each lesson required approximately one half hour of students' time for a total of approximately 12 hours. They completed assignments at home and delivered them to one of the three instructors either by e-mail, by post or in person. The trainers/instructors would read the exercises/assignments. There would be no right or wrong for the answers in the exercises/assignments. The purpose of the assignments was to monitor that students were doing the lessons. The control group was not trained in CT skills. Both groups attended similar regular classrooms which the university provided for the second year students.

4. At the end of the 24 lessons both groups completed a post-test using the same TCT-DP.

Data Analysis

We used analysis of co-variance (ANCOVA) to determine if the students' capabilities were different at the beginning of training. We choose to use ANCOVA because it holds constant pre-test results. This means that the scores of the pre-tests will not have any effects on the post-tests.

RESULTS

Table 1 reveals that the pre-test scores of both the experimental group ($\overline{X}$ = 41.77, *SD* = 8.10) and the control group ($\overline{X}$ = 40.85, *SD* = 6.62) were not significantly different. Thus, the ANCOVA was run. The pre-test scores (which is the main effect of the treatment) were held constant. The post-test scores of CT skills between the experimental group ($\overline{X}$ = 64.54, *SD* = 1.76) and the control group ($\overline{X}$ = 61.54, *SD* 2.50) were significant different ($p < 0.01$). This means the VBT was significant for promoting CT skills.

Tests of Between-Subjects Effects Dependent Variable: Post-test

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	62.983	2	31.492	6.708	.005
Intercept	2744.743	1	2744.743	584.645	.000
PRETEST	4.483	1	4.483	.955	.339
GROUP	56.177	1	56.177	11.966	.002
Error	107.979	23	4.695		
Total	103491.000	26			
Corrected Total	170.962	25			

a R Squared = .368 (Adjusted R Squared = .313)

Table 2: The comparison of mean scores between pre and post-tests

DISCUSSION

Our findings revealed that the experimental group showed significant improvement in CT as a result of the 24 lessons in CT delivered by VBT. It is to be expected that the CT skills of the group would improve. After all they were subject to 24 lessons or 12 hours of training in CT. It was not within the scope of this study to administer a treatment to the control group. Thus, they did not receive any lessons in CT. Our results show therefore that the lessons are effective in enhancing CT skills. What we do not know is whether there would have been a significant improvement in CT skills in the control group if they had also completed some form of CT training. What our study shows is that VBT can be used to enhance and improve CT skills. The fact that the control group did not improve their CT skills suggests that these skills will not develop on their own. They do require an intervention. They do need to be taught. Our study illustrates that they can be taught virtually using VBT.

It is difficult for us to compare our results with those of others since there has been so little research carried out on CT in online environments. Hsiao, Liang and Lin's (2004) study of a CT model in a computer course was different than ours in that it involved creating the model and subsequently assessing students' satisfaction. We did not attempt to assess their satisfaction, although this is an objective that we might aim for in a subsequent study.

We note that the advantage of our approach is that it allows us to control and "package" in a virtual environment the teaching skills. This way we were able to control the approach much more so than if we had asked different teachers to teach the lessons in a classroom. Teaching CT skills is challenging because as Bonk and Smith (1998) explain it requires the adoption of new teaching roles. The teacher must be not traditional but consultative. Being consultative means that the student has a certain freedom, learning is student-centered and knowledge is constructed by the student. Our model offered a consultative approach to learning for the students.

The next steps would be to allow a control group to complete the lessons in a non-virtual environment. By this means we might determine if the VBT is more effective than non virtual for purposes of improving CT skills. The advantage of the VBT is that it can enhance CT skills in a way that allows students to work at their own pace and in their own time. This advantage would not be available with lessons in a face-to-face environment.

CONCLUSIONS, LIMITATIONS AND IMPLICATIONS

The purpose of this research was to develop VBT and to measure its effect on CT skills. Results showed no significant different on the pre-test scores of CT skills (TCT-DP) between the experimental group and the control group; however, there was a significant difference on the post-test scores of CT skills (TCTDP) between the experimental group and the control group. These results indicate that self-study VBT is effective for developing CT skills.

This study was limited to a small group in the country of Thailand only. Results may be different with other students in other countries. Also, the students were second-year students. We do not know how well this VBT would be if we used it at another level or with students in other faculties. Another limitation is that not every institution or instructor will be able to develop VBT because they may not have the required expertise or access to technology and skills. We needed approximately three to four hours in order to create each lesson. Those wishing to create a VBT CT module will need to invest at least 100 hours for 24 lessons. Also the PowerPoint presentations required approximately three hours per lesson for a total of 75 hours. This investment of time may not be feasible for all institutions or individuals interested in using VBT for developing CT skills. However, we would argue that this investment is worthwhile since, once the module is created, it can be used almost endlessly with a variety and large number of groups.

In terms of implications for practice, VBT could be used where the development of CT is aimed for, particularly in contexts of self-study. VBT is also useful for learners to think about their new projects in both higher education and vocational education levels. In terms of policy, the development of VBT requires an investment of time, expertise and money. Therefore, institutions wishing to promote CT through use of such techniques will need to provide the funding and resources necessary to make possible VBT.

Future research might investigate whether similar results could be obtained in other contexts and, for example, with students at higher levels or in other disciplines. Future studies might also administer non-virtual CT lessons to a control group and VBT to an experimental group to determine if VBT is more effective than regular face-to-face training for the development of CT skills. The varying backgrounds of the students and the fact that they were in different years and different faculties may have affected and possibly contaminated results. We do note however that we designed differentiated lessons for the different students. For this reason, we believe it is necessary to conduct further studies using the module with groups of students who are more similar.

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