USING THE SCAMPER TECHNIQUE IN AN ICT COURSE TO ENHANCE CREATIVE PROBLEM SOLVING SKILLS: AN EXPERIMENTAL STUDY

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ABSTRACT
The purpose of this study was to investigate and compare the effects of the SCAMPER technique (directed brainstorming) on the creative problem-solving skills and academic achievements of students. A group of 40 high school students were assigned to either an experimental group or a control group. The hardware components unit of an Information Communication and Technology (ICT) course was taught to all students using case-based learning (CBL), which was supplemented by the SCAMPER technique in the experimental group. Subsequent analyses showed that the SCAMPER technique had a significant effect on the creative problem-solving skills and academic achievement of students.

Keywords**:** Improving classroom teaching, interactive learning environments, pedagogical issues, secondary education, teaching/learning strategies

INTRODUCTION

The digital age demands technology-competent individuals with creative thinking and problem-solving skills who are also empathetic, collaborative, and able to interpret and use data instead of simply memorizing it (Squire & Dikkers, 2012; Beyers, 2009; Head Council of Education and Morality, 2005). Of these many attributes, one is the most emphasized: creativity (Loveless, Burton, & Turvey, 2006). Creativity is defined as “the skill of solving a problem that has not been previously encountered” (Jang, 2009). Creativity is the ability to formulate, re-arrange, and re-test a hypothesis in order to solve a completely new problem.

According to Sternberg (2003), since some teachers confuse creativity with general intelligence, sufficient importance is not given to creativity in schools. Due to personal, social, and economic reasons, creativity varies from one individual to another. It is important to know how to reveal and develop this skill, which resides at some degree within everyone (Majid, Tan, & Soh, 2003). Taymaz (1995) revealed that teachers in their study believed they would lose control of their classrooms and not be able to teach efficiently if they promoted autonomy. Yet, student autonomy in the classroom environment promotes personal development and increased research, assessment, and decision-making skills. An essential function of school is to help students to make correct decisions by assisting them. Thus, a tolerant class environment should support creativity by encouraging free thinking, open discussion, and smart decision making.

Teachers can develop students’ creative thoughts by supporting and rewarding different perspectives and creative connections (Beghetto, 2007). However, it is very difficult to reflect creative thinking in the classroom (Csikszentmihalyi, 1988); new ideas are often not welcomed by peers in discussion. Since new ideas represent unexpected thinking processes, they may also go ignored or unrecognized by a teacher when assessing creativity. However, finding new ideas is a creative activity in itself (Csikszentmihalyi, 1988; Rotherham & Willingham, 2009). In fact, face-to-face classroom discussions provide the ideal environment for developing the creative thinking of students.

Lumsdaine and Lumsdaine (1995) have identified problem solving as an analytic or operative process. The aim of creative problem solving is to develop high level creative, critical, and analytical thinking skills and to use these

developed skills in related processes and disciplines (Ozkok, 2004). Creative problem solving starts by questioning the nature of the problem. Students should act like detectives, seeking out possible solutions and examining evidence. Next, brainstorming begins. The technique applied should be appropriate for the size and structure of the group, taking into account time limitations, environment, and type of problem. At this stage, specific care should be taken to prevent delays in judgment when generating ideas, which should all be recorded. Application of proposed solutions requires creative problem-solving skills (Lumsdaine & Lumsdaine, 1995).

Many educational methods, techniques, and strategies promote creative and critical thinking in the classroom environment, both generally, such as brainstorming, reverse brainstorming, alternatives-probabilities-options, simulations and role playing, attribute listings, analogies, metaphors, forced associations, what-if exercises, and Janusian thinking, and specifically, such as Six Thinking Hats, Semantic Web, Idea Spurring Questions, SCAMPER, Synectics, and Checkerboarding or Morphological Synthesis (Bonk & Smith, 1998; Barak, 2009). Another such method, case-based learning (CBL), requires the active participation of students to resolve a real or imaginary problem. During the learning process, students are expected to seek and examine information related to a given case, analyze their findings, select relevant data, devise and present solutions, and discuss options with their classmates (Kuçukahmet, 1998). CBL introduces real-life events related to specific educational issues into the classroom environment, where students analyze the events by asking why and how questions to find relationships. Thus, students obtain information while developing skills and attitudes, leading to the rapid discovery of efficient solutions (Yilmaz and Sunbul, 2003). With CBL, students have the opportunity to transfer theoretical knowledge into practice, make decisions, and develop problem-solving skills.

Strategies used to create discussion environments that increase the efficiency of CBL include workshops, brainstorming, problem solving, and cooperative learning. SCAMPER, a brainstorming technique, can be applied together with CBL, and was chosen for this study due to fun of application and a lack of studies featuring this technique in Turkey. The acronym SCAMPER stands for Substitute, Combine, Adapt, Modify/Magnify/Minify, Put to other uses, Eliminate, and Reverse/Rearrange. According to Yildiz and Israel (2002), SCAMPER is a fun, easy-to-apply technique used in developing creative thinking and offers a way out of mental blocks. It encourages creative thinking by encompassing a series of thinking processes about a single object or subject and putting discussion methods into practice. Addressing and brainstorming about a specific object requires the changing of that object (Glenn, 1997). In the technique, questions are directed toward students to encourage them to think about new aspects of the object, developing creativity and thinking skills.

The Council of Education and Morality (CoEM, 2005) of the Republic of Turkey has distinguished the necessity of information and communication technologies education in line with growth in the use of computers and computer-based information, which are perceived as symbols of the information society in Turkey. CoEM further identified the need for creative individuals who access, interpret, use, and produce new information, rather than simply memorizing facts. CoEM has suggested that individuals raised in an information society should be equipped with the skills to use developing technologies, such as accessing, arranging, assessing, presenting, and transposing information, and they should develop competencies in creative thinking and problem solving, critical thinking, empathy, and collaboration.

This course aims to contribute to students' abilities to use new technologies and adapt to a rapidly developing world. Information and Communication Technology (ICT) courses are included in elementary and high school curricula in Turkey, whether obligatory or elective, depending on the status of the school. In such courses, students produce new ideas; share knowledge; and learn, use, and develop current technologies. To this end, specific methods and techniques are incorporated to give students freedom during lessons, to provide them opportunities to participate and produce new ideas, to reinforce their communication with classmates, and to improve overall life competencies.

Purpose of the Study

In today's world, where knowledge and technological developments drive the economic status of countries and creativity plays a key role in technological advancement, many countries have begun to foster the creative thinking of their citizens via the educational system. However, creativity is only a part of the creative problem-solving process. Being creative by itself is not sufficient; creative people also need emotional awareness, critical thinking skills, and developed problem-solving skills. A gap about the SCAMPER technique was found in the literature, yet it is important to assess its effects on students. Therefore, this study was designed to investigate and compare the

effects of the SCAMPER (directed brainstorming) technique on the creative problem-solving skills and academic achievement of students.

Limitations

Participants of the study were 10th and 11th grade students, whose ages ranged between 16 and 18. During the 2008-2009 academic year, they were enrolled for the first time in a high school ICT course in a rural area of Turkey. The 11th grade students were assigned to the experimental group, while the 10th grade students were assigned to the control group. Due to restrictions of the educational system, students could not be mixed across grade levels, so the design of the study was quasi-experimental. The study application was limited to the elective 90-minute ICT course offered in secondary education institutions as specified by the Ministry of National Education. Both experimental and control groups were taught the same content by the same teacher.

METHOD

Research Design

In the implementation of this study, ICT courses taught with and without SCAMPER were compared in terms of the creative problem-solving skills and academic achievement of the students. The common pretest-posttest control group pattern was used to detect the effects of the technique, and participants were subjected to a dependent variable both before and after the application. The pretest-posttest control group pattern is a related pattern since the same people are subjected to measurement in relation to the dependent variable. In addition, it is an unrelated pattern in this instance since comparisons are made between experimental and control groups comprised of different types of participants (Howitt & Cramer, 1997). The independent variables of the study were time of testing (pre vs. post) and method (exp. vs. control); the dependent variables were creative problem-solving skills and academic achievement.

Participants

The study was carried out in a rural public high school in Turkey during the 2008-2009 academic year. The 11th grade participants were the experimental group, while the 10th graders were the control group. The control group was taught the ICT lesson via CBL, and the experimental group via SCAMPER and CBL. All 40 participants in both groups were attending the ICT course for the first time. The experimental group included 20 students (8 female, 12 male) from 16 to 18 years old with a mean age of 16.8, and the control group included 20 students (7 females, 13 males) from 15 to 17 years old with a mean age of 16.2. In face-to-face interviews before the application, it was found that none of the students in either group had previously participated in any course that incorporated creative techniques, creative problem solving, or CBL.

Implications

A one-week orientation session was held prior to application of the study. Both the experimental and control groups received information about the CBL process. In addition, in the experimental group orientation, the SCAMPER technique and its stages were introduced to the students and expectations and related applications were explained. The orientation concluded after the students applied all stages of the SCAMPER technique and assessed and discussed all proposed ideas. Then, both groups were given the first case for the study.

In the first case, participants were asked to act as a student who wanted to buy a desktop computer. Their task was to build the best system they could with a very limited budget. System configurations prepared by the students were examined for errors, and students were provided with the opportunity to correct mistakes. The systems compiled by the students were considered a pre-test and graded by two experts. The application of the first case lasted for two weeks. In this stage, no implementation difference occurred between groups.

In the second case, students faced an imaginary problem with their low-budget computers from the first stage: the system crashed when playing a high-definition video game. Students were asked to determine their problems and produce as many qualified and creative solutions as possible, whether drawn from hardware issues, software trouble, or pure imagination. Students in both groups used CBL to create solutions, while the experimental group also used

SCAMPER. Experimental group students wrote the SCAMPER stages on the blackboard, applied each stage, and suggested ideas.

After the implementation, each student was asked to submit an independent written proposal. The aim was to collect ideas that had not been noted in the classroom environment in order to carry out content analysis. The core of content analysis is to collect similar data related to a certain concept and to categorize and interpret them in a comprehensible way (Yildirim & Simsek, 2003). The data were summarized and interpreted via descriptive analyses and examined in detail to access concepts and relationships.

In order to evaluate students' solutions via content analysis, a rubric was prepared and revised based on information obtained from six experts. However, suggestions that were not present in the scale were encountered during examinations. Such suggestions were presented to the experts, and the rubric was expanded and re-sent to the experts for examination before determining a final version. The final rubric included solutions considered creative by the six experts that would not be thought of easily by high school students in their first ICT course.

As a post-test, students were asked to repeat the first case and build another computer system. The first and second lists were compared to assess student improvement.

FINDINGS

An independent sample t-test was conducted to compare the pre-test scores of the control and experimental groups in terms of academic achievement. Results indicated no significant difference between the pre-test scores of the control group (M = 14.20, SD = 3.33) and experimental group (M = 13.90, SD = 3.57); *t (38)* = .28, p > .05. An independent t-test was also conducted to compare the post-test scores of both groups in terms of academic achievement, due to finding no significant difference in pre-test scores. Results indicated a significant difference between the post-test scores of the control group (M = 16.80, SD = 1.88) and experimental group (M = 18.60, SD = 2.06); *t* (38) = -2.88, p < .05, η^2 = .18. Thus, the SCAMPER technique combined with CBL accounted for 18% of variance.

In addition to academic achievement, creative problem-solving skills were evaluated according to a rubric applied to students' solution suggestions. The scores of the experimental group were higher than those of the control group. An independent sample t-test was conducted to compare content analysis scores. Results indicated a significant difference between the scores of the control group (M = 5.50, SD = 3.28) and experimental group (M = 17.45, SD = 12.27); *t* (38) = -4.20, p < .05, η^2 = .32. The SCAMPER technique can be regarded as effective based on the significantly higher scores of the experimental group students.

RESULTS and DISCUSSION

A comparison of the creative problem-solving scores of students who were taught an ICT lesson via the SCAMPER technique in addition to CBL and of students who were taught via only CBL produced a statistically significant difference in favor of the experimental group. Therefore, the SCAMPER technique had a positive effect on the problem-solving skills of the students. An increase was observed in the scores of both groups, indicating increased academic achievement regardless of group. Thus, both instructional techniques had a positive effect on learning. However, because the difference was significantly higher in the experimental group, it can be concluded that adding SCAMPER had a greater effect on academic knowledge than proceeding with CBL alone. In addition, the computer system and possible solution lists prepared by students in the present study could be combined with other related work to create a student portfolio, which would be beneficial in terms of process evaluation and monitoring student development.

When carrying out an application related to CBL, if possible, a video of the case should be shown; if this is not possible, a demonstration of the task in the classroom would help students to better understand and analyze task-related expectations. In the present study, the stages of SCAMPER were projected on a screen. However, since it was necessary to project other images from time to time, the stages could not always be displayed. In a class where the SCAMPER technique is used, it would be more beneficial to present the stages on large cards affixed to the wall

so that students have constant exposure and access to the process. The stages could also be printed on note cards and distributed to students individually or in small groups.

As stated above, a student's ability to be critical, creative, and innovative should be supported under the scope of educational understanding in the 21st century. However, the objective is to ensure both practice and experience with these skills, which was an aim of the current study. While experience means using a skill, practice means trying to carry it out while learning from mistakes and developing new strategies. In practice, feedback from a more competent person is required to improve (Rotherham & Willingham, 2009).

As today's educational systems try to promote creative skills to solve problems, new methods and techniques must be discovered and implemented. SCAMPER, a fun and creative brainstorming method, is one example of a technique that can be used to achieve this objective. The results obtained from the current study indicate that this technique has a positive effect on the academic knowledge and creativity of students in education. SCAMPER is an efficient and easy-to-apply technique that can be used in developing both academic knowledge and creativity, which can produce very surprising results.

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