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Effects of Creating Simulations in Interactive Physics Application and Developing Portfolio on Students' Academic Self-Concept and Creativity

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SYNOPSIS

INTRODUCTION

Creative thinking is defined by Özözer (2004) as finding and establishing new connections in existing connections, building new concepts, generating a unique idea, developing an original product, or proposing a new solution to existing problems by creating a new mental schema. This definition stresses the role of cognition in creativity. Computers might support cognitive dimension of creativity. Computers can be used to reflect what students know; therefore, they act as "cognitive amplification tools". Using computers in this manner allows us to support meaningful learning and knowledge construction (Jonassen, Carr, & Yueh, 1998). According to Clements (1995), computers might become "potent catalysts to improve creativeness."

To support creativity, not only using computers in educational environments, but, more importantly, also how it is used is important. Instead of drill-and-practice applications, providing learners with computers applications which implement constructivist learning strategies such as discovery learning (Akpınar, 2003; Biber, 2006), project based learning (Demirel et al., 2001; Yılmaz, 2006), and problem based learning (Yaman & Yalçın, 2005) supports and nurtures their creativity.

Simulations, as a form of computer-supported instruction, facilitate problem-solving activities and represent a controlled depiction of real world situations (Bayram, 1999). According to Yaman and Yalçın (2005), creative people are good at problem solving

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activities. Since creativity and problem solving abilities are connected, it might be possible for simulations to enhance creativity.

As mentioned above, creative thinking is about generating a unique idea or developing an original product (Güleryüz, 2001). Allowing learners to build a portfolio will help them create and improve various products in educational environments. According to Northwest Assessment Association (1990; as cited in Barrett, 2000), a portfolio is "a purposeful collection of student work that exhibits the student's efforts, progress, and achievements in one or more areas.

While works of the learners can be kept in physical folders, another possibility is to keep them in electronic format (ePortfolio). While defining electronic (or digital) portfolio, Barrett (2000) emphasizes two points: "collect[ing] and organiz[ing] artifacts in many formats (audio, video, graphics, and text)" and including "hyper text links to organize the material to connect artifacts to appropriate goals or standards." The author also mentions that an ePortfolio should be "a reflective tool that demonstrates growth over time." ePortfolios can be created in many formats, and one of the options is creating them as Web pages.

Brooks (2006) investigated changes in self-regulation characteristics, metacognition, motivation, and self-efficacy. In this study, the researcher provided an unthreatening environment for technology use, self-assessment of self-reflective papers, peer-assessment, and a chance to use peer's and teacher's feedback. Brooks reported positive impact of building ePortfolios on learners' technology self-efficacy and motivation. Another research study about ePortfolios was conducted by Özyenginer (2006). In this study, Özyenginer reported positive effects of ePortfolios on the following learner abilities and skills: conducting research, learning new subjects, self-confidence, self-assessment, time management, studying, and creativity. Enhancing these abilities and skills of students might affect learners' self-concept of abilities.

According to Piyancı (2007), self-concept of abilities allows learners to have more self realistic views, and to compare themselves with other learners in same classroom. Piyancı also discusses possible positive effects of self-concept of abilities on learners' academic achievement.

PURPOSE OF THE STUDY

The purpose of this research study is to determine the effects of creating simulation in Interactive Physics application and building a portfolio on pre-service physics teachers' creativity and academic self-concept of abilities in instructional material development course.

In this research, we studied the following four research questions:

1. What is the effect of creating simulations in Interactive Physics application and building a portfolio on pre-service physics teachers' self-conception of abilities in instructional material development course?
2. Is the effect of building a classic portfolio different from the effect of building an ePortfolio on pre-service physics teachers' academic self-concept of abilities in instructional material development course?
3. What is the effect of creating simulations in Interactive Physics application and building a portfolio on pre-service physics teachers' level of creativity?
4. Is the effect of building a classic portfolio different from the effect of building an ePortfolio on pre-service physics teachers' level of creativity?

METHODOLOGY

This study was a quasi-experimental comparison study. Scores from knowledge test on Newton's Law of Motion was only used for matching purpose. The diagram of the design is given below.

Table 1. *Research design*

Pre-Test and Matching	Treatment	Post-Test
Knowledge test on Newton's Law of Motion	Gathering simulations in ePortfolio	Creativity (KAI)
Creativity (KAI - Kirton Adaption-Innovation Inventory)		Self-concept of abilities
Self-concept of abilities		

For all research questions, independent variable was portfolio format (classic or electronic). For the first two research questions, the dependent variable was self-concept of abilities; and for the last two research questions, the dependent variable was level of creativity.

a) Participants

This research took place in a public university located in İstanbul. Participants were last-year students of Physics Education Department in the Faculty of Education. Participants were divided into two branches, and the comparison of all matching criteria (scores of knowledge test on Newton's Law of Motion, self-concept of abilities test, and Kirton Adaption-Innovation Inventory) showed no statistically significant differences between these two groups. The comparison group had 15 last year students, while experimental group had 19 last year students.

b) Research Instruments

For this research study, four instruments were used; namely:

1. Self-Concept of Abilities Scale: Participants' self-concept of abilities in instructional material development course was measured with this instrument. The original self-concept of abilities scale was developed by Brookover; Senemoğlu (1989) translated this scale into Turkish, and adapted to science class. For this study, take re-take reliability was found to be r = 0,79. This result showed that the scale was reliable.

2. Kirton's Adaption-Innovation (KAI) Inventory: For this study, participants' level of creativity was measured with this inventory, which was developed by Dr. Michael J. Kirton in 1976. It was developed for measuring people's preference style of problem solving and decision-making (Bagozzi & Foxall, 1995). This inventory was translated to Turkish. The range of scores of KAI instrument is between 32 and 160. Midpoint for KAI scores is 96. People scoring higher than 96 are considered innovators, and people scoring lower than 96 are considered adaptors. While adaptors will follow rules and regulation to solve problems, innovators will seek new and novel ideas during problem solving.

3. Portfolio: Participants' reflections about portfolio development and each simulation they created were gathered using portfolio. This information was gathered in the portfolio (both classic and electronic formats) under the title of "What did I gain from this project?"

The results collected with this instrument were helpful to gain insight about thought process of participants.

4. Knowledge Test on Newton's Law of Motion: This test consists of five open-ended questions. The questions were created by examining the questions used in the research study conducted by Bekiroğlu (2004). Five subject matter experts reviewed the questions and suggested some rewording, more articulation, etc. Participants' answers to this test were graded by three graders, and averages of these three scores were used.

c) Treatment

For this study, the participants interacted with Interactive Physics applications for six weeks, and they completed some assignments. Starting the second week, they started to develop simulations related to Newton's Law of Motion. Both groups created either classic or electronic portfolio.

The students in the comparison group were asked to gather their materials (printout screen images of simulations and simulations in electronic format in CD) in a classic portfolio, these students had no chance to share or see others' simulations during the course. Therefore, the comparison group had a restricted learning environment.

In the experimental group, the students used Camtasia Studio 6 to create a video of their simulations. In a video, both the development phase and the final product of each simulation were recorded. Then, each student gathered these videos in his/her ePortfolio. ePortfolios were created by using Adobe Dreamweaver application. The students in experimental group shared their ePortfolios with each other using Google Groups.

RESULTS

1) Self-Concept of Academic Ability

Both comparison and experimental groups had higher self-concept of abilities at the end of the study. To test the differences between scores of self-concept of abilities scale implemented as pre-test and as post-test in instructional material development course, Wilcoxon t-Test for Dependent Samples was conducted. Participants who built ePortfolio ($z=3.575$, $p<.05$) and those participants who built classic portfolio ($z=2.581$, $p<.05$) had significantly higher self-concept of abilities in instructional material development class. These results support the idea of building simulations in Interactive Physics application and also building a portfolio with these simulations helps improve last-year physics education students' self-concept of abilities in instructional material development class regardless of the format of portfolio and whether owners of these portfolios shared their portfolios with each other or not.

Even though both comparison and experimental groups had higher scores on self-concept of abilities scale in instructional material development class, ePortfolio group increased their scores even more. According to the results of Mann-Whitney U Test ($U=80$, $p<.05$), the increase in scores of experimental group in self-concept of abilities scale was statistically higher than that of comparison group.

2) Creativity

As in the case of self-concept of abilities, both comparison and experimental groups had higher KAI scores after creating simulations and building portfolios for six weeks. The result of Wilcoxon t-test for dependent samples for experimental group ($z=3.443$, $p<.05$) shows that creating simulations and building ePortfolios for six weeks increased participants' scores on KAI. Even though participants in comparison group built classic portfolio, similar results are

found (z=2.017, p<.05) regarding KAI scores of participants in the comparison group. According to the results of these two tests, creating simulations in Interactive Physics application and then building a portfolio with these simulations support last-year physics education students to become more innovator in problem-solving and decision making processes regardless of the format of portfolio and whether owners of these portfolios shared their portfolios with each other or not.

Both groups enhanced their KAI scores. According to the results of Mann-Whitney U Test (U=117.50, p>.05), the increase in KAI scores of the participants in experimental group was not statistically different from KAI scores of the participants in the comparison group.

DISCUSSION

As mentioned earlier in displaying the results, creating simulations and gathering them in a portfolio regardless of its format (classic or electronic) improved students' self-concept of abilities in instructional material development class. Especially, reflective writings in portfolios might have caused this improvement in self-concept of abilities. However, the effect of creating an ePortfolio on students' self-concept of abilities was higher than the effect of creating a classic portfolio. Since both groups developed portfolios, the cause is either from the role of technology or the role of sharing portfolios. As discussed in literature, using technology might support learning and teaching process. Participants building ePortfolio mentioned the positive effects of using Interactive Physics application with Dreamweaver and Camtasia on their efficiency. Thus, a possible interaction between using Interactive Physics application and other Web authoring tools (Dreamweaver and Camtasia) is possible. Increased efficiency in learning environment might help students to readily evaluate what they can do and cannot do and increase their self-realization, thereby improving their academic self-concept. The effects of ePortfolio development on some self-regulatory characteristics such as motivation, metacognition, and self-efficacy are reported in literature (Brooks, 2006) and such characteristics are reported to be closely related to academic self-concept. Thus, this explanation is in accordance with Brooks' results. Since ePortfolio development requires use of some authoring tools in addition to course materials, possible interaction might explain why using ePortfolios in educational systems is favoured by educators and researchers (such as Kazan, 2006 and Hung, 2006).

Pre-service teachers who created ePortfolio emphasized that their learning process was easier and faster with the use of computer, the Internet, and Interactive Physics altogether. Pre-service teachers in this group stated their gain in better implementation of computers and the Internet in learning. They also stressed that using Interactive Physics application with Adobe Dreamweaver and Camtasia Studio interacted and became a more efficient and effective learning tool.

Pre-service teachers in the comparison group generally stated their positive feelings about Interactive Physics program. They fount it to be very beneficial to them, and stated their intentions to use it in their professional work. According to pre-service teachers, this application helps to create concrete samples of abstract concepts.

RECOMMENDATIONS

Since physics pre-service teachers found creating simulations in Interactive Physics and building a classic or electronic portfolio valuable, and this increased their academic self-concept of abilities, creating simulations and building portfolios can be used to increase physics pre-service teachers' motivation. Given that the results of this study showed ePortfolio creation fostered academic self-concept of abilities even more, choosing ePortfolio

over classic portfolio is suggested. Another result of this study was that creating simulations and building portfolio promoted pre-service teachers' creativity. These findings are important for improving the quality of educational environments. Even though, it is suggested that similar strategies be implemented in other areas of education, it should not be omitted that the participants in this study was physics pre-service teachers. Therefore, further research is required to see if similar effects could be found in other areas.

Even thought some of the questions were answered in the research questions, other questions emerged as well. For example, the effects of portfolio development and simulation creation should be studied independently. In addition, existence of interaction between simulation creation and ePortfolio development should be investigated. In this study, the role of sharing ePortfolios is not clear, therefore to explain its role in classic and ePortfolio development should be studied further. The role of authoring tools and the role of sharing portfolios on academic self-concept should also be studied further. In addition to investigating the effects of creating simulations and building portfolios on students' set of feelings, its effect on academic achievement should also be investigated.

Change in one's creativity takes time; therefore, it is essential to examine possible causes of change in creativity in longer studies. These studies will inform us about the persistence of change in creativity, and also if enhancing creativity is even further possible. According to the related literature, alternative learning approaches were reported to have more positive effects in learning environments than those of classic learning approaches. Hence, not only Interactive Physics, but also other simulation creation applications and virtual laboratories, and their effects on students' creativity and attitudes should be investigated.

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