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The effects of teaching methods on preservice teachers knowledge about basic astronomy subjects

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Abstract

The purpose of this study is to explore the learning effect related to different teaching methods (computer assisted instruction and 5E learning cycle model) on basic astronomy subjects of preservice teachers. In this research the pretest-posttest experimental design was used. The working group consists a total of 78 preservice teachers who were studying different departments (41 Classroom Education, 37 Science Education) of Erciyes University in the fall semester 2016-2017 academic year. Astronomy Knowledge Test which was developed by Tascan (2013) was used for data collection tool. For the analysis of the data; two-way ANOVA and the descriptive statistics were conducted and the findings were interpreted with respect to each research question. The significance level was taken as .05 for the comparisons. Two-way ANOVA results revealed that, the main effect for teaching method and program type interaction were not significant. Suggestions have been developed in the direction of the obtained results.

Keywords: Astronomy education; computer assisted instruction; 5E learning cycle model; preservice teacher.

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1. Introduction

Astronomy is derived from the *astro* and *nomos* words of ancient Greek and is synonymous with sky science. Astronomy is defined "as a science that examine the location of the celestial bodies, their movements, measurement of their distance to each other, their science and chemistry aspects" (TLS, 2006). Astronomy that is interwoven with other sciences, benefit from physics, mathematics, chemistry and biology during the evaluation of data; geography during the detection of the locations of the observatories (Zurnaci, 2015), psychology and physiology during the investigation of the mistakes of the observer (MNE, 2010). Thus, it is possible to say that the developments in astronomy science provide important contributions to our daily life. For instance, it can be stated that astronomy is a good educational instrument in terms of conducting individuals/societies to scientific facts (MNE, 2010).

It is becoming increasingly important to include this area in many educational programs that is intertwined with everyday life. One of these educational programs is science education. The acquisitions of the science course teaching program was designed taking into account the relationship of scientific knowledge with skills, emotion and daily life (MNE, 2013). Astronomy acquisitions are also intensively involved (43 acquisitions) in the World and Universe subject area of this course. Science acquisitions in life science course curriculum are similarly associated with everyday life and referred to astronomy issues (MNE, 2009). In this sense, it is important to learn and teach astronomy meaningfully that is interrelated with daily life, within the scope of science education.

Looking at the studies done in the field of astronomy, it can be stated that it is on identifying alternative ideas (Goncu & Korur, 2012; Trumper, 2001; Trundle, Atwood & Christopher, 2006; Trundle & Troland, 1996), knowledge level (Bostan, 2008; Kanli, 2014; Kaplan & Ciftci-Tekinarslan, 2013), mental models (Iyibil, 2010; Iyibil & Saglam-Arslan, 2010; Vosniadou & Brewer, 1992; Vosniadou, Skopeliti & Ikospentaki, 2004) and astronomy self-sufficiency (Carter, 2005; Gunes, 2010). Except these, studies investigating the effect of the teaching method on the conceptual understandings/learning effects of individuals on astronomy issues are also available in the national literature. Some of these studies are included in the following table.

Table 1. Studies investigating the effect of the teaching method on the conceptual understandings/learning effects of individuals on astronomy issues

Study	Topic(s)	Teaching Method Used in Experiment Group	Teaching Method Used in Control Group	Working Group
Baltacı, 2013	Solar system and beyond unit	Multiple writing methods and science writing heuristic methods	Traditional instruction	114 seventh grade students
Türk, 2010	Solar system and beyond unit	Planetarium and observatory environment	Classroom environment	240 seventh grade students
Ezberci, 2014	Moon phases	5E learning cycle model (group 1) and 5E learning cycle model supported with metaconceptual processes (group 2)	Traditional instruction	87 seventh grade students
Okulu, 2012	What is astronomy?, Solar system and Sun observation, astronomy topics and experimental activities in primary school curriculum,	Six modules developed for astronomy education	-	88 third-year students in the Science Teaching Program

	space exploration and space life, astronomy history and sky observation, sky observation with telescope			
Küçüközer, Bostan & Işıldak, 2010	Topics in astronomy course content	Modeller, computer programs (Stellarium), observation and discussion methods	-	78 second grade pre-service mathematics teachers
		Cooperative learning and Moon observations		
Öztürk & Uçar, 2012	Moon phases		Traditional instruction and Moon observations	33 eight grade students

When the Table 1 is examined, it can be seen that in the studies generally had worked with primary school students as a sample. Besides in Okulu (2012) and Bostan and Isildak (2010) studies was conducted with preservice science and mathematic teachers. It is seen that there is not a study investigating of the effectiveness of astronomy education for both preservice science and classroom teachers. In terms of topic(s), it is stated that the focus is often on the Solar System unit and the Moon phases. Besides, it is clear that the control group is based on traditional methods in the experiment-control group studies. However, except that traditional instruction, doing studies examining the effect of two different methods will allow comparison of these different methods. For this reason, in the present study one of the groups was conducted computer assisted instruction while the other group was conducted 5E learning cycle model. In this context the purpose of this study is to explore the learning effect related to different teaching methods (computer assisted instruction and 5E learning cycle model) on basic astronomy subjects of preservice teachers. The research question identified for this purpose is:

"Do the prospective teachers' scores from the Astronomy Knowledge Test show a statistically significant difference according to the interaction between the program and the teaching method?"

2. Method

2.1. Research design

In this research the pretest-posttest experimental design was used. The most important feature of experimental research that distinguishes it from others is that researchers manipulate the independent variable (Fraenkel & Wallen, 2006). Within the content of this study, teaching method and program type

as independent variables, scores from Astronomy Knowledge Test as dependent variable were considered.

2.2. Participants

The working group consists a total of 78 preservice teachers who were studying different department (Classroom Education and Science Education) of Erciyes University in the fall semester 2016-2017 academic year. The information about the prospective teachers is given in Table 2.

Table 2. The distribution of the preservice teachers by program type and teaching method

Program Type/Teaching Method	Groups	
	Computer Assisted Instruction	5E Learning Cycle Model
Classroom Education	21	20
Science Education	25	12
Total	46	32

When Table 2 is examined, it is seen that there are four different groups. Prospective teachers in classroom education are divided into two groups (computer assisted instruction and 5E learning cycle model), similarly prospective teachers in science education are divided into two groups in this way.

2.3. Instrumentation

Astronomy Knowledge Test (AKT) which was developed by Tascan (2013) was used in this study. There are 21 questions in this test. Questions in the test are related to basic astronomical definitions, Sun, Earth and Moon's movements, Moon phases, Moon eclipse and solar eclipse, stars, galaxy and Solar System. A reliability coefficient was found for this test as .730.

2.4. Data analysis

SPSS 22 was used to analyze data and benefited two-way ANOVA. The significance level was taken as .05 for the comparisons. The two-way ANOVA compares the mean differences between groups that have been split on two different categorical independent variables on one continuous dependent variable (URL, 1). Thus, researcher tries to find out if there is an interaction between the independent variables on the dependent variable.

3. Findings

This section presents the findings from the quantitative data collection tool of the study, i.e. from the AKT scores conducted with all of the selected preservice teachers after the instruction period.

Firstly, assumptions must be made to make two way ANOVA. To check normality assumption for the variables, Shapiro-Wilk test was conducted. Table 3 shows the results of this statistics.

Table 3. Results of Shapiro-Wilk test

			Shapiro-Wilk		
			Statistic	df	Sig.
Program Type	Posttest	Classroom education	,973	32	,595
		Science education	,959	26	,377
*Group	Posttest	5E	,967	25	,573
		CAI	,963	33	,323

*CAI: Computer Assisted Instruction, 5E: 5E Learning Cycle Model

As seen from Table 3, for all variables, it can be said that normality assumption was met. Besides, when we analyzed it was seen that histograms together with their normal curves for AKT posttest mean scores' distribution for each of the groups.

In order to check the assumption of equality of variances, Levene's test was used. Table 3 shows the results of this statistics.

Table 4. Levene's test of equality of error variances

F	df1	df2	Sig.
2,412	3	74	,074

As seen from Table 4, Levene's test was not significant for posttest. Thus, this assumption was satisfied and two way ANOVA could be performed. Descriptive statistics for AKT posttest were given in Table 4.

Table 5. Descriptive statistics for the AKT posttest

Program Type	Group	?	Std. Deviation	N
Classroom Education	5E	8,1500	3,37600	20
	CAI	9,0476	1,98686	21
	Total	8,6098	2,75570	41
Science Education	5E	7,0000	2,44949	12
	CAI	8,9200	3,39018	25
	Total	8,2973	3,21338	37
Total	5E	7,7187	3,07156	32
	CAI	8,9783	2,80863	46
	Total	8,4615	2,96601	78

In view of Table 5, it is possible to say both science and classroom education CAI group mean scores of AKT is higher than 5E group mean scores of AKT. Table 5 gives the information about two way ANOVA in terms of AKT posttest for groups.

Table 6. Results of two way ANOVA for AKT posttest

Source	Sum of Squares	df	Mean Square	F	p*
Program type	7,388	1	7,388	,858	,357
Teaching method	35,931	1	35,931	4,172	,045*
Program type* Teaching method	4,731	1	4,731	,549	,461
Error	637,342	74	8,613		
Corrected Total	677,385	77			

*p<.05

Table 6 shows that two-way ANOVA indicated significant main effects for teaching method ($F(1,74) = 4.172$, $p<.05$) but not for program type or program type*teaching method interactions ($p>.05$). That is to say, preservice teachers learning effect about basic astronomy subjects didn't change in accordance with the teaching method (CAI and 5E) and program type (science education and classroom education) interactions.

4. Discussion, Conclusion and Recommendation

From a general perspective, it can be concluded that preservice classroom and science teachers learning effect about basic astronomy subjects didn't change according to the teaching method and program type interactions. A study done by Ezberci (2014), results showed that when students' pre-test scores obtained from the conceptual understanding test are statistically controlled, a significant difference, was found among the conceptual understanding of students taught by three different

methods. The performed Bonferonni test indicated that the conceptual understanding of students exposed to 5E learning cycle model supported metaconceptual processes was significantly higher than the conceptual understanding of students taught with traditional instruction. However, a significant difference wasn't found between two different teaching methods the 5E learning cycle model and the 5E learning cycle model supported with metaconceptual processes.

When looking at the means in the present study, is was seen that the mean score of those who participate in CAI from preservice classroom and science teachers is higher than preservice teachers participating in the 5E learning cycle model instruction. In this sense, it can be said that materials presented in computer, models and images of sky observations have a positive effect on the conceptual understanding of preservice teachers. Bell and Trundle (2008)'s study also described the conceptual understandings of 50 early childhood preservice teachers about standards-based lunar concepts before and after inquiry-based instruction utilizing educational technology. Thus, they used computer simulations. They have found that after the instruction with technology integration, most participants (82%) held a scientific understanding of the cause of moon phases and stated that well-designed computer simulation used within a conceptual change model of instruction can be very effective in promoting scientific understandings. Another study, in Kucukozer (2008)'s study, prospective science teachers' misconceptions about the seasons and the phases of the Moon were determined, and then the effects of 3D computer modelling on their conceptual changes were investigated. The results of the study suggest that the teaching was quite effective regarding conceptual change. Kucukozer, Bostan and Isildak (2010), used computer programs in astronomy course content. At the end of the study, a significant difference has been found between the results of pre and post-tests of four sections and the general questionnaire. Thus, they said that instruction has lead to a conceptual change. These and similar studies in the literature showed that the CAI has an effect on meaningful learning of astronomy topics. The high mean score in the present study supports this situation.

In the direction of the results obtained, it is thought that new teaching approaches should be included in the learning environments especially in the teaching of astronomy topics; sky observations, video, computer simulations, modeling, etc. should be used during instruction. There was no significant difference in the teaching of astronomy topics between the computer assisted instruction and the 5E learning cycle model in this study. After that in similarly, it is suggested that studies should be done on the effect of different teaching methods (collaborative learning, problem based learning etc.) on the teaching of astronomy topics apart from traditional instruction.

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