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Effect of Technology-Integrated Inquiry Based Learning Approach on Middle-School Students' Conceptual Understanding of Lunar Eclipse

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Abstract: The aim of this study is to investigate the effects of technology-integrated inquiry based learning method and learning method that is based on the curriculum of science on the conceptual understanding shifts among students. In the research mixed explanatory model was harnessed. Sampling of the research consisted of 6th graders in a state middle-school. 33 students in one section constituted the test group whilst 29 students in a different section formed the control group. Members of test and control group were randomly assigned. Test-group students were taught in line with the learning method based on technology-integrated inquiry whereas control-group students received inquiry-based method as per the effective curriculum. In line with the aim of this research, "Conceptual Understanding Test" was administered to students as pretest and posttest before and after the learning process. In addition, a semi-structured interview was implemented among 9 students from each of the 2 groups. In the selection of students for this interview, their science grade from the previous year was examined. In the conceptual understanding test that was prepared as our data collection tool, 5 open-ended questions to measure 3 of the program acquisitions were included. The said questions entailed acquisitions on "the student can predict how lunar eclipse is formed", "the student is informed about what phase the moon is in during lunar eclipse" and "the student is informed about the fact that lunar eclipse is not a regular phenomenon for each month". 5-category grading key was utilized for the analysis. These categories comprised of "exactly true", "partially true", "scientifically invalid answer", "non-codable" and "no answer" options. In the analysis of data, total score was computed by giving 4 points to "exactly true" category, 3 points to "partially true" category, 2 points to "scientifically invalid answer" category, 1 point to "non-codable" category and 0 point to "no answer" category. In the analysis of data, t-test for unrelated measurements was harnessed. Based on the answers obtained from data analysis it was evident that not a significant difference existed between technology-integrated inquiry based learning of lunar eclipse concept and inquiry-based learning that followed the curriculum format.

Keywords: Technology integrated inquiry-based learning, Lunar eclipse, 6th grade Students

Introduction

With the implementation of 2018-dated Science curriculum, research & inquiry based learning has been implemented much more effectively in Turkish classrooms (MEB *Ministry of National Education*, 2018). Conducted studies also indicate that, stipulated by a common objective, the mission was to revise the curriculum (Akuma & Callaghan, 2018). In these researches common goal has been to train students as science-literate individuals with some awareness on their surrounding and aptly using scientific-process skills. In learning of scientific knowledge there is a myriad of studies on inquiry-based method in which students gain experiences via active participation (National Research Council (NRC), 1996; Duit, 2009). Bostan Sarıoğlan and Abacı (2017) in their research implemented inquiry-based method while learning lamp radiance concept to 5th graders. In the posttest results of students it was seen that, compared to pretest results, there was a rise in the ratio of scientific answers provided. Duru, Demir, Ören and Benzer (2011) in their study investigated the effect of inquiry-based laboratory applications on students' attitudes and scientific-process skills. Their findings

concluded that inquiry-based laboratory applications had no significant effect on students' attitudes although it led to a positive effect on their scientific-process skills. In another study however; a three-dimensional graphic was used for inquiry-based learning. At the end of this study it was attested that compared to students in control group, students in test group were more successful in inquiring, hypotheses-generation and critical thinking on available data (Chen, Wang, Grotzer and Dede, 2018). Kaya and Yılmaz (2016) in their research examined academic achievements of open inquiry-based method on "Force and Moment". They detected that students in test group achieved significantly higher academic scores than those in control group. In former studies there was a variation with respect to research groups. In another study an inquiry-based learning was provided to undergraduate students. In this practice, students utilized 3-B modeling tools in order to forge virtual-reality model of Solar System. This research pointed that inquiry-based method could be an effective learning method to help students understand astronomical phenomena (Barab, Hay, Squire, Barnett, Schmidt, Karrigan, Yamagata-Lynch, 2000).

There is an abundance of studies in which both education and technology are closely intertwined. Küçüközer (2008) in his study examined via 3D model the conceptual change in phases of the moon and seasons. This study revealed that his method triggered a significant conceptual change among prospective science teachers. Küçüközer (2013) in one of his studies claimed that prospective science teachers could facilitate conceptual change via administering computer-model supported education and this conceptual understanding could also be saved for a long time. In other relevant studies the technique was blended with technology-based methods. In their research Çakır and Oktay (2013) blended technology with brain-based learning. Although technology supported brain-based learning was implemented in test group, effective curriculum was activated in control group. Next its effect on the permanent learning level and metacognitive awareness level was investigated via checking students' academic success level. It was attested that technology supported brain-based learning had a positive effect on students' academic success and permanent learning level but had no effect on their metacognitive awareness level. Similarly in another study virtual-reality computer models were activated in order to support students' understanding of astronomy concepts. As a result of the applied modeling it was concluded that students enhanced understanding of astronomy-related contexts via computer-modeling(Barnett, 2005). In other studies it became clear that computer supported learning positively influenced students' attitudes (Yenice, 2003). On the other hand it is not, in all circumstances, viable to obtain identical results from all studies. In their study Güven and Sülün (2012) concluded that computer supported or traditional learning created not any significant change in students' attitudes. It is worth noticing that, in addition to technology, the models are also used in the learning of subjects. Türk and Kalkan (2017) in their study focused on learning of astronomy via models. Commonality between their study and this research is mentioning of Lunar Eclipse Concept. In the study of Türk and Kalkan(2017) it was identified that students' responses favored learning of Lunar eclipse concept via models.

Moon concept has been a focal point in numerous studies. Bostan (2008) in his analysis aimed to compare the "position of the Earth, Sun and Moon during Lunar eclipse" via conducting interviews across a wide range of age groups. At the end of this research he concluded that with an increase in students' age there was a corresponding decrease in their misconceptions and non-codable responses. In his study Ogan Bekiroğlu (2007) investigated the effect of model based education on prospective teachers' concepts about Moon, Phases of the Moon and Moon-related phenomena. With this study prospective teachers' incorrect or incomplete mental models were regulated with the support of model-based education. In their study Kavanagh, Agan and Sneider (2005) claimed that inquiry-based researches could be effective in correcting students' misconceptions on the phases of moon. Unlike these previous studies, in our research, a mixed model has been proposed in which technology, inquiry and Lunar eclipse concept are presented collectively. In line with this aim 6th grade students were taught of moon concept. Test-group students were administered the designed technology integrated inquiry-based model whereas students in control group were taught in accordance with inquiry-based learning method as per the curriculum. It then became feasible to compare conceptual understanding levels of students' on lunar eclipse concept with respect to the different learning methods applied.

Method

In this study one of the mixed method patterns, explanatory successive pattern in short, was utilized. Explanatory successive pattern allows to conduct a wider scope of research(Creswell, 2017). While the quantitative part of the research entailed "Conceptual Understanding Test" its qualitative part was composed of semi-structured interviews held among select students.

Sampling of the research

In the selection of research sampling one of the random sampling methods, also known as simple random sampling method, was harnessed. In simple random sampling method the sampling that refers to the whole population is arbitrarily selected (Büyüköztürk, Kılıç Çakmak, Akgün, Karadeniz & Demirel, 2014). As the sampling, two 6th grade classes studying in a state school in Manisa city were randomly selected. Classes were divided into test group and control group students. In test group a total of 33 students took part whereas in control group there were 30 students in sum. 15 students in test group were female and 18 were male while in control group 13 students were female and 17 were male.

Data collection Tool

Data collection tool "Conceptual Understanding Test" (CUT) employed in this study was concocted by the researchers. Questions in CUT were directed to highlight the acquisitions in the Science Curriculum for 6th grade "the student can predict how lunar eclipse is formed", "the student is informed about what phase the moon is in during lunar eclipse" and "the student is informed about the fact that lunar eclipse is not a regular phenomenon for each month". After the preparation of questions, experts' opinions were asked. In accordance with experts' views, questions were reorganized and administered among 30 7th grade students who were previously educated on these concepts. 5 open-ended questions in CUT were directed to students in test and control group as pretest and posttest. Interviews were conducted with 8 volunteer students from test and control groups. Semi-structured interviews were tape recorded during the sessions.

Data Analysis

To analyze CUT a five-category grading key was harnessed. These categories consisted of options "exactly true answer", "partially true answer", "scientifically invalid answer", "non-codable" and "no answer" . Exactly true answer category contained an exactly true response and correct explanation. Partially true answer category contained the true answer but lacked the explanation for the response. Scientifically invalid answer entailed false answers and false explanations. Non-codable answers contained irrelevant answers and no answer category entailed students who did not respond. Scoring was performed by giving 4 points for "exactly true" category, 3 points for "partially true" category, 2 points for "scientifically invalid answer" category, 1 point for "non-codable" category and 0 point for "no answer" category. To analyze the total scores collected, SPSS package program was benefited. T-test for unrelated measurements was implemented to analyze the relation between obtained pretest and posttest scores and test and control group. In order to compare posttest scores of test and control groups with the pretest scores of test and control groups, t-test for independent groups was conducted. In the comparison of test group's pretest and posttest scores with control group's pretest and posttest scores, t-test for related measurements was administered. T-test for related measurements is used for repetitive measurements on the same subject (Büyüköztürk, 2017). Semi-structured interviews that had been tape recorded during the sessions with test and control group were then scripted.

Teaching Process

In test group teaching process was executed via technology integrated inquiry-based learning method while in control group inquiry-based method in science curriculum was followed accordingly. In both methods common objective was to gain the acquisition of; "the student can predict how lunar eclipse is formed". In the planning stage of learning the test group 5E learning model was utilized. In the warm-up stage role-play was the preferred technique. During discovery stage students in groups of four were asked to perform the activities via Prediction-Observation-Explanation method. Students having written their predictions on relevant acquisition then watched the simulation. After viewing the simulation, observations were noted down by the students. In the following group discussions, students exchanged their explanations. During Explanation stage students clarified their views and teacher acted as a guide in directing their views. In the deep-learning stage students were provided with a worksheet in which the reasons of yearly observed Lunar Eclipse and "Super Blood Blue Moon" eclipse were noted. During the analysis stage, students were provided with a worksheet in which gap filling exercises were listed.

Results and Discussion

In this section findings obtained from the analysis of administered CUT on test and control group have been exchanged.

Comparing the Pretest Scores of Test and Control Group

Comparison of t-test results of the scores obtained from the pretests of test and control group is as exhibited in Table 1.

Table 1. T-test results of the scores obtained from the pretests of test and control group

GROUP	N	$\overline{X}$	S	Sd	t	p
Test group	33	10.48	2.516	60	.160	.295
Control Group	29	10.58	2.062			

Table 1 reveals that pretest scores are not significantly different (t(60)=.160, p>.05) in test and control group. This finding can be interpreted as the absence of a significant difference among test and control groups with respect to the results of pretest scores**.**
Below is a model interview conducted among students before learning process.

Interviewer: *Is it possible to observe Solar Eclipse or Lunar Eclipse each month?*
CGS1: *No.*
Interviewer: *Why do you think we cannot observe this phenomenon every month?*
CGS1: *Because Earth's cycle-time around itself and Moon's cycle-time around itself are not the same. So it is impossible to reach Solar Eclipse or Lunar eclipse position in only month.*

Interviewer: *Is it possible to observe Solar Eclipse or Lunar Eclipse each month?*
TGS4: *Nope, not possible. Not only one time or two times in every month. In some months it may be 2 and in some months only one.*
Observer: Why do we observe this phenomenon if it can be observed every month?
TGS4: *During a month Sun can move ahead of Moon a few times.*
Observer: *Can it be observed in each movement?*
TGS4: *Yes.*

Above is an excerpt of interview conducted with one student from control and test group before learning process. Pre-interview notes reveal that as for the question "*Is it possible to observe Solar Eclipse or Lunar Eclipse each month?"* students in control group and test group failed to give an exactly true answer unlike the concept test administered in the beginning.

Comparing the Posttest Scores of Test and Control Group

Comparison of t-test results of the scores obtained from the posttests of test and control group is as exhibited in Table 2.

Table 2. T-test results of the scores obtained from the posttests of test and control group

GROUP	N	$\overline{X}$	S	Sd	t	P
Test group	33	14.42	2.264	60	.388	.379
Control Group	29	14.17	2.842			

Table 2 reveals that posttest scores are not significantly different (t=.388, p>.05) in test and control group. This finding can be interpreted as the absence of a significant difference among test and control groups with respect to the results of posttest scores**.**
In light of this insight post interviews with the same students were reiterated individually as test and control group. In these interviews different answers from 2 students for the same questions are as seen below.

Interviewer: *Is it possible to observe Solar Eclipse or Lunar Eclipse each month?*
CGS1: *No.*
Interviewer: *Why do you think we cannot observe this phenomenon every month?*
CGS1: *Nope because Earth, Sun and Moon are not in the same line.*

Interviewer: *Is it possible to observe Solar Eclipse or Lunar Eclipse each month?*
TGS4: *No because errrmm, they cannot always get on the same line all the time.*

As for the question "*Is it possible to observe Solar Eclipse or Lunar Eclipse each month?*" results of post-learning interview indicate that, similar to the conceptual understanding test, students in test and control group answered in exactly true answer category.

Comparing the Pretest and Posttest Scores of Control Group

Comparison of t-test results of the scores obtained from the pretests and posttests of control group is as exhibited in Table 3.

Table 3. T-test results of the scores obtained from the pretests and posttests of control group

GROUP	N	$\overline{X}$	S	Sd	t	P
Pretest	29	10.48	2.51	28	6.42	.00
Posttest	29	14.17	2.84			

In Table 3 a significant difference was observed in pretest and posttest scores of control group students (t(28)=6.42, p<.05). This finding can be interpreted such; inquiry-based learning as per the science curriculum created a significant change in the conceptual understanding of students in control group.

Comparing the Pretest and Posttest Scores of test Group

Comparison of t-test results of the scores obtained from the pretests and posttests of test group is as exhibited in Table 4.

Table 4. T-test results of the scores obtained from the pretests and posttests of test group

GROUP	N	$\overline{X}$	S	Sd	t	P
Pretest	33	10.48	2.06	32	10.13	.00
Posttest	33	14.42	2.26			

In Table 4 a significant difference was observed in pretest and posttest scores of test-group students (t(28)=6.42, p<.05). This finding can be interpreted such; inquiry-based learning as per the science curriculum created a significant change in the conceptual understanding of students in control group.

Conclusion

The findings of this study led to the results below;
Pretest scores of the test and control group manifested that there was not a significant difference with respect to

mean scores of conceptual understanding test. Hereby the lesson to take is; prior to learning experience, students in test and control group were in the same cognitive level about the lunar eclipse concept. The fact that posttest mean scores of control and test group are mostly identical led us to conclude that there was not a significant difference between technology integrated inquiry-based learning and inquiry-based learning as per the effective curriculum. As for the scores that control-group students received from pretest and posttest, it was identified that a significant difference existed between pre and posttest mean scores. Based on this finding it can be argued that inquiry-based learning that followed science curriculum positively affected students' conceptual understanding. This is a finding in the same vein with a good number of literature studies. As has been attested inquiry-based learning has a positive effect on students' conceptual understanding and academic performance (Kayacan & Selvi, 2017).

As pretest and posttest scores of students in test group are examined, a significant difference becomes evident between pre and posttest mean scores. Based on this finding it can be argued that technology integrated inquiry-based learning positively affected students' conceptual understanding. Simulation learning was implemented in test group. In their paper Sarı and Bakır Güven (2013) employed an interactive board support that complied with inquiry-based learning. Besides, their research was also supported via simulation. As a result they concluded that students' academic achievement increased more dramatically (Sarı & Bakır Güven, 2013). According to the results obtained from the findings of this study, technology integrated inquiry-based learning and inquiry-based learning as per the science curriculum created a significant difference in the conceptual understanding of students. Prior to learning process, students in test and control group lacked scientific knowledge on Lunar eclipse concept but the learning session for both groups enabled a jump in the scientific answers of students. Despite that this increase failed to create a significant difference between both groups. Likewise implemented pre and post interviews also indicate that there is not a significant difference between technology integrated inquiry-based learning and inquiry-based learning as per the curriculum. Unlike this study, an abundance of analyses proved that computer supported learning is quite an effective method in bolstering students' success (Akçay, Aydoğdu, Yıldırım, Şensoy, 2005; İçel, 2011). Difference across the obtained results may be related to a variety of factors. Difference of research group, difference in practitioners, employed materials and various other factors can change the outcome of any study.

Suggestions

At the end of this study our suggestions to researchers who also aim to conduct studies related to Lunar eclipse concepts are as below;

- It is suggested that other studies, in which a new learning method, could be used instead of 5E learning model provided for the use of test group in our study. To give an example, learning domain or 7E model can be used.
- In the same way, instead of inquiry-method applied as per the curriculum in control group, it is suggested to use another learning method.
- The sampling of this research consists of 6th grade students studying in two different sections in a state middle-school. Sampling size could be much wider in the subsequent researches.
- While in this study technology was integrated to inquiry-based learning, in a different study technology could be integrated with different learning methods. Çakır and Oktay (2013) in their research integrated technology with brain-based learning. Similarly different educational methods and technology could be blended in the learning process.

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