Discovery Learning with the Solar System Scope Application to Enhance Learning in Middle School Students

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ABSTRACT In education, "Industrial Revolution 4.0" refers to utilizing technology to present students with complex situations that will develop their critical thinking and problem-solving skills. The use of technology in the science curriculum should be designed according to established learning models. This study aimed to investigate the effect of implementing a discovery learning model, supported by the Solar System Scope computer application, on the ability of students to master essential concepts. This research used a One-Group Pre-test-Post-test design. Participants were 31 7th-grade students at one school in Bandung, Indonesia. The results showed a medium enhancement of concept mastery in students from pre-test to post-test (N-Gain=0.48). No gender difference in outcomes after the implementation of discovery learning with the Solar System Scope application was found. Based on these results, discovery learning supported by the Solar System Scope application could be an alternative teaching approach to enhance students' skills in mastering concepts.

Keywords Discovery learning, Solar system scope application, Students' concept mastery, Solar system

1. INTRODUCTION

Curriculum 2013 is one of Indonesia's education systems, which is chosen as an education system for the time being. Based on *Kementerian Pendidikan dan Kebudayaan* (2014) curriculum 2013 is one of the highly effective teaching models because this curriculum can accommodate and approach students' emotional, physical, and academic. Besides, they also stated that in addition to delivering instructional materials, teachers also need to be able to develop the value and skills of students.

It is not easy to achieve the purpose of curriculum 2013, especially learning in science. Based on the comprehensive survey study by OECD (Organization for Economic Co-operation and Development) using PISA (Program International for Student Assessment) test as the international study of the achievements of reading and math. The data shows Indonesia is ranked 62nd with a score of 403 from 70 countries that participated in the PISA test in 2015 while neighboring country Singapore is in the rank 1 with a score of 556. According to the International Survey of Trends in International

Mathematics and Science Study (TIMSS) in 2015 shows that the average rating of Indonesian students' science achievement is below the international average score. The data of TIMSS indicates that Indonesia is ranked 45th out of 48 countries participating in this survey. The global score is 600, while Indonesia's average rating is 397 (Martaida, Bukit, & Ginting, 2017). From the statement, it means that learning science still becomes one of the hardest subjects in Indonesia.

The statement also supported by several problems related to the implementation of science learning in Indonesia. Some of these studies state that there are problems related to students' conceptual understanding (Sani, Rochintaniawati, & Winarno, 2019; Vania, Setiawan, & Wijaya, 2018; Furqani, Feranie, & Winarno, 2018). Before the treatment done, the researcher conducts an interview and observation with some students in the

school. The interview was conducted by asking ten students some questions regarding how they learn science in their school. Then the researcher observes teaching-learning activity in the class. They were stated that physics is the most difficult subject in science. The statement also supported by Ornek, Robinson, & Haugan (2007), who say the most challenging topic in science is physics since the students have to comprehend the science content with different representations. Different representations, in this case, means concepts and laws in physics. Science and technology teaching curriculum should accordingly be developed with the implementation of learning methods because teaching students with the notion of discovering, critical thinking, questioning, and problem-solving skills is one of the main principles of science and technology teaching (Balim, 2009). There are a lot of learning models that can be used by the teacher in the learning activity, especially in learning science. But one of these models that developed based on constructivists is discovery learning. Discovery learning is one of the learning models because it has stages of learning, such as stimulation, problem statement, data collection, data processing, verification, and generalization.

The basis of science teaching is understanding that natural phenomena and the nature of science require inquiring and discovering; it is consists of experiments and inquiring natural phenomena by discovery learning (Bruner, 1961). Several studies about discovery learning were done by researchers who used it on their teaching-learning process. Balim (2009) stated using the discovery learning is considered to increase students' success and inquiry learning skills more than the traditional teaching methods. Mukherjee (2015) also found that during the exercise using discovery learning, students found themselves engaged in a relatively challenging cognitive activity; it is useful in getting students interested and curious.

In learning science, especially solar system topics, students will get instanced content that has to be understood. The hardest part of learning the solar system is not every single object or phenomenon in the solar system could be observed directly, such as the character and movement of each planet and the process of the lunar and solar eclipse (Furness, Winn, & Yu, 1997). The teaching-learning process more efficient and accurate, it is better to apply technology such as simulation for a solar system. Virtualization on science has a way to observe natural phenomena, which, perhaps because of their location, duration, and size, are impossible to direct observe (Furness, Winn, & Yu, 1997).

Talking about cognitive activity and skills, Pillow (2008), has examined the gender differences between students on their academic performance showed that their cognitive and non-cognitive effect is one of the most important and influential characteristics in academic performance in individual context characteristics. The topic of gender has become the talk of the forum today. Other research was conduct by Goni (2015) the result shows that there were no significant differences exist between gender in students' academic performance. It is quite interesting to observe whether any differences between male and female students according to their cognitive skills in learning science since there has been no study about it previously.

Solar System Scope application is one of the planetarium software to see the virtualization of the solar system to help the students identify or observe the solar system. This application was first presented in 2010, supported by excellent Scope team, Adrian Bayer, who came up with the idea, Marian Bayer, as the first one to make real programming for Solar, etc. Solar System Scope application has many features for students as users to learning solar systems in order to make them learn better. Some features are night sky features that allow students to see the sky by using handphone, near stars, and messier objects feature is to explore any object besides planet and stars in the solar system, and planet explore feature in the application to learn about characteristics of each component in the solar system.

By using virtual planetarium environments, students will get the experience of a phenomenon or a place that seems so complicated and impossible to see directly in real life (Dede, 2000). One as exciting examples of Virtual Learning Environments, planetarium software, offers many possibilities for learning the solar system in a new way and beneficial ways, as the software provides students the structure, details, and complexity of the solar system through 3D visualization (Gilbert, 2008; Mikropoulos & Natsis, 2011). De Jong and Van Joolingen (1998) also stated that learning with simulations based on discovery learning can take place in education and instruction as a new line of learning environments, based on technology, in which more emphasis is given to the learner's initiative.

Previously, several studies about discovery learning were done by the researchers. Balim (2009) research the effects of discovery learning on students' success and inquiry learning skills. Mukherjee (2015) investigates the effective use of discovery learning but focusing on improving understanding of factors that affect quality. Mostafae (2015) also research discovery learning towards learners' speaking ability. Another research by Saab, van Joolingen, and van Hout-Wolters (2009) investigates the relation of learners' motivation with the process of collaborative scientific discovery learning. In 1984, Andrews researching discovery and expository learning compared: their effects on independent and dependent students. Singer and Pease (2013) also study about discovery learning by comparing discovery learning and guided instructional strategies on motor skill learning, retention, and transfer. De Jong and Van Joolingen (1998)

Table 1 One-group pre-test-post-test design

O	X	O
Pre-test	Treatment	Post-test

study about discovery learning with computer simulations but focusing on conceptual domains. And similar research conducted by Dalgarno, Kennedy, and Bennett (2014) on research discovery learning using computer-based simulations to investigate students' exploration.

There are several studies about discovery learning supported by technology, which is a computer-based simulation. However, the differences between this research with those previous research are implementing discovery learning as a learning model using the Solar System Scope application as technical support. Knowing about the demands of science education that the learners should increase their concept mastery, this study aims to determine the effect of implementing discovery learning supported by Solar System Scope application to enhance students' concept by analyzing students' gender differences.

Solar System Scope application can be the technical support in discovery learning for solar system topics. Because discovery learning can be used as a learning model in learning the solar system and Solar System Scope application is the facilitation to help students to observe the solar system. It will be a way to solve the problem in learning the solar system since students should identify the object of the solar system and analyze the phenomenon in the solar system.

By implementing discovery learning that supported by the Solar System Scope application, hopefully, teachers can deliver the material of the solar system in another way with an easily understandable, more creative, and interesting way other than a traditional teaching-learning activity. Through the implementation of the discovery learning model with a supporting app, which is Solar System Scope application in the classroom, students will understand this concept easily and give students a new experience in learning solar systems too. Also, this research can be used as a reference for further research. Other researchers can investigate the implementation of discovery learning that supported by another planetarium software or implementing other learning models since there is still a lot of learning model and planetarium software that can be used, or researchers can investigate the other students' skills in the teaching-learning process.

Table 3 Test item of students' concept mastery

No	Indicator	Test Item
1	Remembering	1, 2, 6, 7, 8
2	Understanding	4, 5, 9, 10, 11, 13, 14, 17
3	Applying	3, 12, 16
4	Analyzing	15, 18, 19, 20

Table 2 Data of the sample

Population	Sample		Percentage (%)	Total (%)
7th grade	Male	13	41.93%	100%
	Female	18	58.06%	

This study aimed to investigate the effect of implementing discovery learning supported by the Solar System Scope application on students' concept mastery.

2. METHOD

2.1 Method Design

The method used was experimental research. According to Fraenkel, Wallen, and Hyun (2011), a poor experimental design involving one group that is pre-tested, exposed to a treatment, then post-tested. That is related to the purpose of this study, which is to investigate the effect of the implementation of discovery learning supported by Solar System Scope application towards students' concept mastery in learning solar system.

The design used in this research is One-Group Pre-test-Post-test Design (Fraenkel, Wallen, & Hyun, 2011). One-group pre-test-post-test design measuring a single group not only after being exposed to the treatment of some sort but also before the procedure. Treatment in this research is learning solar system using discovery learning supported by Solar System Scope application. Solar System Scope application is one of the planetarium software to see the virtualization of the solar system to help the students identify or observe the solar system. This application was first presented in 2010, supported by excellent Scope team, Adrian Bayer, who came up with the idea, Marian Bayer, as the first one to make real programming for Solar, etc. Table 1 shows the research design used in this research.

2.2 Population and Sample

The location of this research is at one of secondary school in Bandung. The curriculum that is used in this school is Curriculum 2013, which is fitted with the implementation of discovery learning. This curriculum requires students to not only understand the concept but also be active and contribute to the learning activity. It can be done through some steps in discovery learning implemented in this research.

The population in this research is all the students in one of the classes in 7th grade who have not studied the solar system topic before. The sampling technique used in this research was convenience sampling. According to Fraenkel, Wallen, & Hyun (2011), convenience sampling is a group of individuals who are available for study. The researcher selects participants because they are available to be studied. There are 31 students in one class at this school with 13 male students and 18 female students with an age average of 12-13 years old. The students as the sample to be studied because they are available, and the

researcher has the permission of the principal. Table 2 shows the recapitulation of the sample.

2.3 Research Instrument

In this research to measure students' concept mastery in learning the solar system, researcher use objective test, which consists of 20 multiple choices. The questions cover all the content and concept mastery that is used in this research, so five questions for each cognitive domain. Twenty multiple choices distributed before and after conducting learning activity. Pre-test distributed to the students before they learn about the solar system. Solar System topic and post-test distributed after learning activity measure the enhancement in students' concept mastery. There are C1 (Remembering), C2 (Understanding), C3 (Applying), and C4 (Analyzing) as a cognitive domain that used in this research. Test items of students' concept mastery can be seen in Table 3.

The data were analyzed in terms of its discriminating power, difficulty level, and validity by using ANATES. The recapitulation of the test item is tabulated in Table 4. The total number of multiple-choice questions is 26 questions. The questions were distributed to be tested to 32 students of 8th grade in Junior High School who already learned about solar system topics. Those questions researchers use based on some books, national exam exercises, and some items are from the research that previously validated. After we analyze using ANATES, regarding the result of reliability and validity (appendix), there are five questions rejected, and 20 questions are used with two questions are need some revision before used as an objective test in this research.

2.4 Data Analysis

Analysis of the objective test to measure students' concept mastery was done by Microsoft Excel calculation to determine the score of pre-test and post-test. The process of data calculation is explained as follows:

Scoring of Test Item

Pre-test and post-test test items were calculated to know the result of each student. The question of each test item pre-test and post-test is 20 multiple-choice questions.

Calculate the Gain and Normalized Gain

The normalized gain, introduced by Hake 1998, has become the standard measure for reporting scores on research-based concept inventories. After scoring the test item, the data was processed to know the gain score and normalized gain score. Hake defined the average normalized gain as:

$$< g >= \frac{\%S_f - \%S_i}{100 - \%S_i}$$

Description:
<g>= Normalized gain
Sf= Post-test score
Si= Pre-test score

(Hake, 1998)

Normality Test

A normality test is a test about the normal distribution of data. This test is the most widely performed test for parametric statistical analysis. The data that is normally distributed is a requirement for parametric tests. The data analyzed using SPSS 24.00 and was distributed normally.

Homogeneity

The homogeneity test aims to determine whether the measured score variance in both samples has the same variation or not. Populations with equal variation are called populations with homogeneous variance, whereas populations of unequal variance are called populations with heterogeneous variance.

Independent T-Test

An independent sample T-test was used to test the significance of the average difference between the two groups. This test is used to test the effect of the independent variable on the dependent variable. The significance value is 0.05 and determines the hypothesis.

2.5 Research Procedure

There are three stages of this research procedure: preparation, implementation, and completion stages. Preparation stage as the first stage, including literature review, conducted to analyze the information about Curriculum 2013, discovery learning, Solar System Scope application, students' concept mastery, and solar system topic. After analyzing the researcher arrange instruments and observation sheet instructional tools that will be used; lesson plans and worksheets that arranged to support the implementation of this research. Then, experts will conduct the judgment of instrumentation. To do the trail test of an objective test instrument that will be conducted to identify the quality of the instruments. The result of the trial test was revised based on judgment results and test item analysis.

After the preparation stage, the implementation stage is done by conducting a pre-test to identify students' preliminary skills first. Then come to the main part, which is treatment. In this part, students are learning using discovery learning supported by the Solar System Scope application that conducted since the first meeting until the last meeting of learning the solar system. In the end, a post-test will be conducted to analyze students' understanding.

The data that the researcher got will be obtained then calculated; this is the first step to do in the completion stage. Then, the result of data calculation will be analyzed,

Table 4 Results of normality test on students' concept mastery

	Kolmogorov-Smirnov[a]			Shapiro-Wilk
	Statistic	df	Sig.	Statistic
Pre-test	0.144	31	0.103	0.961
Post-test	0.143	31	0.110	0.945

Table 5 Homogeneity test of variance on students' concept mastery

Levene Statistic	df$_1$	df$_2$	Sig
.002	1	60	.981

and discussion will be done to elaborate on the result of the analysis—the researcher concluding the result of this study based on the analyzed data.

3. RESULT AND DISCUSSION

3.1 The Effect of Discovery Learning Supported by Solar System Scope Application on Students' Concept Mastery

The purpose of this research is to investigate the effect of discovery learning supported by solar system scope application on students' concept mastery. Previous studies reported that students had difficulties in learning physics (Afriani, Agustin, & Eliyawati, 2019; Winarno, Rusdiana, Riandi, Susilowati, & Afifah, 2020). In this study, the students' concept mastery of solar system is measured by using 20 multiple choice questions, which represent variance cognitive level domain. The cognitive level based on A Revision of that tested in this research is C1 (remembering), C2 (understanding), C3 (applying), and C4 (analyzing). There are three topics of the solar system that involves in this research. Those are the characteristics of solar systems component, rotation, and revolution of the earth, and solar and lunar eclipse.

The result of the pre-test and post-test score, which is used to be analyzed, is the score of one tier test. The data were analyzed using SPSS for Windows version 24.0 program to know whether the data is normally distributed or not. After that, the data is analyzed using a parametric test or non-parametric test based on the result of the normality test. The statistic test was done to know the difference concept mastery between pre-test and post-test. The result of the normality test of the pre-test and post-test is shown in Table 4.

Table 7 Students' score on pre-test and post-test

	Average	Gain	N-gain	Category
Pre-test	49.19			
Post-test	73.55	24.36	0.48	Medium

From the result in the Kolmogorov-Smirnov test, the significance value (α) of the pre-test is 0.103, and the significance value of the post-test is 0.110. The Kolmogorov-Smirnov test is the test of the difference between data that is tested and the standard normally distributed data. The level of significance use on the test is 0.05. The result of the significant value of the data tested shows > 0.05, which means that the data is normally distributed.

Since the data is normally distributed, then the test continued with a homogeneity test. The detail of the data result of the homogeneity test can be seen in Table 5. Based on the results of the Levene Statistic test, the significance value (α) is 0.981. If the significant value compared with the level of significance use on the test, which is 0.05, resulting in 0.981 > 0.05, then H0 is accepted. It means that the data value is homogeneous.

The sample of the research comes from one class, and the data that is compared is pre-test and post-test in the class. The Paired Samples t-Test is used because it compares the means for two related units on a continuous outcome that is normally distributed. The result of the Paired Sample t-Test is shown in Table 6.

The statistical test is used to test two hypotheses statements below:

H0: There is no difference in students' scores on pre-test and post-test.

H1: There is a difference in students' scores on pre-test and post-test.

The level of significant value used in the test is 0.05. If the result of the analysis shows the significant value, which is more than 0.05, it means that H0 is accepted, while when it is less than 0.05, H1 is accepted. The result of the test shows that the significant value is 0.000 or less than 0.05, which means that there is a difference in students' scores on pre-test and post-test.

The data gained is also analyzed using a normalized gain test based on the rule of Hake (1998). The average n-gain score of students' conceptual mastery in pre-test and

Table 6 Result of paired sample t-test

	Paired Differences					t	df	Sig.
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pair 1 Pre-Test Post-Test	-24.35	8.73	1.56	-27.55	-21.15	-15.53	30	.000

post-test showed in Table 7. Based on the data analysis in Table 7, it can be found that the average pre-test score was 49.19, while the average post-test score was 73.55. There is an enhancement of students' concept mastery in learning solar system concepts since the average score on the post-test is higher than the pre-test.

From the graph, it is seen that there is an enhancement in students' concept mastery from pre-test to post-test. The initial average score is 49.19, from the average ideal score 100. The students' pre-test scores show that the students' prior knowledge about the solar system is still lack after the implementation of discovery learning supported by Solar System Scope application. There is an enhancement in the average score, which is 73.55 from the average ideal score 100.

The score also has gain normalization with the value of N-gain 0.48 between the average of pre-test and post-test scores. According to Hake's rules of normalization, the value of N-gain 0.48 means that it categorized as medium. Students' concept mastery enhancement in learning solar system proved by the result of N-gain score. Students could enhance their understanding (concept mastery) is because, in this research, discovery learning is supported by Solar System Scope application as the technology called planetarium software to help students learning the solar system better. The technical term is similar to the research done by De Jong and Van Joolingen (1998). They used computer simulation as the technology; the result of their study is discovery learning with computer simulation leads to knowledge that is more intuitive and deeply rooted in a learner's knowledge base. Dalgarno, Kennedy, and Bennett (2014), in their research, also stated using discovery learning with computer simulation as an active exploration process is more effective than passive observation. It could happen because students are more active by discovering the information by themselves based on discovery learning and Solar System Scope application as the technology support called planetarium software to help students observe and analyze solar system. Prima, Putri, and Sudargo (2017) also stated that the implementation of the Stellarium virtual observatory could improve students'

Figure 1 Solar system scope application features

understanding of learning solar systems.

In this research, discovery learning has a role as a learning model to guide students learning the solar system. Discovery learning in this research refers to guided discovery through six steps (syntax) during a learning activity. The syntax of discovery learning could be the main reason students can improve their understanding of learning the solar system. According to Rivers and Vockell (1987), discovery learning involves planning (designing an experiment), executing (carrying out the experiment and collecting data), and evaluating (analyzing the data and developing a hypothesis). This research used syntax from Joyce, Weil, & Showers (1992). Six learning steps are used: stimulation, problem statement, data collection, data processing, verification, and generalization.

Stimulation is the first step during a learning activity; in this step, students are stimulated by some questions or problems. The teacher has a role in stimulating them with the question based on some phenomena in daily life that related to the solar system. Students will feel interested and curious to find the answer, and it will motivate the students to start to learn. Making a hypothesis is also essential for students. Hence, they know what topic or concept that they want to learn, or students have some ideas so they can prove their ideas by observing, and they can develop the hypothesis. For example, is in the learning characteristics of solar system components, the first step is a simulation. In this step first, students are asked about what they already know about the solar system. After that, students are given a short story about the process that happens in the solar system. This step will stimulate them to give more attention and curios to the topic.

The second step is the problem statement. Students are asked to identify the questions, problems, or making a hypothesis. In this research, questions are stated in the worksheet, and students have to complete it. While the hypothesis is based on the phenomenon related to the solar system, the phenomenon in daily life could be the effect of rotation and revolution of the earth, so students will be more understanding of the problem or question because the phenomenon happens every day. In learning characteristics of solar system components, students were given the simulation about the solar system by using Solar System Scope. After that student was given the worksheet that contains some questions to answer (table of the component of the solar system and they should fill it), in this step, students need to understand first what they have to learn and find the information using the application.

Data collection is the third step. This step asked students to answer the question or problem. Students were given a chance to gain some relevant information by reading and observing. In this step, the role of the Solar System Scope application as planetarium software is essential. Students freely explore the application to obtain information and data. When students were seeking information by themselves, it could help them to understand better rather than just memorizing the concept or topic. The data collection step could help students to solve their problems. For characteristics of solar system components topic, students were asked to observe and analyze the component in the solar system as much as they want using the Solar System Scope application. Not only to answer the questions in the worksheet but also to seek new information as much as they can. In case they have something to see and observe besides the questions in the worksheet. They want to find the data, for example, the other planets beside eight main planets or the phenomena of a falling star and constellation shape based on their astrological sign. So learning activity not only focuses on the worksheet, but they can observe and analyze anything they want to see but related to the topic.

Data processing is the step where students process all the information by reading and observing in the previous step, or if necessary for some questions, students have to calculated first then interpreted it. This step will teach students to learn the information that they found by themselves. After getting the data, students need to think and analyze fist before concluding. It makes students learning the concept twice by collecting the data and process it. In the characteristic of the solar system components topic, students were discussing, write, and answer the questions in worksheets with their group. They explain this step is based on the data they get in the data collection step. They can share their idea with other members before concluding and share it with the other students.

The next step is verification, based on the result of the previous step, which is processing the data, the questions, problems, or hypothesis that has been formulated earlier, is checked. In this research, students need to make their predictions about the phenomenon in the solar systems, such as the planet movement, it could be earth's rotation and revolution or by analyzing the process of the solar and lunar eclipse. The verification step is essential to make the student concluding what they have already learned by themselves. It will improve understanding—the steps in line with the next step, which is a generalization. For example, in learning about characteristics of solar system components, students were present about the result of their data, because each group writes the different data. The first group is writing about the eighth planets, the second group writes the planet, and

their satellite and the other groups are writing the other object beside planets. So they can share and tell their idea of the component in a solar system based on what they get.

After collecting the data, processing the data, and verification to check the hypothesis or the problem that we're in the first step, then it comes to the concluding. Each group is asked to go in front of the class and share what information, conclusion, and concept. They have already obtained it. Since the term of discovery learning in this research is guided discovery learning, the teacher could correct if there is a wrong concept that students get. In the last step, teachers and students concluded about what they have learned about components of the solar system. Since in this research, the term discovery learning is guided discovery so the teacher can make some corrections for student's answers. By sharing and concluding the topic together, it prepares students are more understanding so that learning activity will be more fun.

Those six steps could improve students' understanding and learn better since the N-gain score in learning solar system after using discovery learning supported by Solar System Scope application is improved. This statement is supported by some studies before. The steps that are used for learning activity based on discovery learning is generally can make students explore acquire a deeper understanding of the world because rather than just memorizing the concept, they discover it by themselves

Figure 2 Planet explore features in solar system scope application

Figure 3 Earth in planet explore features

(Westwood, 2008).

Based on Großmann and Wilde (2019), in their research about discovery learning, they found that students who worked with guided discovery had higher conceptual and procedural knowledge than the other who is not. Balim (2009), in his research, also stated that using the discovery learning method. Which is one of the various teaching methods in which the students are active and are guided by the teacher, is considered to increase students' success and inquiry learning skills more than the traditional teaching methods. Another research also could support that discovery learning could enhance the understanding of students. Mostafaee (2015) stated that discovery Learning has a significant effect on students as learners. It is because students found themselves engaged in a relatively challenging cognitive activity, and learning using a discovery model could be quite useful in getting students interested and curious (Mukherjee, 2015).

Another statement also stated by Singer and Pease (2013), in their research, learners that were administered discovery instructional strategies in the initial learning situation were superior to the guided learners in retention performance and in the early stages of learning a second related task. It could happen because, during learning activity, using the discovery model. Students are asked to solve the problems, questions, or making hypotheses, and learners who often formulated theories had better learning results while working with the discovery learning environment Saab, van Joolingen, & van Hout-Wolters (2006). They using discovery learning, the performance of a dyad existing of a high, and a lowly motivated learner can be influenced positively by the highly motivated peer Saab, van Joolingen, & van Hout-Wolters (2009). It means learning based on the discovery model could make the students affect the other students to understand about the topic. The other research could support this statement, Andrews (1984) states there is effectiveness using guided learning approach for not only independent students, but it still applies to the dependent individuals.

The other reason that could enhance students' concept mastery in this research is using planetarium software as technology support through discovery learning. Solar System Scope application is an interactive way for students to observe and analyze solar systems. Through syntax in discovery learning, students can seek information, concept, and explore the solar system by themselves using the Solar System Scope application. Solar System Scope application has many features for students as users to learning the solar system to make them learn better. Some features in the Solar System Scope application used by students in this research can be seen in Figure 1.

Figure 1 shows features that are used by students, which are the solar system to explore every single object and movement in the solar system. The features night sky is to see the sky by using a handphone, so students only place their phone directly to the sky, and they will see what objects in the sky at that time. Planet explores students to explore each planet in the solar system, the characteristics until their movement. Besides the planet explore, there is star explore which provides students to see the stars in the solar system in detail. The other features are near stars, and messier objects are to examine any object besides the planet and stars in the solar system, it will improve their knowledge in learning the solar system.

One topic that can be applied using the Solar System Scope application is the characteristics of solar system components. Students can use the planet to explore features in the app to learn about the characteristics of solar system components subtopic. Some students still did

Table 8 Results of normality test on students' gender differences

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	Df	Sig.
Male	0.171	13	0.200	0.932	13	0.359
Female	0.192	18	0.078	0.934	18	0.226

Table 9 Homogeneity test of variance on students' gender differences

Levene Statistic	df1	df2	Sig
4.080	1	29	0.053

Table 11 Students' pre-test and post-test scores on gender

		Average	N-gain	Category
Male	Pre-test	50.38		
	Post-test	73.85	0.48	Medium
Female	Pre-test	48.33		
	Post-test	73.33	0.48	Medium

Table 10 Result of paired sample t-test

	Paired Differences					T	df	Sig.
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pair 1								
Male & Female	-0.020	0.259	0.072	-0.177	-0.137	-0.278	12	0.786

not know the arrangement of the solar system and the name of each planet. Through this application, students freely explore what they want to know. Figure 2 and Figure 3 show the feature of the planet explore in Solar System Scope application.

There are eight planets that students can explore, such as Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune. Figure 3 shows the explore features of each planet. They can observe the earth in the planet system, gain information about earth genuinely, and see the structure of the earth in detail. Not only planets that can be explored by students, Sun as the star is also can be explored in detail. It helps the students learn more comfortable and better since this application comes with great virtualization and animation through some features.

Using the Solar System Scope application as planetarium software to help students learning the solar system through discovery learning could improve their understanding since the N-gain score of students' concept mastery is developed after the implementation. This statement is supported by the result of some studies before, by using the planetarium software, students are better equipped to learn fundamental aspects of the Universe (Persson & Eriksson, 2016). Yu, Sahami, Sahami, and Sessions (2015) stated that using visualization can accurately represent the correct scale, orientation, and position of Solar System objects. The other researcher Yu, Sahami, Denn, Sahami, and Sessions (2016) agree with that, the state after using planetarium software, the students show more significant learning gains when comparing to another group with no visualization, even when the instructors, lecture content, and visuals are constant. By using virtual planetarium environments, students will get the experience of a phenomenon or a place that seems so complicated and impossible to observe directly in real life (Dede, 2000).

3.2 The Effect of Discovery Learning Supported by Solar System Scope application on Students' Gender Differences

To analyze deeply the effect of discovery learning supported by Solar System Scope application in learning the solar system. An analysis was done to see the differences between male and female students. Then a statistic test was done for pre-test and post-test. The result of the normality test of the pre-test and post-test is shown in Table 8. From the result of the Kolmogorov-Smirnov test, the result of the significance value (α) of male students is 0.200. Meanwhile, the significance value of female students is 0.078. The Kolmogorov-Smirnov test is the test of the difference between data that is tested and the standard normally distributed data. The level of significance use on the test is 0.05. The result of the significant value of the data tested shows (α) > 0.05, which means that the data is normally distributed.

Since the data is normally distributed, then the test continued with a homogeneity test. The detail of the data result of the homogeneity test can be seen in Table 9. Based on the results of the Levene Statistic test, the significance value (α) is 0.053. If the significant value compared with the level of significance use on the test, which is 0.05, resulting in 0.053 > 0.05, then H0 is accepted. It means that the data value is homogeneous.

Thus, the data were analyzed using the Paired Samples t-Test to compares the means for two related units on a continuous outcome that is normally distributed. The result of the Paired Sample t-Test is shown in Table 10. The statistical test is used to test two hypotheses statements below:

H0: There is no difference in students' pre-test and post-test scores on gender.

H1: There is a difference in students' pre-test and post-test scores on gender.

The level of significant value used in the test is 0.05. If the result of the test shows the significant value, which is more than 0.05, it means that H0 is accepted, while when it is less than 0.05, H1 is accepted. The result of the test shows that the significant value is 0.786 or more than 0.05, which means that there is no difference in students' gender after the implementation of discovery learning supported by the Solar System Scope application.

The result of the acceptance of H0 is also supported by using N-gain. The data gained analyzed using a normalized gain test based on the rule of Hake (1998). The average n-gain score of students' conceptual mastery in pre-test and post-test showed in Table 11. Based on the data analysis in Table 11, it can be found that the average pre-test score is 50.38, and the post-test score is 73.85 for male students. Meanwhile, the average pre-test score is 48.33, and the post-test score is 73.33 for females students. There is an enhancement of students' concept mastery in learning solar system concepts for both male and female students since the average score on the post-test is higher than the pre-test.

Comparison of the average of pre-test and post-test scores for both male and female students, the score also has gain normalization with the value of N-gain 0.48. According to Hake's rules of normalization, the value of N-gain for male students is 0.48 and categorized as medium. It is the same as the N-gain score for female students, which is 0.48 and also classified as medium. The result of the N-gain score for both male and female students shows that there are no differences between male and females students in learning solar systems after the implementation of discovery learning supported by the Solar System Scope application. Gender issue has become the talk of today's forum. The result of this research is similar with other study conducted by Baharudin and Luster (1998) they stated that the gap between the average scale scores of males and females in mathematics

achievement was quite small and has fluctuated only slightly over the past ten years. Goni (2015) also stated that there was no significant differences exist between gender in students' academic performance. Those statements also supported by the result of research conducted by Güzel (2010), who says that there was no significant difference between male and female students of their success in a physics lecture. In other words, those statements mean there was no significant difference by gender in learning.

During learning activity, students are divided into some groups, and the member of the groups is consists of both male and female students. This could be a reason for the result that stated that there are no differences in students' gender differences in learning solar systems based on the data of N-gain. Using discovery learning could improve both male and female students in learning the solar system. Großmann and Wilde (2019), in the research, stated that the students who worked with guided discovery had higher conceptual and procedural knowledge than the students who are not. Saab, van Joolingen, & van Hout-Wolters (2006) also said that with collaborative discovery learning, the performance of a dyad existing of a high and a lowly motivated learner could be influenced positively by the highly motivated peer. Since in this research, both male and female students are work in the same group with the same treatment, they could have a positive impact on another student (different gender) such as the motivation so the other students can be influenced positively in the learning activity. The groups were made randomly by shuffle students' names to make fair for all groups.

4. CONCLUSION

Based on the discussions, results, and analysis of previous chapters, the researcher summed up several findings. Implementation of discovery learning supported by the Solar System Scope application could enhance students' concept mastery. It can be proved by the acceptance of H1, which means that there is a significant effect of learning solar system using discovery learning towards students' concept mastery. The improvement of students' concept mastery, also supported by the results of N-Gain, is 0.48, which means that it is categorized as medium. This research also concludes that there is no difference in students' gender after the implementation of discovery learning supported by the Solar System Scope application. From the analysis result of the research, there are some suggestions. First, the instruments for implementing the discovery learning should be prepared and made well. It includes worksheets during a learning activity. The application as the technical support also should be available in Bahasa, since not all of the students. The recommendation for further research is discovery learning supported by solar system scope application that can be implemented to investigate other variables such as critical thinking, creative thinking, or others.

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