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Applying Pre and Post Role-Plays supported by Stellarium Virtual Observatory to Improve Students' Understanding on Learning Solar System

Eka C Prima[1]*, Chika L Putri[1], Fransisca Sudargo[2]

[1]International Program on Science Education, Faculty of Mathematics and Science Education, Universitas Pendidikan Indonesia
[2]Department of Biology Education, Faculty of Mathematics and Science Education, Universitas Pendidikan Indonesia

*Corresponding Author. ekacahyaprima@upi.edu

ABSTRACT Solar system is an abstract phenomenon that needs to understand by junior high school students. The phenomenon cannot be observed directly in the classroom. In this research, the role-play model is first proposed to provide analogical phenomenon combined by Stellarium as an astrophysical virtual laboratory to give better visualization of Solar System Model. Role-play is a part of psychodrama used as a learning method to help students understand some aspects of science. However, the best strategy on this approach needs to be further investigated. The research attempts to improve students' understanding on learning solar system. The role-play model is applied before or after using Stellarium virtual observatory as pre and post role-play learning designs, respectively. This research employed quasi-experimental method. The method used in this research is experimental with pretest-posttest design. There are three types of instrument used in this research. There are objective test, rubric, and questionnaire. The quantitative data of this research was collected by objective test (pretest-posttest), while the qualitative data is used to describe students' performance and students' responds in role-play. The result shows that there are statistically significant between pre role-play and post role-play. The N-gain of students' understanding improvement on post role-play was 0.40 and pre role-play was 0.18. The result is confirmed by students' performance and responds implying that students need learning concept previously so that they can perform role-play effectively.

Keywords Role-play, Stellarium, Students' Understanding, Solar System

1. INTRODUCTION

Curriculum development in Indonesia causing some of changes of its learning objectives, its contents and its implementations. According on curriculum 2013, the student are required to be more active, and seeking for knowledge from various sources, not only teacher. Therefore, learning methods involve students more are needed. One of the learning method that can be used is role-play. Role-play is a part of psychodrama that could be used as a learning method to help students understand the more specific aspects of literature, social studies, and even some aspects of science or mathematics. According to Craciun (2010), stated that learning using role-play implies students to be more actively involved, more creative, more confident, more cooperative in-group work and more cooperative to solve problem. Role-play really contributes in developing the creativity, communication skills and leadership skills' aspects.

Role-play is a method that can be implemented to improve students' understanding. According to works conducted by Duveen & Solomon (1994), Aubusson, Fogwill, Barr, & Perkovic (1997), Craciun (2010), Eilks, Belova, & Feierabend (2015), role gave positive effect to students understanding, creativity, empathy, cooperative group work, communication skills, and leadership skills. Role-play is often used in social studies, historical, politics, and even science and mathematics as a teaching methodology. However, role-play have some disadvantages such as it spends more time to preparation rather than the classical methods, and not all of the topics in science is appropriate for role-play methods.. The topic in science that can be taught using role-play should be abstract phenomena, which occur in students' daily life and need analogical analysis. Solar system is chosen as a topic for this

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research because it is abstract phenomena happen in daily life and it is hard to observe directly that representative teaching of solar system is needed. By using role-play, a teacher encourages students to be intellectually and physically involved in the lesson content and his understanding on difficult concepts.

Role-play is often used in the end of learning processes. In line with the study conducted by Duveen & Solomon (1994), they stated that students need to have already been taught the concept first because without prior knowledge, the role-play is much less effective. Using this method, the teacher encouraged the student to be intellectually and physically involved in the lesson content and that facility his understanding of difficult concepts (Craciun, 2010). However, there is no study investigating the best strategy to put role-play as pre or post learning. In this research, students' understanding treated using role play conducted in the beginning learning process (pre role-play) compared to role play in the end of learning process (post role-play) will be investigated. The Stellarium software will be used as a virtual astrophysical laboratory providing better visualization of Solar System. The previous works reported the use of Stellarium as a teaching media such as Hughes (2008), Baleisis, Dokter, & Magee (2007).

One of the indicators to measure the differences between pre role-play and post role-play is the students' understanding. According to the research conducted by Gibbs & Simpson (2005), students' understanding is one of the important aspects to measure the students' improvement. Assessing students' understanding might be the most complex task for an educator or academic institution. Unfortunately, the professional development gives a low attention to develop the qualified assessments, and assessment training. The challenge of assessment is not only about figuring out what a learner knows but also where they need to go next. The students' performance in role-play should also be assessed because it is one of the indicator to measure the learning objective has been achieved or not achieved by students.

2. METHOD

This research used quasi-experimental method, According to Creswell (2014), quasi experiment includes the assignments, but not random assignment of participants to group because the experimenter cannot artificially create groups for the Creswell (2014). The researcher fully conducted the pre role-play and post role-play treatments. Class A conducted post role-play activities while Class B conducted pre role-play activities. The experiment design is shown in Table 1.

The location of this research was held in one international school in Bandung Barat in the school period of 2015/2016. The school used Cambridge curriculum 2013. The population in this research was 8th grade students. The participants are 50 students at 8th grade from two different classes in an International Junior High School, Bandung. The sampling technique was Simple Random Sampling. Fraenkel & Wallen (2003) stated that simple random sampling is one in which each and every member of the population has an equal and independent chance being selected.

Table 1 Experiment design

Class	Test	Stage I	Stage II	Test	Action
A	Pre-test	Virtual Lab	Role Play	Post-test	Post Role-Play
B	Pre-test	Role Play	Virtual Lab	Post-test	Pre Role-Play

In this research, the concept of solar system is limited based on Indonesian Curricula 2013 by core competence No. 3 and No. 4, basic competence No 3.13, 3.14, and 4.12 as attached in *Badan Standar Nasional Pendidikan (2013)*. The analysis of curriculum about core competence and basic competence indicates the subtopics that will be investigated by students such as (1) Characteristics of solar system component, (2) The movement of planets in the solar system, (3) Moon phase, (4) The effect of earth rotation and revolution, (5) Climate change in the earth surface.

The terms of solar system in this research refer to the Sun and all of celestial objects traveling around. There are planets, natural satellites such as our moon, asteroid belts, comets, and meteoroids. Our solar system is part of a spiral galaxy known as the Milky Way. The sun, the center of our solar system, holds eight planets and countless smaller objects in its orbit. Our solar system formed about 4.6 billion years ago. The four planets closest to the sun - Mercury, Venus, Earth, and Mars - called as the terrestrial planets because they have solid, rocky surfaces.

There are three types of instrument used in this research. There are objective test, rubric, and questionnaire. **First,** the objective test is conducted to describe cognitive ability of students in mastering the concept. Objective test consist of two sections that is pre-test, and post-test. Multiple-choice question consist of cognitive domain C2 which is about students' comprehension including summarize, convert, defend, paraphrase, interpret, give examples, classify, infer, compare, explain, paraphrase, and discuss (Anderson & Krathwohl, 2001). Cognitive paper test firstly consist of fifteen questions before passing judgment by experts. It is used to look students' comprehension. After judged by the expert the objective is only ten questions as a representative for each learning indicators. Then, test was distribute to students in grade 8 as a limited test. The next step after conducting limited test to X grade students is analyzing this objective test using ANATES to measure the validity, reliability, difficulty level, discriminating power and distractor. **Second,** Observation sheets has been created so that teaching staff can take the opportunity to observe and

reflect on the particular positive teaching and behavior management strategies employed. A range of different observation sheets is provided, so that teachers can choose the ones most appropriate to their observations focus. In this research the observation sheet is based on Craciun (2010) to evaluate the students' performance and to differentiate from sessions pre and post role-playing activities, there are 8 aspects that observed used a scale from 1(lowest) to 5 (highest). The aspects are active presence, cooperative group work, creative performance, scientific knowledge, students' confidence, students' communication skills, students' responsibility, and students' leadership skills. **Third,** Questionnaire is an instrument, which is distribute to the students the purpose, is for investigate and describe students' perspective of role-play as a learning method. Students are asked to assess their learning in terms of course content, teaching or research skills and technology use. They reflect on the course learning objectives as well as the advantages or limitations of the teaching method.

The results shows quantitative and qualitative data. The pre-test and the post-test are conducted to determine the students' understanding before and after treatments. Qualitative analysis will describe the students' performance and impression during learning solar system using role-play.

3. RESULT AND DISCUSSION

The results shows quantitative and qualitative data. The pre-test and the post-test are conducted to determine the students' understanding before and after treatments. Qualitative analysis will describe the students' performance and impression during learning solar system using role-play.

3.1 Students' Understanding

Pretest was conducted in the beginning of the learning to investigate the students' understanding before this lesson. Pretest with the same question was given to both Class A and Class B. Class A performed post role-play while Class B performed pre-role play. Statistic result shows that the data of Normality test with significance 0.166 and 0.251 for post and pre role-plays, respectively, is normal with criteria Sign. ≥ 0.05 as normal and Homogeneity test with significance 0.684 as homogeny. The Class A showed the highest score 80.00 and the lowest score 30.00 with the average score 58.80 and standard deviation 13.329. Class B showed the highest score 80.00 and the lowest score 20.00 with the average 50.80 and the standard deviation 14.978.

The analysis of pre-test resulted that there is no statistically significant between pre-test in Class A and Class B. This result indicates that prior knowledge of students' understanding is rather similar. The average of students' understanding pre-test in Class A is 58.80 and

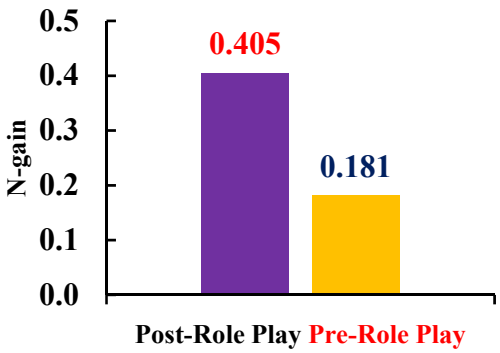

Figure 1 Average N-gains of post and pre role plays

Class B 2 is 50.80. These results are categorized as medium because solar system concept have been taught in the primary school, but not as deep as discussed in junior high school. Some students also might forget this concept. The result of pre-test is use as the reference for a teacher to investigate students' prior knowledge in learning solar system using role-play. By giving the pre-test about solar system concept, students do not have enough knowledge about this subject to accomplish the standard as required by Indonesian Curriculum 2013 to meet minimum score 70.

Post-test given in the end of the learning process is to know students' understanding after conducting this lesson. Post-test are also given to both Class A performing post role-play and Class B conducting pre role-play. Statistic result shows that the data of Normality test with significance 0.121 and 0.160 for post and pre role-plays, respectively, is normal with criteria Sign. ≥ 0.05 as normal and Homogeneity test with significance 0.711 as homogeny. The Class A showed the highest score 100.00 and the lowest score 50.00 with the average score 72.50 and standard deviation 13.266. Class B showed the highest score 90.00 and the lowest score 40.00 with the average 61.60 and the standard deviation 13.127.

The analysis of post-test resulted that there is no statistically significant between pre-test in Class A and Class B. According to the students' average score, post role-play supported to better students' understanding improvement than pre role-play. Moreover, average students have successfully accomplished the standard as required by Indonesian Curriculum 2013 to meet minimum score 70. These results indicate that role-play can improve students' understanding supporting previous research conducted by Aubusson (1997). It showed that role-play was able to make students more understand deeper concept and happy with this method.

The work implied that students in Class A have already taught the Solar System concept visualized by Stellarium, so they can perform the role-play more effective. Consequently, the result of average post-test score is better than Class B. According to our direct observation in class B, some students do not know the concept previously, so

Table 2 Result analysis of n-gain

Component	Post role-play	Pre role-play
Number of students	25	25
Highest score	1	0.67
Lowest score	-0.25	-0.67
Average	0.404	0.180
Standard Deviation	0.276	0.318
Normality Test	**Sig. ≥ 0.05 = Normal**	
Sig.	0.166	0.160
Conclusion	Normal	Normal
Homogeneity Test	**Sig. ≥ 0.05 = Homogeny**	
Sig.	0.384	
Conclusion	Homogeny	
Hypothesis Test	**Sig. (2 – tailed) ≥ 0,05 = H_0 Accepted**	
Sig. (2-tailed)	0.011	
Conclusion	H_0 rejected	

they feel confuse to perform role-play. In contrast, the students in Class A are more enthusiast to perform role-play. Some students also focused on learning solar system concept. The pre role-play treatment make students more active and noisy, so the learning material might not be understood effectively.

Another analysis is performed to investigate students' understanding improvement using role-play. Analysis of N-gain as seen in Figure 1 is conducted to investigate the statistically significant different of students' understanding improvement between pre and post role-plays. The average N-gain result is tabulated in Table 2. Class A performing post role-play resulted the average N-gain 0.404 while Class B performing pre role-play showed the average N-gain 0.181. Statistic result shows that the data of Normality test with significance 0.166 and 0.160 for post and pre role-plays, respectively, is normal with criteria Sign. ≥ 0.05 as normal and Homogeneity test with significance 0.384 as homogeny. The hypothesis test showed the value of 0.011. It indicates that the value 0.011 < 0.05 with criteria of Sig. (2 – tailed) ≥ 0.05 = accepted H_0. Therefore, H_0 is rejected. The result indicated that there are statistical differences of average N-gain Class A from Class B. This result also confirms Duveen's (1994) and Aubusson's (1997) works

Table 4 Average of students' performance in Class A and B

No	Aspect	Post Role-Play	Pre Role-Play
1	Active Presence	4.64	3.88
2	Cooperative group work	4.96	3.92
3	Creative performance	4.52	3.56
4	Scientific knowledge	4.60	3.64
5	Students confidence	4.52	3.88
6	Students communications skil	4.56	3.64
7	Students responsibility	4.92	3.80
8	Students leadership skills	4.84	3.96
	Average	**4.69**	**3.78**

stating that students have already been taught the concept before doing the role play, without prior knowledge role play is much less effective.

Objective test of students' understanding is given to the students. The test includes several sub-indicators. Table 3 shows the percentage of correct answers by students for each indicator in pre-test and post-test performing post and pre role play. Based on N-gain, post role-play shows better improvement on several indicators than pre role-play such as (1) describing movement of the moon towards the sun, (2) explaining the component of the solar system, (3) describing various impacts of earth rotation and revolution, and (4) describing the earth movement towards the sun. On the other hand, the pre role-play has successfully improved other indicators about (1) describing the earth revolution, (2) explaining the earth rotation phenomena, (3) mentioning the impact of earth rotation and revolution. According to the curricula 2013 minimum standard, both pre and post role plays have achieved 5 indicators accomplished by students during learning Solar system. The indicator about describing various impacts of earth rotation and revolution cannot be achieved by average students. Students' analysis might be needed to improve this understanding so that students can fulfill this indicator. The role-play is also suggested to describe how student can act as a model to visualize the impact of earth revolution and rotation with another appropriate supporting media. The visualization of Stellarium describing this impact might be needed to give better understanding about the effect of

Table 3 Average of students' understanding for each indicator

Indicator of Students' Understanding	Post Role Play			Pre Role Play		
	Pre-test (%)	Post-test (%)	N-gain	Pre-test (%)	Post-test (%)	N-gain
Describe movement of the moon towards the sun	64	**84**	**0.56**	68	**72**	0.13
Describe the earth revolution	92	**96**	0.50	64	**92**	**0.78**
Explain the component of the solar system	52	**80**	**0.58**	60	**80**	0.50
Describe various impacts of earth rotation and revolution	40	58	**0.30**	36	41	0.08
Describe the earth movement towards the sun	48	**80**	**0.62**	64	**76**	0.33
Explain the earth rotation phenomena	88	**92**	0.33	64	**92**	**0.78**
Mention the impact of earth rotation and revolution	88	**96**	0.67	80	**96**	**0.80**

Table 5 Recapitulation of students' responds regarding the role-play

No	Question	Post Role-Play					Pre Role-Play				
		SA (%)	A (%)	NS (%)	D (%)	SD (%)	SA (%)	A (%)	NS (%)	D (%)	SD (%)
1	Did you like creative role-playing activities?	20	47	13	20	0	20	27	20	23	7
2	Do you prefer science learning and teaching with or without role-playing?	20	20	74	6	6	14	14	60	26	0
3	Do you like science learning and teaching more after these activities?	6	60	34	0	0	0	20	53	27	0
4	Did you adopt some of the role-playing techniques in your future teaching activities?	7	33	53	7	0	0	20	34	26	20
5	Do you spend more time to design a role-playing scenario?	13	47	27	13	0	14	7	46	26	7
6	Do you consider that these activities are easier or harder to control?	13	34	47	6	0	0	26	40	26	7
7	Do you consider that these activities are generally valuable or must be adapted to the audience?	27	27	33	13	0	14	26	33	20	7
	Average	**15**	**38**	**40**	**9**	**1**	**9**	**20**	**40**	**25**	**10**

Notice: SA = Strongly agree, A = Agree, NS = Not sure, D = Disagree, SD = Strongly disagree

earth rotation and revolution. Therefore, students are able to make a creative media supporting role-play.

3.2 Students' Performance

Rubric in this experiment is used to investigate students' performance during preparation and role-play performance. This rubric contains students' performance based on criteria previously defined. The score range around 1-5. Score 1 is categorized as very bad performance contrasted to 5 as excellent performance. The student's performance in Class A and B is described in Table 4.

Based on Table 4, the students' performance average in post role-play 4.69 is better than pre role-play 3.78. It can be concluded that the students' performance on post role-play mainly contributes to higher students' understanding improvement in post role-play as previously described. The previous Solar System concept presented using Stellarium virtual observatory supports students' interest to be involved in post role-play. Consequently, their cooperation of group work shows the highest achievement of students' performance aspect.

3.3 Students' Responds on Pre and Post Role-Plays

Students are asked to assess their learning in terms of course content, teaching or research skills and technology use. They reflect to the course learning objectives as well as the advantages or limitations of the teaching method (Craciun, 2010). Anonymous questionnaire is given to the end at the learning process. It is used to know students' response toward learning using role-play.

Students responds is important to evaluate this learning method applied and to investigate students' impression during this learning process. The result can reflect the teacher awareness about students' emotion. The result of students' responds is shown in Table 5.

Based on Table 4 and Figure 2, the students' performance average in Class A (Post role-play) of 4.69 is higher than Class B of 3.78. The average performance of post role-play can be categorized as good, while average performance in pre role-play is categorized as enough. In all aspects of students' performance, students performing post role-play show higher score than students performing pre role-play. The highest aspect of Class A is cooperative group work and its lowest aspect is creative performance and students' confidence. Moreover, the highest aspects of Class B is students' leadership skill and its lowest aspects is creative performance. For both class A and class B, creative performance results the lowest aspects.

In this anonymous questionnaire, all of the questions are positive statement or questions indicating that students like role-play as a teaching method for science education. Role-play is also helpful method in learning science. Based on Table 5, students in Class A are 15% strongly agree, 38% agree, 40% not sure, 9% disagree, and 1% strongly disagree that role-play is an effective method to learn solar system concept. While students in Class B are 29% strongly agree, 20% agree, 40% not sure, 25 disagree and 10% strongly disagree that role-play is an effective method to learn solar system concept.

Based on the Table 5, almost all aspects of questionnaire are positively responded by the students in Class A and B. However, some aspects are not positively responded by the students. For example, 60% students in the Class B are not sure performing role-play during learning science. More than half students from both Class A and B prepare the role-play, so the preparation of role-play activity does not show maximum performance. Students do not fully welcome to perform role-play activity. It might happen due to time limitation for preparation and performance.

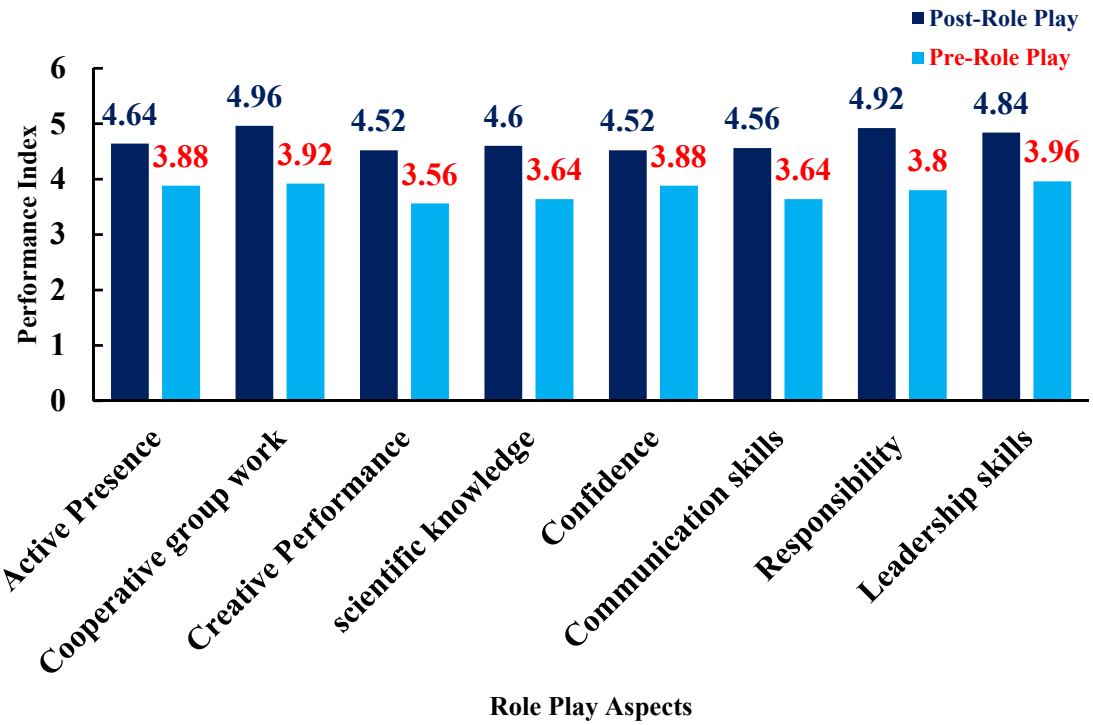

Figure 2 Comparison between students performing post and pre role-plays

Students answer the questionnaire to express their own opinion about role-play. The result shows that almost all students give positive impression about their learning science using role-play. Almost all students feel that role-play is a funny activity. Students can also explore their talent and knowledge through role-play. Some students think that role-play can be used to refresh their mind in school because students feel easy to learn solar system concept by implementing role-play. Moreover, some students does not prefer to learn science using role-play because role-play takes more time to prepare the materials. Other students are not confidence to perform role-play in front of the class. They also feels stressful to conduct role-play.

Students' performance is an important aspect in role-play. Students' understanding can also be improved using role-play as well as the improvement of students affective and psychomotor. Based on Craciun (2010), by implementing this method, we are able to develop our skills and our abilities such as responsibility and leadership in learning, peer learning/teaching, group work, or creative problem solving. These achievements would be difficult to developed using other teaching techniques without role-play. However, students stated that not all topics in science are suitable to implement role-play. The abstract topics such as planet positions in solar system or current flow in electricity are suggested to perform role-play. Most of students like learning science more after conducting role-play because they previously known that learning science using lecturing method is boring, difficult and creepy. By conducting role-play, students feel fun and joyful.

Most of students performing post role-play are agreed and not sure that they will adopt some role-play activities in the future, role-play spend more time than other method, so some students think that it is hard to prepare role-play. Students spend 1-3 days in average to prepare role-play. Many students complain this preparation.

Most of students stated that this role-play is valuable. Therefore, the audience must adapt this activity. Aubusson (1997) stated that role-play give positive impact to students' behavior because students can more fun and enjoy in classroom. Role-play also make student understand deeper concept.

4. CONCLUSION

Role-play is a useful method to learn certain topic in science based on teacher and students perspective. Role-play can improve students' understanding as proven by the result of post-test for both Class A and B, which are higher than the pre-test. Students need to learn the concept before performing role-play. The visualization of Stellarium is needed to support better understanding on Solar System. By showing this media, students are able to make a creative media supporting role-play. Moreover, without this prior knowledge, role-play is ineffective. Some students who do not know the concept previously, they feel confused to perform role-play. The pre role-play treatment make students more active and noisy, so the learning material might not be understood effectively. In contrast, the

students in Class A performing post role-play are more enthusiast to implement role-play. In this case, some students also focused on learning solar system concept. The average performance of post role-play can be categorized as good, while average performance in pre role-play is categorized as enough. Finally, most of students like learning science more after conducting role-play because they previously known that learning science using lecturing method is boring, difficult and creepy. By conducting role-play, students feel fun and joyful.

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