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Grid Analysis Display System (GrADS) and Multi Modus Visualization in Earth Science Learning Mastery and Spiritual Aspect to Enhance Concept

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ABSTRACT

The aim of this study was to enhance the student's concept mastery and embedded spiritual attitude in the learning of earth science with the help of visualizations and authentic data analysis using GrADS. 23 pre-service physics teachers in Bengkulu, Indonesia participated in this study. This study used mixed methods with embedded experiment design. Multiple choice questions were used to collect the concept mastery data; questionnaires and open ended questions were used to collect data about spirituality attitude. The students' testimonials about the learning program were explored by using open ended questions. The multiple choice questions were analyzed quantitatively while the observation, questionnaire, and open ended questions were analyzed qualitatively. The results show that the students' concept mastery improve from no mastery to mastery with the average N-gain being 0.8 (high). The students got implicit values that had an impact on their spirituality of awareness and belief in the divinity of God. Similar research about embedding the spiritual aspect in the learning of earth science has not been reported widely

Keywords: concept mastery, spiritual aspect, earth science, visualization, GrADS

INTRODUCTION

Almost all of earth and space science (ESS) concept is imaginary. Most of them cannot be observed directly, (Sunderlin 2009). There is a very high potential to make students feel it is difficult to understand the concept correctly. Character concept that is related to directly unobservable phenomena cause an alternative concept or naïve concept among students (Miller & Brewer, 2010; Jolley, Lane, Kennedy, Seneclauze, & Frappe, 2012). That appears different to alternative conceptions besides scientific conceptions (Joley, 2012; Miller, 2010). Media visuals can be a solution to help visualize the abstract concept. Various

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media visuals can be used to explain the earth concept. An animation is a potential media to visualize the concept of the earth's atmosphere that otherwise could not be observed directly. Animation is a sample of using technology in a learning activity (Bezen, Aykutlu, and Bayrak, 2016). Phenomenon that happen in nature can be understood, observed, and interpreted through the help of technology. A learning activity using technological resources help students to get a complete understanding (Santos, 2016).

Although media visualization had been used widely in learning, there is still a need to encourage its use, especially in Bengkulu, Indonesia, and especially in ESS. Smith and Bermea (2012) investigated the alternative conceptions about plate tectonics using visualization from students' sketches in a learning activity. Sibley (2009) used scientific model as visualization to analogize a concept to help the student's to understand the concept well. In addition, collaboration science research and learning research is just a recent trend in education study. The result of science research is used to facilitate the student's thinking process. Visualization in earth science learning can support the student to improve their concept mastery. According to Bloom, concept mastery is the ability to understand the material of learning comprehensively, be able to provide interpretation, and be able to apply it (Anderson, 2001).

Based on a study case whose purpose was to investigate the student's conception about the phases of the moon in the University of Bengkulu, it was known that most of the respondents had naïve concept. 45 pre-service physics teacher students in Bengkulu, Indonesia participated in the study case. 1 respondent had alternative conceptions, and 2 students had incomplete conceptions. None of them showed any scientific conception. The criteria of conception followed the criteria of Park (2013). Student alternative concept can be seen at Figure 1.

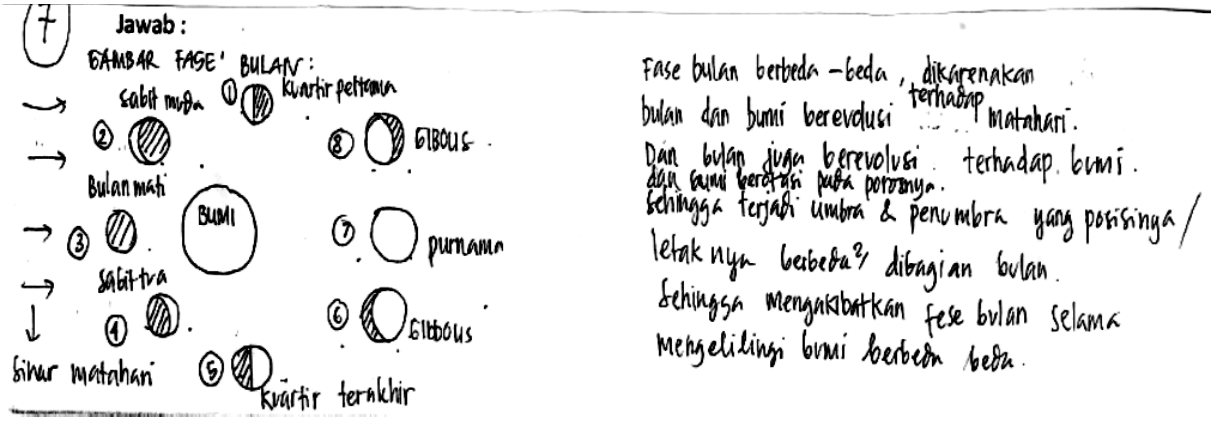


Figure 1. Students' alternative concept of the phases of the moon

Figure 1 shows that the student could not explain that the total amount of sun rays that reaches the moon's surface is constant. The student assumes that the total amount of sun rays that reaches the moon's surface is different in each phase of the moon. The student understands that the phases of the moon are caused by the umbra and penumbra, similar to the eclipse of the moon. This result indicated that the student's mastery of especially earth and space concept still needs to be improved. Johan (2014) reported that the improvement of concept mastery after implementation was only with an N-gain of 0.49 in category moderate. That study used the learning model search, solve, create and share (SSCS) problem solving in the University of Bengkulu. Werts and Hinnov (2011) present visualization in the form of a three dimension graph from authentic data that was analyzed by Matlab. Ellwein (2014), and was concerned with developing a module based data to facilitate the learning of students who

have never worked with authentic scientific data. This study provides an ESS learning program using multi modus visualization such animation, picture, and graph to enhance concept mastery. The GrADS software is easier to operate for the simple analysis of geoscience data. The research science was harnessed to enable the student to understand the concept, and provided a different learning process. These results indicate that the concept mastery of college students in Bengkulu still must be focused especially on earth and space concept. Media visuals can visualize every step of the process in nature phenomena related to the ESS concept. An authentic data analysis using GrADS is expected to help to strengthen and help the student's proper understanding of the concept.

Unayah and Sabarisman (2015) publicized that about 60% of adolescents were involved in crime. The Central Bureau of Statistics of Indonesia (2010) documented that more than 60% of adolescents participated in theft and more than 9.5% of them were involved in drugs. Reza (2013) stated that the increase in cases was caused by the decline in the moral values of teenagers in Indonesia. The religious aspect of learning ESS can influence the morality of a teenager. The spiritual aspect has an important value as it can block the degradation of morality. The spiritual aspect increased also our awareness of God Almighty (Muthohar, 2013). In addition, the decline of moral values among teenagers in Indonesia is very worrying. The axiology side of learning ESS are to understand the phenomena of nature well, to appreciate nature and to behave responsibly in nature, to be able to perform actions in disaster mitigation appropriately, to exploit nature wisely, and to increase the awareness of the existence and greatness of God Almighty. A common description of the Indonesian National Qualification Framework (INQF) stated that the implementation of the national education system and work training systems, which were done in Indonesia at every level qualification, included the processes that cultivate affection, one of which is the fear of God Almighty. The INQF general description can be the basis for developing learning programs in higher education. In the ministerial regulations appendix No. 49 of 2014, it was also stated that every graduate from an academic, a vocational, and a professional education program must have good moral attitudes, including the fear of God Almighty and be able to demonstrate a religious attitude. Integrating a spiritual value in the learning of science is expected to contribute to blocking moral degradation and is expected to be the solution for the demands of the INQF in relation to the religious aspect.

Concept mastery is an important aspect of learning. Earth and space science (ESS) concept is related to phenomena that are unobservable directly so it needs media visuals to help visualize it. Media visuals can help students to understand the concept more comprehensively. Earth and space science (ESS) is related to nature phenomena. In order to understand fully the ESS concept there is the need for research based material (RBM) related to geoscience research that can help display the real condition of nature, especially in Indonesia. Authentic data of geoscience can be analyzed using the Grid Analysis and Display System (GrADS) to display the real condition of Indonesia. The result of the GrADS can be harnessed as a RBM in learning earth science. This study provided a learning of the earth that focused on improving the student's concept mastery with the help of media visuals and with the help of authentic data analyzed using GrADS. Based on the research background, this study provided earth science learning using media visuals to enhance concept mastery and to embed a spiritual attitude. Research questions included how to enhance the student's concept mastery with the help of media visuals and with the help of authentic data analyzed using GrADS and how to embed a spiritual attitude through the learning of earth science. Authentic data analized using GrADS was used to strengthen the students' concept mastery. The embedding of the spiritual aspect was done by exploring the value of the earth's atmosphere concepts. The embedding of the spiritual aspect of learning natural science, especially ESS, had not been reported widely. The novelty of this study is the harnessing of multi modus

visualization, compilation research science from analysing authentic atmosphere data using GrADS in learning, and integrating the spiritual value of ESS.

The aim of this study is to enhance concept mastery and to embed a spiritual attitude in the learning of earth science with the help of media visualization and the analysis of authentic data using the GrADS.

METHODS

Research Design

This study used the mixed methods research design with embedded experiment design. A mixed methods research is a method of collecting data and analyzing data by combining the qualitative and quantitative approach used together in one study. One type of mixed methods research is embedded experiment design. Embedded experiment design can use pre experiment, true experiment, or quasi experiment design at its intervention step (Creswell and Clark, 2007). The mixed methods research design with embedded experiment design was selected in this study because before the intervention step we needed to develop a learning process in order to enhance the student's concept mastery and to embed a spiritual attitude. In the intervention step (pre experimental design was used), it needed the quantitative data to measure the enhancement of the student's concept mastery and the shifting of the student's spiritual attitude and at the same time we needed the qualitative data to get a description of how the learning process could enhance the student's concept mastery and effect of the student's spiritual attitude. This article focuses on the result of the intervention step related to the enhancement of the student's concept mastery and the shifting of the student's spiritual attitude.

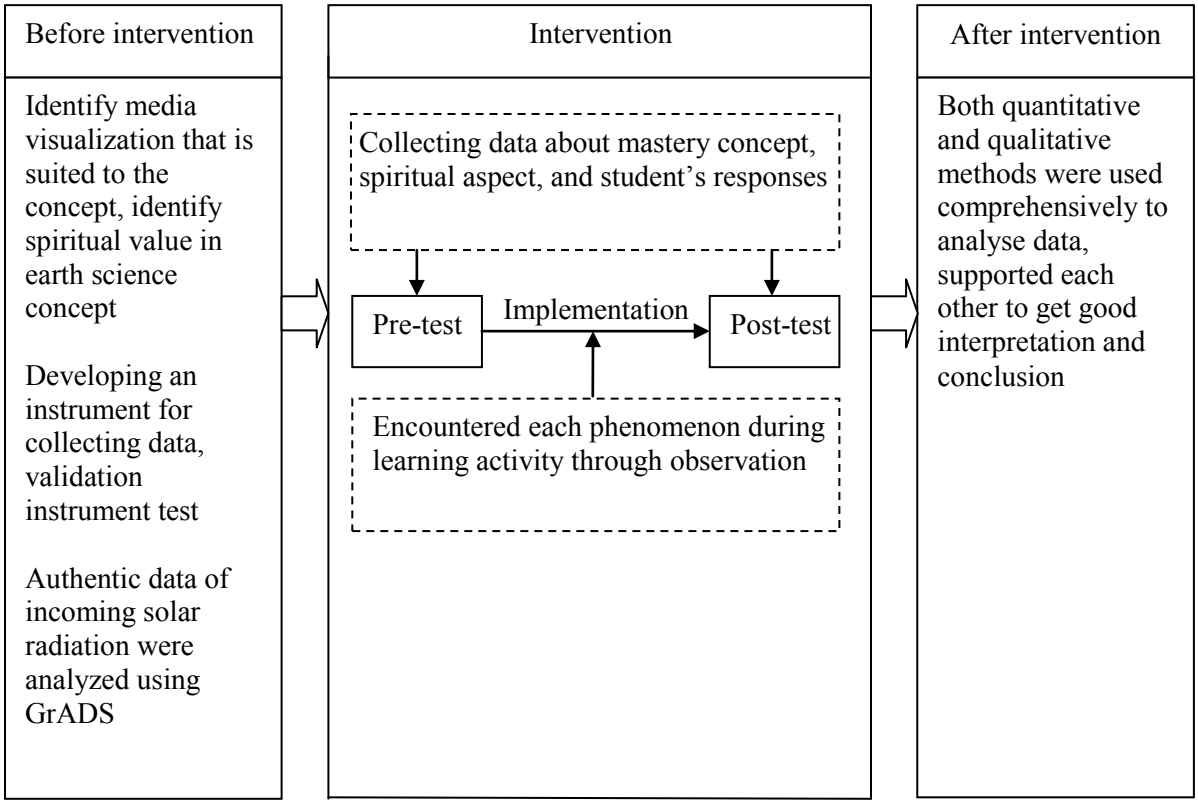


Figure 2. Embedded Experiment Design (Creswell and Clark, 2007)

The embedded experiment design in this study included three steps: before intervention, intervention, and after intervention. The before intervention step included developing media visualization, analyzing authentic data, developing an instrument, and designing learning activities. Interactive Conceptual with Chain Till Unanswered Questions (IC-CTUQ) was designed in this step. Interactive conceptual learning included four parts. They were concept focus, using text, interactive classroom, and RBM. The RBM came from science research which analyzed authentic data using GrADS. Concepts were explored to embed a spiritual aspect. Spiritual attitude in this study was belief in the nature of divinity. The nature of divinity in this study were God is the infinite creator, God is the infinite gracious, God is the infinite assign, God is the almighty, God is the infinite nurture, and God is the infinite wills. In this article, the before intervention step, including developing media visualization, analysis authentic data, developing instrument, and designing learning activities is not the focus of the discussion.

In the intervention step, earth learning using interactive conceptual with chain till unanswered question using visualization was implemented on 23 pre-service physics teacher students in Bengkulu, Indonesia. This step was used in the one group pre-test and post-test design Both quantitative and qualitative data were collected in this step. The implementation learning program used the one group pre-test post-test design. In the learning activities of the IC-CTUQ model, multi modus visualizations were used in the concept focus steps. The students were engaged to construct the concept interactively with the help of visualization. The visualization used in this study included figure, animation, and graph. The visualization came also from the analysis of authentic data. Media visuals were used to visualize unobservable concepts to facilitate the students' understanding easily. Questions and feedback were done along the learning activity. Media visualization, questions, and feedback were used to present spiritual values for embedding the spiritual aspect. The students were given questions to explore the value in natural phenomena. The use of text step helped the students to find key words about the concept which was presented by media visualization. In the RBM step, the students were engaged to interpret visualization about the real condition of Indonesia. The students were engaged to find the correlation among concepts using real visualization from GrADS about the real condition of the earth especially in Indonesia. The last step was the analysis and the conclusion. In this step, both the quantitative and qualitative methods were used to analyze data comprehensively; the quantitative and qualitative methods supported each other to get a good interpretation and to reach a conclusion.

Subject in This Study

To conduct this study, a group included people who knew each other. 23 pre-service physics teacher students who are taking the ESS course during a semester of the 2015–2016 academic year were involved in this study. Convenience sampling was used in this study. The characteristics of the subjects in this study can be seen in Table 1.

Table 1. *Characteristic study's subject*

Gender	Quantity	Range of age
Male	9 person	18–19 years old
Female	14 person	

Instrument for Collecting The Data

Three instruments were developed to collect data quantitative and data qualitative. The quantitative data were collected by conducting a multiple choice test (for the data of the

enhancement of concept mastery) and questionnaire (for the data of embedding spiritual attitude) while the qualitative data were collected by open ended questions (for the data of embedding spiritual attitude), student's testimonials (to collect the students' responses to the learning process). Both the student's testimonials and open ended question were used to support the quantitative data (concept mastery and spiritual attitude). A sample of a question in the multiple choice questions can be seen in Figure 3.

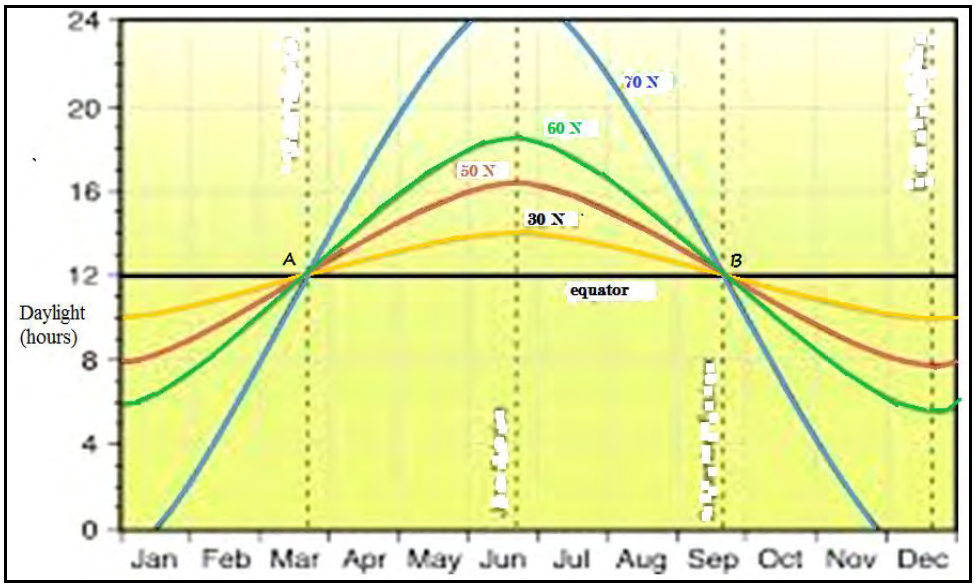


Figure 3. Graph of length of daylight

Look carefully at the graph. Based on the graph above, how is the difference in the solar position in March, June, and December?

a. Perpendicular at 23,5o Northern Hemisphere, perpendicular at 23,5o Southern Hemisphere, and perpendicular at equator.
b. Perpendicular at 23,5o Southern Hemisphere, perpendicular at equator, and Perpendicular at 23,5o Northern Hemisphere.
c. Perpendicular at 23,5o Northern Hemisphere, perpendicular at equator, and perpendicular at 23,5o Southern Hemisphere.
d. Perpendicular at equator, perpendicular at 23,5o Southern Hemisphere, and Perpendicular at 23,5o Northern Hemisphere.
e. Perpendicular at equator, perpendicular at 23,5o Northern Hemisphere, and perpendicular at 23,5o Southern Hemisphere.

To answer the question, the student must pay full attention to the graph and must be understand to correlated concept length of daylight in graph and concept incoming solar radiation of the annual solar motion.

The students' spiritual attitude was obtained by the questionnaire. The data from the questionnaire was supported by the qualitative data from the open ended questions. The questionnaire used in this study can be seen in Table 2. The questionnaire was given at the pre-test and post-test stage. The open ended question was given in post-test stage only. The open ended question includes 6 questions. A sample of the open ended question can be seen below:

"After learning activities, how can you explain that the concepts of earth science and learning process make you believe more that God is the infinite assign?"

Table 2. *Questionnaire for spiritual aspect*

No	Spirituality Aspect	Response No → yes									
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	I realize that God is the infinite creator										
2	I realize that God is the infinite gracious										
3	I realize that God is the infinite assign										
4	I realize that God is the almighty										
5	I realize that God is the infinite nurture										
6	I realize that God is the infinite wills										
	Total response (%)										

Students' testimonial about learning program was explored by using open ended questions. For example, the open ended question was to collect the students' testimonials about how visualization in the learning process could help them understand a concept clearly and easily. Both the data for concept mastery and the spiritual attitude were supported by the qualitative data of the testimonial and the observation sheet during the learning activity. These instruments were validated by three experts. Logical validity for these instruments included the verification of three aspects: formulation of indicators, key answer, and editorial. The experts confirmed that the instruments were valid and worthy to use in this study. A set of multiple choices used to collect data of concept mastery was tested to obtain the reliability value. 34 pre-service physic teachers were involved. The validity value obtained was in range 0.45 (category moderate) - 0.74 (category high). The test retest method was conducted to get the score of reliability. The distance between the first test and the second test was two weeks. The reliability score of 0.83 obtained in the category was very high.

Learning Activities

The Learning Model Interactive Conceptual with Chain till Unanswered Questions (IC-CUQ) using visualization was developed to enhance conceptual understanding and to embed a spiritual attitude. This learning model included five parts: concept focus, using text, RBM, class room interaction, and chain till unanswered questions. The chain till unanswered questions at the end of the learning process was focused on embedding spiritual attitude. Before the intervention step, this learning model was tested on 15 pre-service physics teacher students in Bengkulu, Indonesia. The result indicated that this learning model, the IC-CUQ, using visualizations could enhance the students' understanding of concept and embed a spiritual aspect. In the intervention step, this learning model IC-CUQ using visualizations was implemented to know whether there has been a shift in the students' mastery and their spiritual attitude. The design of the learning activities in this study followed the learning model in Table 3.

Table 3. *Learning model Interactive Conceptual with Chain till Unanswered Questions (IC-CUQ) using visualization*

<table>
<tr><td>Concept focus
Visualizations are used to represent the concept, to help the student understand a concept. Concepts are explored to embed an attitude of belief in the disposition of God. In this section, visualization such as animations was used to help embed a spiritual attitude, spiritual value inserted in nature phenomena.
For example, students were given an animation about the annual movement of the sun and a graph of the sun’s position during a year. Questions and feedback were used to engage the student to construct their concept actively.
An example is for embedding the spiritual aspect, a spiritual value was inserted in the earth rotation concept. The revolution of the earth causes a change of seasons. It balances the condition of the earth so human life and every life on earth can feel comfortable. It becomes very unbalanced if there is just one season (just winter or just summer). It shows that God is infinite creator and infinite gracious</td><td rowspan="3">Classroom interaction
Discussions are done during the learning activity.</td></tr>
<tr><td>Use of text
Literature books and hand outs are used to find the key word about the concept that was visualized. Handout were designed also to embed the spiritual aspect. The spiritual values about the dispositions of God in nature phenomena are inserted in the hand out. The hand out also has pictures as a visualization of concept. The students discuss the key word of the concept using the text (handbook and hand out)</td></tr>
<tr><td>Research based material :
Science research, which analyses authentic data using GrADS (Grid Analysis and Display System) are harnessed to help students understand the concept easier and also clearly. The students were encouraged to interpret the visualization from the GrADS analysis, correlated it to the earth concept that they learned.</td></tr>
<tr><td colspan="2">Chain till Unanswered Questions
A series of questions related to a natural phenomenon was given until the question could not be answered scientifically and returned to the statement of God is almighty</td></tr>
</table>

Analysis data

The multiple choice questions and the questionnaire were analyzed quantitatively while the open ended questions, student’s testimonial, and observation sheet were analyzed qualitatively. The students’ testimonial related to the spiritual aspect and the students’ responses for the learning activities were coded to find the pattern of the responses. Both quantitative and qualitative approach were used comprehensively to analyze the data supported each other to get a good interpretation and to reach conclusion. For calculating the enhancement of concept mastery, normalized gain was used. The enhancement of concepts mastery was analyzed by the difference between pre-test and post-test score and then was calculated. The enhancement of the level of mastery for each concept in the earth’s atmosphere was analyzed also. The formula to calculate the normalized gain score <g> of enhancement of concepts mastery can be seen below.

$$< g >= \frac{< S_{post} > - < S_{pre} >}{S_{\max} - < S_{pre} >}$$

S_{post} is post-test score, S_{pre} is pre-test score, $S_{\max}$ is maximum score, and <g> is normalized gain average score (Meltzer, 2002).

FINDINGS

Concept Mastery

The data for the concept mastery were collected at the pre-test and post-test stage. After the learning process, the concept mastery shifted as shown in Table 4.

Table 4. *Mastery shifted in each concept*

Concept	Pre-test	Post-test	<g>	Category
earth revolution	39%	100%	1	high
solar eclipse	35%	100%	0.94	high
moon phase	52%	96%	0.83	high
annual solar movement	35%	98%	0.89	high
moon eclipse	4%	35%	0.32	moderate
incoming solar radiation	48%	96%	0.85	high
Average			0.8	high

Concept mastery in this study followed the taxonomy bloom revision (Anderson, 2001). Table 4 indicates the concept mastery shifted from no competence to mastery with the category of improvement being high. The improvement in the student's concept mastery was calculated from the pre-test and post-test score. The N-gain distribution for the concepts mastery can be seen in Table 5 below.

Table 5. *<g> distribution for concepts mastery*

N-Gain	Category	Total
$g > 0{,}7$	High	87%
$0{,}3 \leq g \leq 0{,}7$	Moderate	13%
$g < 0{,}3$	Low	none

Category <g> in Table 5 shows that most of the student's concepts mastery improvement was mostly in the category high. The distribution of the N-gain/<g> in each category indicates that the learning activity had a good impact on the improvement in the student's concepts mastery. No one stayed at category low. The average of the student's <g> score is 0.8 (category high) <g> in this study can be seen in Figure 4.

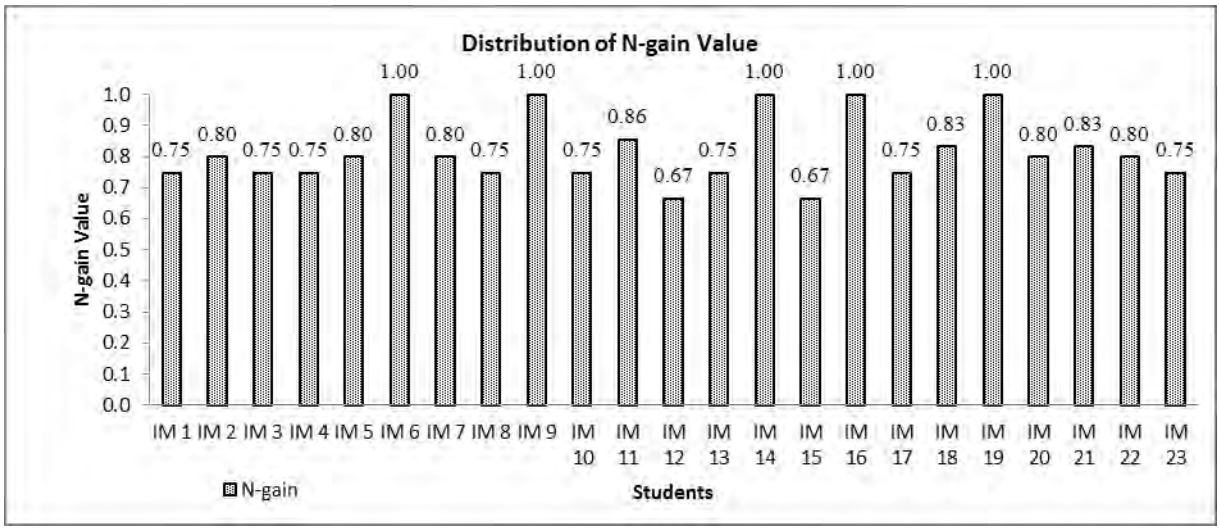


Figure 4. N-gain of each student

Spiritual aspect

The data for spiritual attitudes were obtained by questionnaire and open ended questions. The students' spiritual attitude in this study can be seen in Table 6.

Table 6. *The shifting of students' spiritual*

No	Spirituality Aspect	Before implementation					After implementation				
		No →				Yes	No →				Yes
		1	**….**	**8**	**9**	**10**	**1**	**….**	**8**	**9**	**10**
1	I realize that God is the infinite creator	0	0	0	0	23	0	0	0	0	23
2	I realize that God is the infinite gracious	0	0	1	1	21	0	0	0	0	23
3	I realize that God is the infinite assign	0	0	1	2	20	0	0	0	1	22
4	I realize that God is the almighty	0	0	1	1	21	0	0	0	0	23
5	I realize that God is the infinite nurture	0	0	2	1	20	0	0	0	2	21
6	I realize that God is the infinite wills	0	0	1	1	21	0	0	0	0	23
	Total (%)	0	0	4.4	4.4	87.5	0	0	0	2.1	97.8

Table 7. *Result of analysis spiritual aspect from open ended question*

No	**Student's evidence related to process of embedding spiritual**
1	Spiritual values were revealed when earth and science concepts were presented along the learning activity.
2	The harmony, complexity, and precision everything in nature that was presented during the learning process improved the students' total awareness of a mighty God.
3	Unanswered questions in chain questions made students aware about human finitude.
4	Media visuals especially animation could present detail of unobservable phenomena.

Based on Table 6 above, the students' spiritual attitude shifted between before and after the implementation of the learning program. Before the learning process, the students' spiritual attitude had been good. The result of the analysis of the spiritual aspect from the open ended question is showed in Table 7.

Authentic data analyzed

The result from the analysis of the authentic data using GrADS is also an important finding in this study. Authentic data of the incoming Surface Net Solar Radiation on Indonesian atmosphere during 1990 and 2010 were analyzed. A sample of the result of the authentic data analysis can be seen in Figure 5.

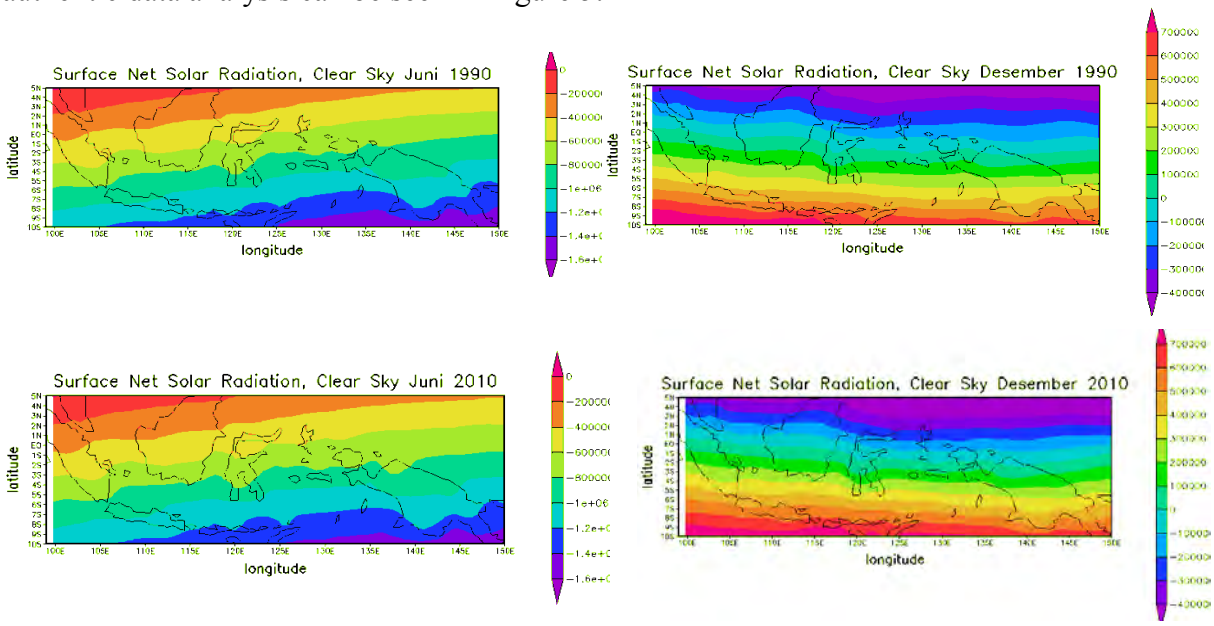


Figure 5. Sample of surface solar radiation at atmosphere in Indonesia in 1990 and 2010

The red colour was interpreted as surplus solar radiation than the blue one. In June 1990 and 2010, northern of Indonesia had surplus solar radiation. It is opposite to the southern Indonesia. It indicates that the intensity of solar radiation in northern Indonesia is greater than at the equator and in southern Indonesia. In December 1990 and 2010, it is opposite with June. Solar radiation in southern of Indonesia is greater than at the equator and northern Indonesia. Figure 5 can support the understanding of the concept such as incoming solar radiation (insolasi), earth revolution, and annual solar movement. In addition, these concepts used visualization also (animation and figure) to facilitate the students' understanding of these concepts.

DISCUSSION

Concept mastery

Based on the findings in Table 6, the improvement of mastery for concept is very satisfactory with an average <g> score of 0.8 (category high). Allegedly, the improvement of the student's concept mastery was influenced by visualization in the learning activity. Visualization included animation, figure, graph, and display from authentic data analysis. Multi modus visualizations used in the learning activities provided a chance to engage the students to construct concepts, correlate concepts, and also facilitated them to thinking

causality. Presseisen in Costa (1988) reveals that one of type of thinking skill is correlation including partial thinking skill and totality, pattern, analysis and synthesis, sequences and logical deduction. An example of visualization used in the learning activities can be seen in Figure 6.

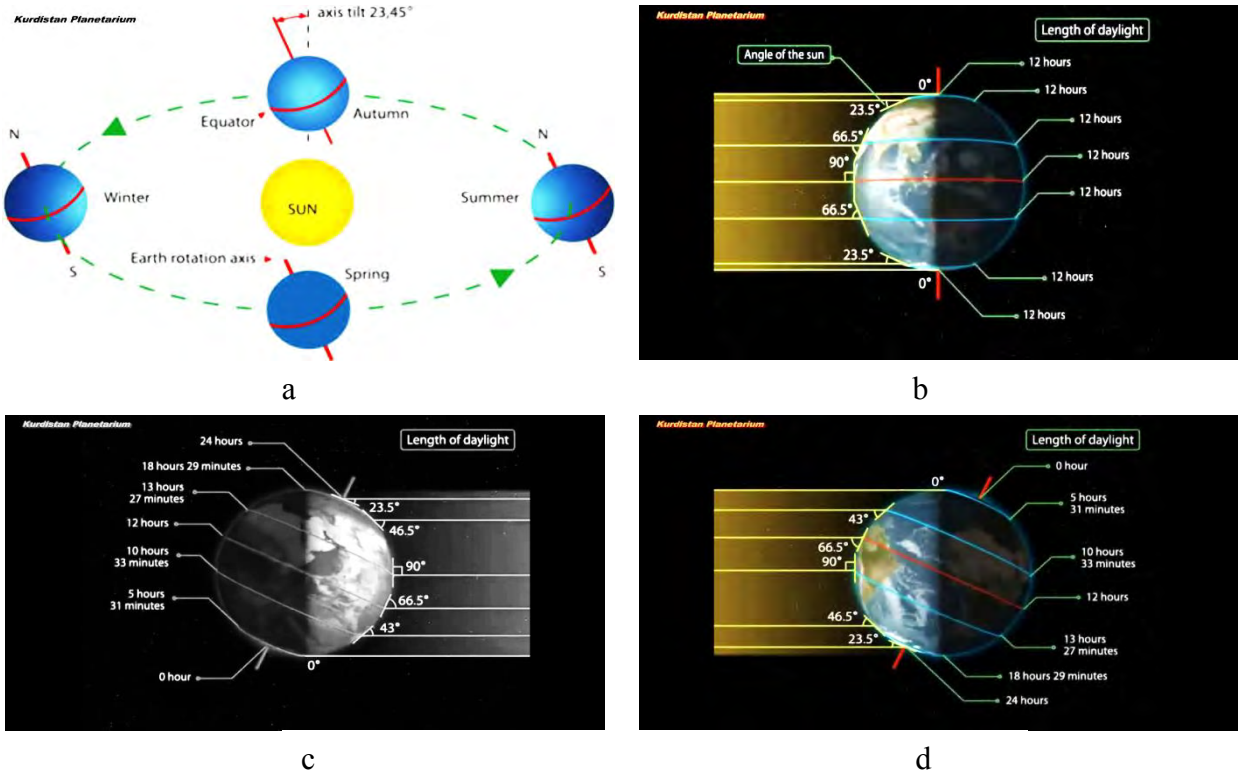


Figure 6. Capture from an animation used in learning activities, a. earth revolution during a year; b. equinox; c. summer solstice; d. winter solstice (source: Kurdistan planetarium)

Figure 6 is captured from an animation that showed the earth's revolution process during a year. The students were encouraged to discuss the concept of earth's revolution, incoming solar radiation, and annual solar movement based on the animation. Animation in Figure 5a visualized the earth's revolution completely while the animation in Figure 5b, 5c, 5d visualized the equinox, summer solstice, and winter solstice as part of earth revolution. Media visualizations succeeded in helping the student improve their reasoning and concept mastery on ESS (Johan, Suhandi, and Wulan 2016, Johan, Suhandi, and Wulan 2017a). Visualization can explain the correlation among various variables (Werts and Hinnov 2011). The demonstration, which involved a seminar and exhibitions of models, videos, posters, and a graph display the growth in atmospheric CO2 and total temperature, looks to have had an impact on the pre-service teachers' understandings and mindfulness about environmental (Saribaş, Küçük, and Ertepinar, 2016). Drawing or diagrams could represent students' conceptions about the nature of science (Colagrande, Martorano, and Arroio, 2016).

Figure 6b, 6c, and 6d showed different angles of the sun during the equinox, summer solstice, and winter solstice during the annual movement of the sun. A difference in the angle of the sun influences the intensity of the incoming solar radiation to the earth's surface. The media visuals in Figure 6 are supported by Figure 7.

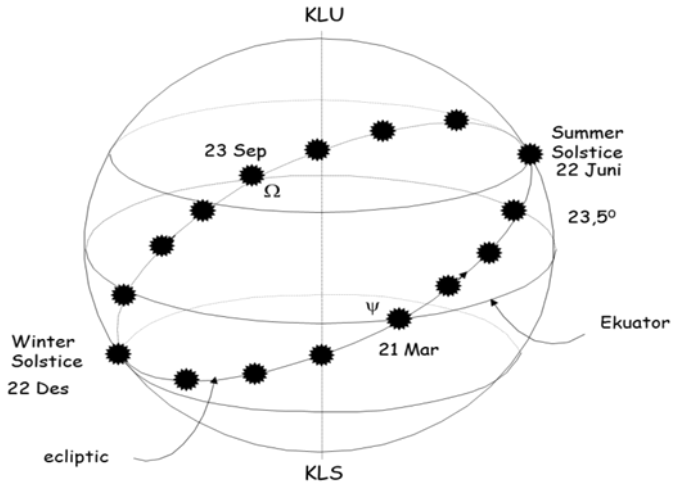
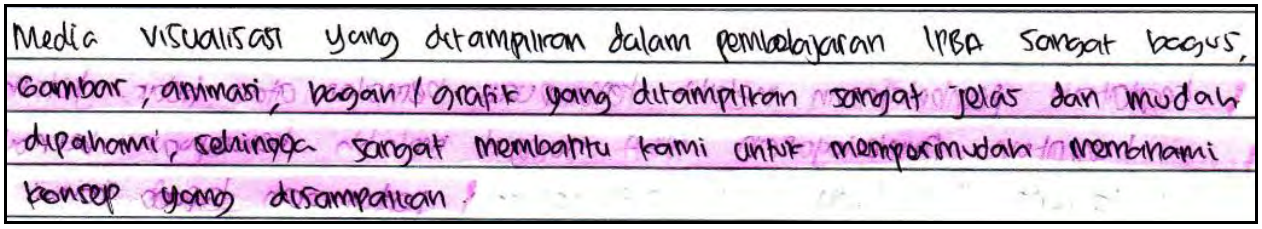
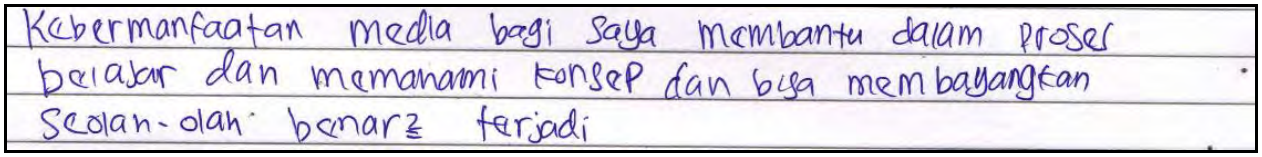


Figure 7. Diagram of annual solar movement

Figure 7 above visualizes the position of the sun's motion. It shows the position of the sun during the summer solstice and winter solstice. In this study, multi modus visualizations are explored maximally to help the students to construct and understand the concept well. Visualization that was used to support each other facilitated the student's correlation of the concept. This is supported by qualitative data from the student's testimonial that gives evidence that animation helps them to understand the concept easier. A sample of the student's testimonial is available in Figure 8 (a) and (b).



(a)



(b)

Figure 8 (a) and (b). Sample of the student's testimonial related to the aids of media visuals in the learning process

The student's testimonial in Figure 8 (a) provides evidence that "Media visuals used in learning ESS learning was great, figure, animation, diagram/graph displayed were clear and easy to understand so it helps us to understand the concept easier and comprehensively." The student's testimonial in Figure 8 (b) gives evidence that "The aids of media visuals is help the student to learn and understand the concept and to display the abstract concept so that it as if it is real"

The result of a study by Bezen, Aykutlu, and Bayrak (2016) indicates that animation should be used to support the learning process effectively. The compilation of animation and visualization from GrADS were able to explain the concept and bring out the real condition of

the incoming solar radiation on Indonesian atmosphere. The visualization from GrADS that was presented in the learning activity also helped the student to have the ability to interpret the result of the analysis of the authentic data such as in applied science research. Figure 9 below can support Figure 6 to help the students construct the concept of the earth's revolution, incoming solar radiation, and annual solar movement.

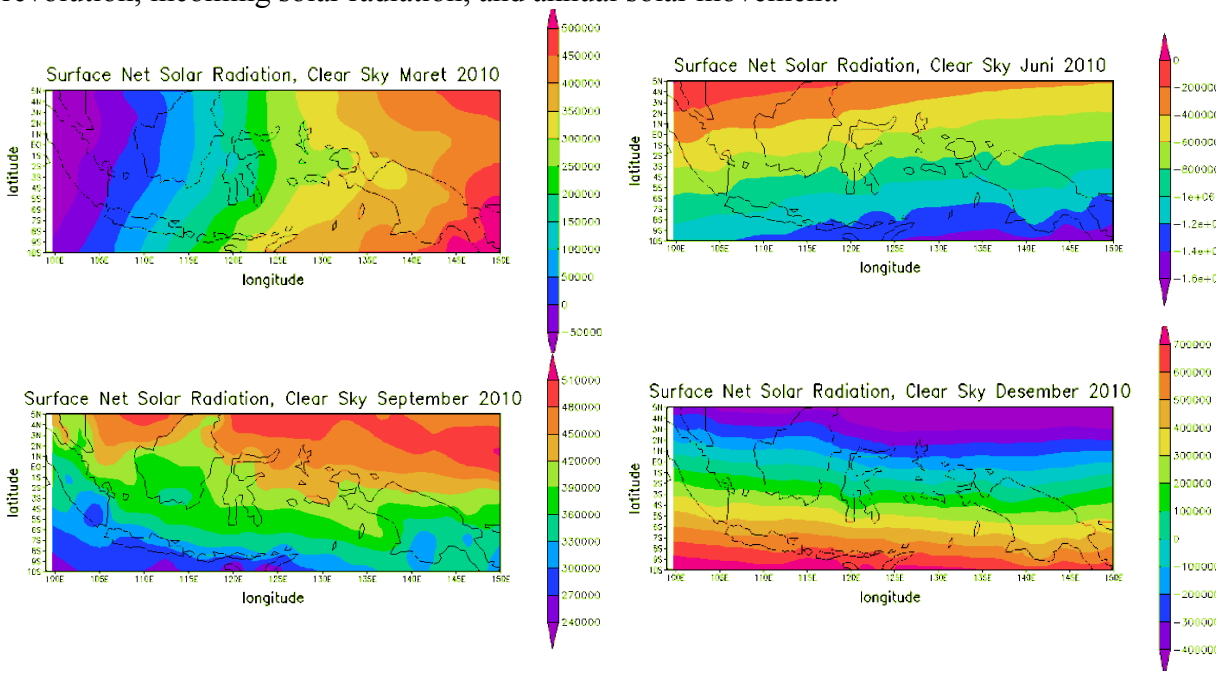


Figure 9. Incoming solar radiation in Indonesia's atmosphere in March, June, September, and December

This result was supported by the students' responses. They testified that animation helped them to understand concept. Animations helped them to visualize unobservable natural phenomena related to earth science. There was evidence that the students have obtained considerable benefits from the visualization used in the learning activities. The students' responses showed that all the students testify that the learning activities using visualizations were more interesting, made the understanding of the concept easier, especially the use of animations, and enabled them to explore their high order thinking. Based on the phenomena encountered by observation, we argue that the applied results of the analysis of authentic data using the GrADS in the learning activities gave them different experience learning about the real condition of solar radiation in the Indonesian atmosphere and helped the students to understand the concept clearly. Johan, Suhandi, Samsudin, and Wulan (2017b) revealed that analysis authentic data using GrADS also facilitated the student's reasoning skills. Similar with Ellwein (2014), it revealed that authentic scientific data can provide an engaging learning experience. Based on the student's responses, they recognized that visualization included animation, figure, graph, and display from GrADS facilitated their high order thinking. The animation that was used had the potential to explore logical thinking in the learning activities because it gave the dynamic situation of an object especially an unobservable object (Lowe, 2004). Kali (2003) stated that virtual visualization as a game in learning activity improved the students' enthusiasm or interest in learning. Kastens (2010) stated that the geoscience learning activity using visualization can give motivation and encourage students to enjoy the learning process. Motivation was an important factor for the learning activity (McConnell, 2011). The finding in this study was supported also by the qualitative analysis of open ended questions. Based on the responses to the open ended questions, the students provide evidence also that: visualization helped them to think about

the cause, effect, and relationships between concepts; the animation is very clear, helps to simplify concepts; the complicated concept becomes easier because of its visualization; animation makes learning activity more enjoyable, brings out curiosity, and is interactive.

Spiritual aspect

One of the aims of this study was to answer the spiritual attitude requirement of the INQF (KKNI). Spiritual attitude was based on the religious attitude competency in general description of the INQF (KKNI). This religious attitude competency was divided into spiritual attitude related to concepts of earth science and any phenomena in nature. Spiritual attitude in this study was related to awareness and belief in the divinity of God. The divinity of God in this study included awareness and belief in Godhead. Nature's divinity was that God is the infinite creator, infinite gracious, infinite assign, almighty, infinite nurture, and infinite wills. Basically, students had had a good spiritual attitude related to awareness and belief in the divinity of God before the intervention learning model. It was seen from the spiritual attitude before the learning process. Before the implementation of the learning program, their awareness and belief to divinity of God were at scale 8 to 10 in scale 1 to 10 (from no awareness and belief to having awareness and belief in the divinity of God).After the implementation, their awareness and belief in the divinity of God was at scale 9 and 10. The shifting of the students' spiritual attitude as a learning effect was indicated by the differences in the data before the implementation and after the implementation. According to the questionnaire in Table 5 above, after the implementation 97.8 % of the students' responses were at scale 10. Before the implementation, only 87.5% of the students' responses were at scale 10. It indicates that the learning process gave effect to improve the students' spiritual attitude. Beside it, the nature of earth science contributed also to improving the students' spiritual attitude. Natural science could bring out a transformation in the material side of our life while religion brings out the transformation of the spiritual side. In this case, absolutely science could not replace the function of religion but science and religion could support concurrently the human's life to be better in both the material and the spiritual sides. The separation of science from the religious aspect made it lose value and control for the science axiology side. This shows how important its value is in science.

Based on the qualitative data from the open ended questions, the students also provided evidence that exploring the spiritual value in earth science concepts successfully affected their belief in almighty God. Chain till unanswered questions in this study brings out the phenomena of tides as the effect of integration gravity from the earth and the moon. Students were guided by questions and feedback. Begin with Questions that can be answered by scientific reasoning:
"How can tides happen?"
"Why does the moon's gravity make tides?"
And then questions already cannot be answered by scientific reasoning:
"Why the moon and the earth have a mass the size and distance precision so that the tide may occur?"
After that student were given questions to embed the spiritual aspect related divinity:
"What happens if the size of the earth and the moon is greater so that force of gravity acting bigger than now?"
"What happens if the distance between the earth and the moon is made much closer, what happen to the tides?"
"What happens if the universe was created not in a very perfect precision?"
"Why is everything in the universe was created with great precision?"
"how and what is the aim of perfect precision of universe?"

These questions were aimed to guide the student to find the divinity in the universe with its perfect harmony. The students were engaged to discuss the questions above to embed the spiritual aspect. This is supported by the qualitative data from the students' responses to the open ended questions. A sample of student responses is available in Figure 10 (a) and (b).

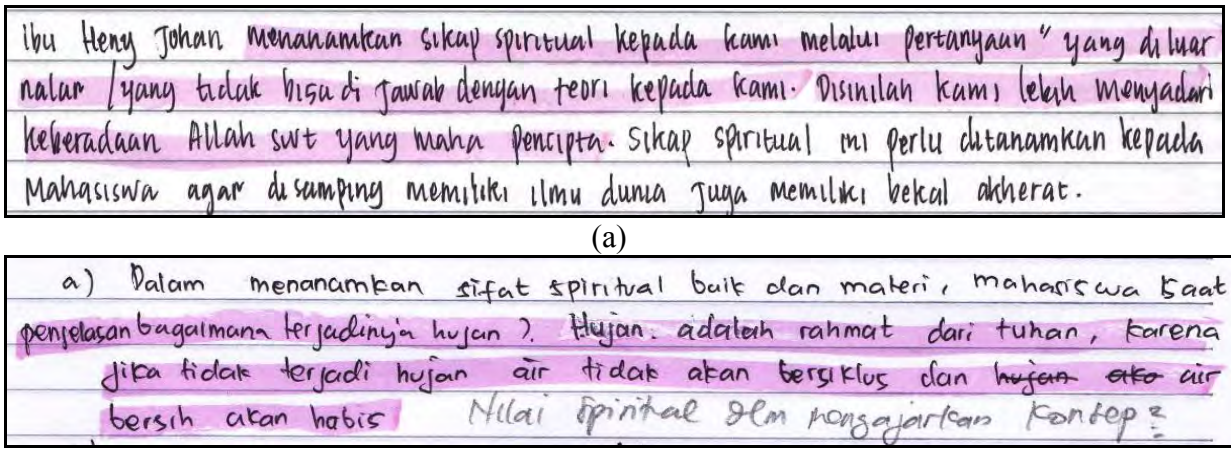


Figure 10 (a) and (b). Sample of student' evidence related to the embedding spiritual value

Student's response in Figure 10 (a) gives confirmation that "The lecturer embedded the spiritual value through unanswered questions in chain questions to lead us to be aware of God divinity and guided the student to the awareness of human finitude." Student testimonial in Figure 10 (b) gives confirmation that "the concept of rain embedded spiritual value related to God finite gracious. Rain is a part of the hydrological cycle."

Embedding a spiritual attitude also was got by presenting spiritual value in each concept. A sample of exploring concepts to embed spiritual attitude can be seen in Figure 11.

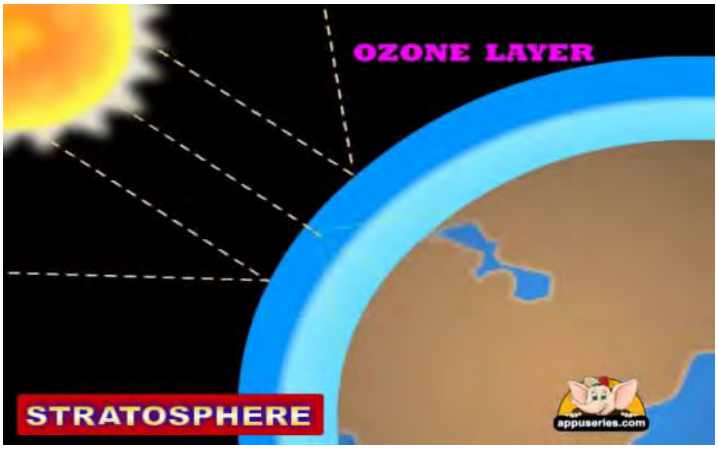


Figure 11. Ozone layer prevents UV from coming into the earth (Source: appuseries.com).

Embedding spiritual attitude was done by explaining the negative effect if the UV came into our earth. The existence of the ozone layer is aimed to protect humans from the negative effect of the UV from solar radiation. This perfect design of the atmosphere shows how God nurtures humans and everything on earth. The spiritual values related to how the nature of the Godhead needs to be explored in the earth's atmosphere phenomena. Johan, Suhandi, Wulan, and Samsudin (2017c) reported that the student got spiritual value of God's infinite nurture when the student learned the geomagnetism concept in ESS lesson. It strengthens the fact that ESS has a high potential to embed spiritual value. Exploring the spiritual aspect in learning

could be an alternative way of teaching science especially earth science. Similarly to Karwardi (2008), he revealed that integrated science and spiritual aspect in learning activity allowing the occurrence of complementation, comparison, inductive, and verification. The science concept was break-down to bring the concept of Godhead. In addition the results of the analysis indicated that the interactive activities in class by giving chain questions positively affected on the spiritual aspects. Charles Townes (2003) stated:
"I see religion as an attempt to understand the purpose of our universe and science as an attempt to understand its nature and characteristics"

Based on the study literature, similar research about embedding spiritual aspect in learning natural science especially ESS has not been reported widely.

CONCLUSION

Based on the results and discussions above, it can be concluded that the learning model IC-CUQ has the potential to improve the student's concept mastery and embedded spiritual attitudes related to belief in the Godhead. The student's concept mastery improve from no mastery to mastery level with the average N-gain being 0.8 (category high) with the help of visualization and compilation of authentic data analysis using GrADS. The display of authentic scientific data from GrADS helps students to understand the concept and gives them experience about the real condition in Indonesian's atmosphere. Visualization used in this study makes learning more interesting and explores their thinking skills. Multi modus visualizations visualized the details of the concept (phenomenon) clearly. Applying science research in the learning process gave some benefits, including: helping students to reason and to understand concepts, giving them different experience learning about real condition of nature, showing correlation among concepts, and providing enjoyable learning process. Embedding spiritual attitude in the learning activity was done through exploring the values of divinity in various phenomena and presented chain till unanswered questions at the end of learning process. It improved successfully students' spirituality.

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