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Validation and Students Scientific Inquiry-Aided by Multimedia on Climate Change

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Abstract. The research aims to (1) obtain the validity of scientific inquiry instruments on Climate Change material; (2) analyze students' scientific inquiry activities based on the different time of problem distribution with multimedia; (3) Obtain students' scientific attitude during learning. The design was research & development. The participants were two classes of PGMI. Validity obtained from expert judgment, scientific inquiry activities obtained from observations during learning. Research shows that the validity of scientific inquiry instruments (multimedia, worksheets and scientific attitude sheets) are good and appropriate. Different time of problem distribution influence the students' scientific inquiry activity. Communication is a dominant indicator of the scientific inquiry activities in both classes. Cooperation and curiosity are a dominant scientific attitude in both classes.

1. Introduction

The high rate of population growth and the development of industries have slowly changed the condition of the earth and the atmosphere, which results to climate change. The emergence of impacts of climate change that lead more harm to the inhabitants of the earth becomes a crucial issues to be addressed and learned by human, including reports and research on human contributions to natural disasters [1]; [2]. In understanding these reports and research, inquiry learning is applicable for developing scientific understanding of complex topics, where inquiry learning with simulations assists students to understand more complex topics, such as greenhouse effect [3].

The need to direct students to think critically and creatively as well as to have scientific attitude becomes the obligation of educators to prepare them for the challenges of the future and the world of work. Educators engage students in conducting research and teaching science through inquiry. Scientific inquiry activities are part of inquiry learning, such as formulating problems, inputting data, formulating hypotheses, plotting tools and materials, calculating, creating tables, predicting, communicating, summarizing and reporting [4]; [5]. Meanwhile, multimedia has the potential to provide new bioscience learning environments, such as climate change, and pedagogy applications to encourage students’ interest, engage in research processes, advance problem-solving skills, and develop conceptual understanding [6];[7][8]. Thus, it is necessary to conduct research that aims to find out the scientific inquiry activities and scientific attitude of the students, through inquiry learning, where multimedia is used as a source for exploring information as well as explaining the concept.
2. Method
The type of research is quasi experiment, because there is no randomness in selecting participants. The research subjects consisted of two classes of PGMI (Islamic elementary school education department) students who took Biology/Environmental subject with the topics on climate change. The design of the research is Nonequivalent Control Group Design [9]. Instrument validation, including materials on climate change, worksheets about climate change, multimedia and attitudinal observation sheet, was done by two expert judgment. Selection of two classes in the study was based on the equality of students’ abilities. One class of 36 students is used as a class of experiments and another class of 35 students became the control group. The experimental class was assigned a worksheet problem before multimedia is served (BW = before watching) and the other class receives the worksheets once the multimedia is served (AW = after watching).

Multimedia-assisted inquiry learning models on the topics of climate change was implemented in both classes. Scientific inquiry activities were obtained from students’ work on the worksheets. The indicators of scientific inquiry refers to the indicators defined by National Research Council [4], namely using the information/data, formulating the problem, creating variables, formulating hypotheses, making graphs/tables, calculating, communicating, predicting and making inferences. Multimedia was used as a resource to collect data information. The worksheet assessment used a 0-5 rubric score adapted from National Research Council [4] and Popham [10]. Scientific attitudes were observed immediately when the classroom session was done by using an observation sheet in Likert scale of 1-5, where 1 = very poor, 2 = poor, 3 = fair, 4 = good and 5 = very good [11]; [12].

3. Results
The results of the study included the results of instrument validation, the results of scientific inquiry activities and students’ scientific attitudes. The results of instrument validation is shown in Table 1.

| Type of Instruments | Validator I Score | Validator II Score | Average Score | % | Result |
|---------------------|------------------|--------------------|---------------|---|--------|
| Teaching Materials (8 items) | 3.88 | 4.00 | 3.94 | 78.8 | Valid |
| Rich Media (6 items) | 4.33 | 4.17 | 4.25 | 85.0 | Valid |
| Worksheet (4 items) | 4.5 | 4.25 | 4.38 | 87.5 | Valid |
| Scientific attitude sheet (4 item) | 4.5 | 3.75 | 4.13 | 82.5 | Valid |
| Average Value | | | | 83.45 | Valid |

Criteria for the percentage of validity from quantitative to qualitative: (a) 86%-100%, very valid; (b) 70%-85%, valid; (c) 60%-69%, less valid; (d) 0%-60%, invalid [11]; [13]. Based on Table 1, the average percentages of validity of the instrument was 83.45, which fell into the valid qualification. This meant that all instruments met the criteria of validity and could be used in the study.

The results of scientific inquiry activities were obtained from students’ work on the worksheet. The worksheet itself consists of nine questions. Each question represented a scientific inquiry indicator. The following issues are found on the Climate Change worksheet.

- Arrange the information and data you get from multimedia neatly and clearly!(using data).
- Define some of the problems you found on the movie! (formulating the problem).
- Make a hypothesis from the problem formulations you have made! (making the hypothesis).
- Formulate independent and bound variables from the hypotheses you have created! (determining the variables).
- Draw a graph of the relationship of CO2 concentration with temperature change!(creating table/graph).
In relation to task number 5, what happens to the CO2 gas and the earth's temperature if the tree planting is done continuously? (predicting)
If there is 5 kg of waste containing methane, calculate how much CO2 will be produced from the waste. (counting)
Define the causes of global warming that you know! (communicating).
Formulate some conclusions about the climate change! (making conclusions)

The worksheet assessment uses a rubric with a 0-5 score range. The scientific activity of student inquiry activity between BW and AW group on Climate Change material is shown in Table 2 and Table 3 below.

Table 2. The descriptive statistics of students’ scientific inquiry activities.

| Description        | BW   | AW   | INFORMATION |
|--------------------|------|------|-------------|
| Mean               | 35.11| 32.03| Different   |
| Min                | 32.00| 30.00| P=0.00.     |
| Max                | 38.00| 34.00|             |
| Variance           | 2.09 | 1.44 |             |
| St. Dev            | 1.45 | 1.20 |             |

Table 3. The results of students’ scientific inquiry activities per indicator.

| Indicators                     | BW   | AW   | INFORMATION |
|--------------------------------|------|------|-------------|
| Using Data                     | 4.18 | 3.17 | Different   |
| Formulating Problems           | 3.16 | 3.11 | Same        |
| Defining Variables             | 3.76 | 3.66 | Same        |
| Formulating Hypotheses         | 3.74 | 3.71 | Same        |
| Communicating                  | 4.55 | 3.77 | Different   |
| Creating a Picture / Graph     | 4.18 | 3.14 | Different   |
| Calculating                    | 3.82 | 3.71 | Same        |
| Predicting                     | 3.84 | 3.74 | Same        |
| Concluding                     | 3.66 | 3.60 | Same        |

Based on Table II, the mean score of BW is 35.11 and AW is 32.03, out of the maximum value of 45. The standard deviation of BW is bigger than AW group, meaning that the diversity of BW group scores is higher than AW group.

Meanwhile, Table III shows the scientific inquiry activities obtained from students’ worksheet. Almost all indicators of scientific inquiry activities in the BW group were indicated higher than the AW group. Regardless of scores in each indicator, communicating appears to be the highest indicator in both BW and AW groups.

![Figure 1. Students' Scientific Attitude Observed](image-url)
In terms of students’ scientific attitudes, Figure 1 above shows the scores of scientific attitudes observed: being cooperative, curiosity, respect for evidence, creativity, and sensitivity to environment.

4. Discussion
Based on the validation of the instruments, it was found that the validity was 83.45, which qualified as valid. This means that all instruments sufficiently met the criteria of validity and can be further used for data collection. Table II indicates that the total mean for BW group score was significantly different from the AW group. Meanwhile, the mean of BW group in the scientific inquiry activities is higher than AW. It was because the BW group has the opportunity to study the worksheet issues ahead of time, to strategize problems solving, to work together and to think critically. Scientific inquiry learning model encourages students to construct knowledge from their learning experiences, which allows them to build experiences such as respect for data, selecting accurate and precise data [4].

An interesting finding from Table III is the existence of several scientific work activities that shares significant differences and similarities in the results. The significant differences in the results of scientific inquiry activities between BW and AW are in 1) using data, 2) communicating and 3) creating images/graphs. All these activities are directly related to the information and students’ impression on the data shown on the multimedia. On different scientific work activities significantly showed higher scores in the BW group. This means that in the BW (Before Watching) group students have the opportunity to learn the problems first, so they can use the information shown in the multimedia more effectively.

The results of students’ scientific inquiry activities that do not show significant differences are: 1) formulating the problems, 2) determining the variables, 3) formulating hypotheses, 4) calculating, 5) predicting and 6) concluding. These six scientific inquiry activities are related indirectly to the way information and data on the multimedia are displayed. Students were faced with problems that require them to find solutions by asking, discussing, working together, and formulating answers with their own understanding, in the absence of multimedia assistance. Formulating the problem is the activity with the lowest score in both BW and AW. Students encountered difficulties in determining the dependent variables and the independent variables that are used to formulate the question. At the stage of formulating the problem, students were assisted through scaffolding [14]. Scaffolding is the crucial part in the inquiry learning in the unfamiliar learning discourse, such as formulating hypotheses and formulating problems [15]. Thus, the low involvement of scaffolding further implicates these six low activities compared to other scientific inquiry activities and shows no significant different scores, either in the BW group or AW group.

Figure 1 shows the students’ scientific attitude during the lesson. Cooperation and curiosity are the dominant scientific attitudes to inquiry learning both in BW and AW groups. Meanwhile, respect on data dominates attitudes on BW groups. Inquiry learning encourages students to seek out and explore their own knowledge through cooperation, respect for evidence/data, and ask questions about the problems he/she faces.

With a simple regression test, the scientific attitudes in the BW group influences 64% on the scientific inquiry activities. This further implies that having scientific attitudes has a positive influence on the scientific inquiry activities [16][17]. Students’ positive attitudes and perceptions on the science influence their level of engagement and activeness in constructing and understanding conceptually, leading to a more improved learning achievement and academic achievement [18]. The attitude to care about the environment has not been properly embedded in the students’ mind. Caring for the environment on campus or during the learning process, turning off the electricity when not used, turning off the LCD when not used, cleaning the whiteboard, turning off the AC/fan when not used, and tidying up the table after used are some activities that must be nurtured and reminded constantly. The attention to science is not necessarily followed by the concern for the environment, but it requires regulation, firmness, and rules that support environmental awareness.

5. Conclusion
Scientific inquiry activities play an important role in raising students’ awareness on understanding various environmental issues. Before implementing to the learning session, validation towards the instruments of scientific inquiry on climate change materials had been found to meet the criteria of validity and could be used to collect data. The total mean of BW group differs significantly with the AW group, which means that there is an influence on the use of multimedia in achieving the objectives of scientific inquiry learning. The scientific inquiry activities that are directly related to the information and data shown on the multimedia differ significantly between BW and AW groups. These activities include 1) using data, 2) communicating, and 3) creating images/graphs. Scientific inquiry activities that are not directly related to the information and data shown on the multimedia and do not differ significantly between BW and AW groups. These activities include 1) formulating problems, 2) defining variables, 3) formulating hypotheses, 4) calculating, 5) predicting, and 6) concluding are do not differ significantly between BW and AW. Out of all indicators, communicating is the only indicator of the dominant scientific inquiry activity in both groups. In terms of scientific attitudes, the dominant scientific attitudes in both groups are cooperation and curiosity.

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