

WhatsApp as a Collaborative Tool for Enhancement of Students' Critical Thinking: An Analysis of Environmental Pollution Learning Material at a Junior High School

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Date of Submission: 15th June 2021 Revised: 27th August 2021 Accepted: 18th September 2021

How to Cite: Hidayat, A., Jamaluddin, D., and Fauziah. (2021). WhatsApp as a Collaborative Tool for Enhancement of Students' Critical Thinking: An Analysis of Environmental Pollution Learning Material at a Junior High School, *International Journal of Computational Intelligence in Control* 13(2), pp. 97-106

Abstract - WhatsApp-assisted group investigation model is employed as an alternative to improve students' critical thinking skills on environmental pollution learning material at a junior high school. The research method used in this study was quasi-experiment. The participants were taken from two classes; each class comprised 22 students: class VII-B as the experiment class and students from class VII-A as the controlled class. There are three research instruments used in this investigation, which are the observation paper, students' critical thinking test, and a questionnaire. The result reveals that the learning process runs smoothly with or without the WhatsApp-assisted group investigation model. Based on statistical analysis, students' critical thinking in the experiment class is higher than the controlled class. The t-test outcome displayed a positive development of the implementation of the WhatsApp-assisted group investigation model on students' critical thinking. The average students' responses to the WhatsApp-assisted group investigation model learning and the conventional class was in the high category.

Index Terms - critical thinking skills; learning model group investigation, WhatsApp

INTRODUCTION

Education is an everyday human activity. It is the product of human culture. The educational activities are completed to preserve and sustain human life. Education is designed for humans. Thus, to fully grasp its essence, education should be seen through the lenses of human nature and its purpose [1]. Alhejaili et al. [2] define that the education at school has a purpose of changing students to have knowledge, skills, and attitude of a learner due to their education so that students can play an active role in the learning process. In the implementation of pedagogical competence, teachers are demanded to have methodological skills in planning and implementing the learning process, which includes the ability to control the use of learning models. Many educational practitioners have realized that media or teaching aid has provided excellent support for the learning process both inside and outside the classroom, especially in flourishing the learner's knowledge and skill. According to [3], life in the 21st century requires students to cultivate their skills while learning; one of the skills is student' critical thinking.

The learning materials on environmental pollution is one of the materials in science that has a strong relation to everyday life. Hence, by learning about environmental pollution, we can analyze its impact on the ecosystem. With the analysis process, students can study thoroughly and collaboratively, and they will be pushed to express their opinions. Consequently, it will develop students' critical

thinking skills. Moreover, in the learning material of environmental pollution, it has been found that there are considerable evidence and phenomenon that might cause problems that will harm the organism and its environment. Therefore, the young generation should own a sense of care for the environment. Environmental pollution is one of the learning materials for junior high school students. We can utilize several models in the learning process, such as Group Investigation, discovery learning, project-based learning, and others. Paolini [4] stated that selecting the proper learning models for learning would impact the learning process itself, where students can be active, interactive, and it can stimulate student's critical thinking.

A Student's critical thinking is a skill in mastering the motoric motion that involves the cognitive mental function, which means gaining knowledge with a mental action [5]. Holmes et al. [6] believe that critical thinking is one of the complex thinking or high order thinking activities, which applied to shape the students' conceptual systems in science. The critical thinking skill is essential for anybody as it works as mental preparation to face life problems.

A Previous study applied an interview with one of the teachers in a private Junior High School in Bandung to investigate environmental pollution's learning material. The teacher states he once used the group investigation model. However, only several students are involved in learning; thus, it is not optimal. The typical learning process uses the cooperative method such as is observing, asking questions, collecting data, associating, and communicating. Other than that, the teacher rarely implemented the use of WhatsApp as the teaching aid or media in learning, specifically in learning about environmental pollution. In learning environmental pollution [7], students are generally unable to use their ability in critical thinking. This ability can reflect the learning process, where a lack of students asks questions and shares their ideas. Also, the ability led to the low result of students learning, in which only 60% of students reach the average score in learning science where the minimum mastery criteria are 70. Accordingly, the suitable types to develop students' critical thinking are the cooperative group investigation model, which is the types of method for cooperative learning designed to influence students' interaction pattern.

One of the most popular media that can be used to facilitate the learning process with the cooperative group investigation model is WhatsApp. WhatsApp is a free messenger application that works across multiple platforms like iPhone and Android phones, and this application is being widely used among undergraduate students to send multimedia messages like photos, videos, audio along with simple text messages [8]. WhatsApp has become one of the leading messaging applications on cell phones worldwide and is used by teachers and teenagers alike. However, little is known about the nature and the content of secondary school teacher-student WhatsApp communication [9].

Although cellphone and the various applications in phones have some negative effects, their use in education

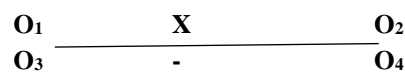
has proven to have a positive impact [10]. One of the studies by Alghamdy [11] states that cellphone through WhatsApp can enhance and provide more interactive lessons while increasing the cognitive outcomes of students in Learning. On another side, the information on the use of the WhatsApp-assisted group investigation model is still limited, especially at junior high school. There are several similar investigations to this research. The first one is the study conducted by Pratama & Kartikawati [12] on Group Investigation (GI) model integrated with WhatsApp towards students' critical thinking. Nevertheless, the research is conducted on a higher-level student on the subject of Basic Electro. Another similar research is completed by Mushoddik et al. [13] which focuses on the learning model of group investigation on the ability of critical thinking on a higher-level student. Nonetheless, their study on the effect of model group investigation on students' critical thinking does not implement WhatsApp as its teaching aid. The investigation also focuses on the environmental preservation of senior high school students. Gultom [14] also administers similar research on Junior High School students, class VII, with a WhatsApp-assisted group investigation model on biodiversity material.

As previously explained, the research on using model group investigation through WhatsApp on students' critical thinking in learning about environmental pollution has not been completed, and it is essential to be conducted. Consequently, this research will provide additional information to support teachers in selecting the learning models suitable for the level of education.

MATERIALS AND METHOD

1. Research Method and Design

This investigation implements a quasi-experiment as its research method. In this research, the experiment group utilized the WhatsApp-assisted group investigation model as the teaching aid. On the other hand, the control group studies the subject using conventional learning. Moreover, this study applied a mixed-method approach that combined qualitative and quantitative methods [15]. The research design implemented in this study is the pre-test and post-test nonequivalent control group design (Figure 1) that refers to Bustami et al. [16] study. This study uses two classes, one as the experiment class and one as the controlled class. The independent variable in this research uses the WhatsApp-assisted group investigation model, and the dependent variable is students' critical thinking. Both skills are then measured with a pre-test before the treatment and a post-test after the treatment.



(O1: Experiment group pre-test, O2: Experiment group Post-test, O3: Controlled group pre-test, O4: Con-trolled group post-test, X: Treatment using group investigation with WhatsApp as teaching aid)

FIGURE 1

RESEARCH DESIGN.

II. Data Type and Resource

In this research, the data type that will be utilized includes the quantitative data which were collected from the pre-test and post-test results from the experiment class and control class; qualitative data which were collected from the observation paper to measure the learning completion of teacher and students in experiment class; the questionnaire data to investigate experiment and controlled class students' respond in learning, which will be further analyzed quantitatively. The questionnaire data will be interpreted to the category, which will generate qualitative data.

The data source in this study was taken from the primary data acquired from the research outcome in class VII-A and VII-B in Al-Hasan Junior high school in Raya Panyileukan Street No.8a, Cipadung Kidung, Kecamatan Panyileukan, Bandung, West Java 40614. The 7th-grade students in this school are divided into three classes. However, this research only analyzed two classes, which are VII-A and VII-B. Both classes A and B have 22 students. The reason why class A and B was chosen is that that they have a relatively similar skill. Thus, a comparison of both classes can be completed.

- **Observation.** Observation is applied to identify students' activities during the learning process. According to Suharsimi [17], observation is an effective way to complete the collection of data. The observation sheet contains items that relate to specific events or behaviors.
- **Test.** The test in this study is on students' critical thinking skills. There are nine essay questions. A pre-test and post-test were given to the participants. After analyzing the average pre-test and post-test scores, the acquisition of the average calculation of students' critical thinking skills has an increase in each item of the student's critical thinking skills sub-indicator. The indicators are (1) Providing a simple explanation: Focusing on questions, analyzing an argument, answering an explanation or a challenge; (2) Building basic skill: Considering the credibility of a source; (3) Giving a conclusion: Inducting and considering the result of the induction; (4) Providing further explanation: Defining a term and considering it and (4) Constructing a strategy and the procedure: Determining an action. Suharsimi [17] explained that a test is a list of questions or exercises utilized to measures an individual or group's skill, knowledge, and intelligence.
- **Questionnaire.** The type of questionnaire used in this study is a closed questionnaire. It aimed to scrutinize students' responses towards learning with and without the Model Group Investigation through WhatsApp. Suharsimi [17] states that a questionnaire is a written question designed to collect the respondent's information (personal information or other information.

III. Data Analysis

After obtaining the research data, furthers analysis is carried out on these data. The steps taken are as follows.

Instrument analysis

The quality of the research instrument can influence the research finding. Hence, before the instrument is used, a trial should be completed. The steps taken in the trial tested the validity and reliability of the questions and the difficulty of the questions.

Finding analysis

- **The analysis of the learning process.** The observation was used to analyze the learning process with or without group investigation. On the observation, the teacher and students' activities were investigated by using a checklist.
- **The analysis of student's critical thinking.** The calculation of Gain and N-Gain was addressed to investigate students' critical thinking. In this research, Gain is the growth student's critical thinking between the students who use the WhatsApp-assisted group investigation model in their learning activities and students who learned using the conventional method, namely by analyzing the average result of the instrument in this research, Microsoft Excel 2016.
- **The analysis of the WhatsApp-assisted group investigation model.** The t-test was conducted to find the influence of the group investigation learning model on students' critical thinking. However, before the t-test is completed, the normality test of N-gain, homogeneity test of N-Gain variances, and hypothesis testing were accomplished.
- **The analysis of students' responses to the learning model.** This analysis is proposed to discover students' reactions toward the learning process. The indicators are 1) students' attitude towards learning biology (students' interest and seriousness in learning biology), 2) students' attitude towards learning (students' interest in the learning model; students respond on their critical thinking skill through the learning model), 3) Student's reaction on the critical thinking questions (students respond on the critical thinking questions; their preference on the critical thinking questions).

RESULTS

The learning process with and without the WhatsApp-Assisted Group Investigation model

The learning process with the group investigation model assisted by WhatsApp was observed through the teacher and students' observation when the learning process occurs.

a. Teacher Observation

Table I shows the implementation of teacher activities in the classroom with and without the Group Investigation model. The table portrays the average implementation of the learning process activities from the first meeting until the

third meeting. The result of the class that uses the group investigation model is 90%. Furthermore, the control class average is 93%.

TABLE I
TEACHING ACTIVITIES' WITH AND WITHOUT THE GROUP INVESTIGATION (GI) MODEL ASSISTED BY WHATSAPP AS A TEACHING AID

Meeting	Using GI Model assisted by WhatsApp		Class without GI model	
	Average	Category	Average	Category
1 st	80%	Good	87%	Very Good
2 nd	90%	Very Good	93%	Very Good
3 rd	100%	Very Good	100%	Very Good
Average	90%	Very Good	93%	Very Good

b. Students Observation

The implementation of the student's activities in the learning process with and without the group investigation model assisted by WhatsApp can be seen in Table II. The table depicts the average score of implementing the learning process that implements the group investigation model using WhatsApp gain 92% in the "very good" category. Additionally, students in the other class that does not utilize the group investigation model facilitate by WhatsApp obtain an average score of 85% in the "good" category

TABLE II
STUDENTS' LEARNING ACTIVITIES WITH AND WITHOUT THE WHATSAPP-ASSISTED GROUP INVESTIGATION (GI) MODEL

Meeting	With the WhatsApp-assisted GI model		Without the WhatsApp-assisted GI model	
	Average	Category	Average	Category
1 st	85%	Good	80%	Good
2 nd	90%	Very Good	87%	Very Good
3 rd	100%	Very Good	87%	Very Good
Average	92%	Very Good	85%	Good

Students' critical thinking skills with and without WhatsApp-assisted group investigation model

Students' critical thinking skills were analyzed based on the pre-test and post-test. Moreover, the data were counted using the N-Gain formula to find the enhancement of students' skills. The result of the data analysis pre-test and post-test of students in the experiment and controlled class can be seen in Table III.

TABLE III
ENHANCEMENT OF STUDENTS' CRITICAL THINKING SKILLS IN EXPERIMENT CLASS AND CONTROL CLASS

Meeting	Using the WhatsApp-assisted GI model		Without using the WhatsApp-assisted GI model	
	Average	Category	Average	Category
1 st	85%	Good	80%	Good
2 nd	90%	Very Good	87%	Very Good
3 rd	100%	Very Good	87%	Very Good
Average	92%	Very Good	85%	Good

The enhancement of students' critical thinking skills in each sub-indicator before and after the learning process can be seen in the graph below (Figure 2). The graph includes the data taken from both the experiment class and control class.

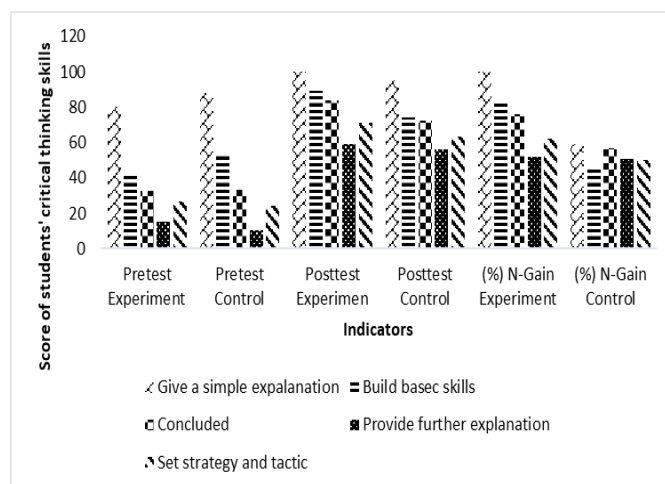


FIGURE 2
AVERAGE SCORE OF EACH SUB-INDICATOR IN THE EXPERIMENT CLASS AND CONTROL CLASS

The influence of WhatsApp-assisted group investigation model on students critical thinking about environmental pollution

The impact of the WhatsApp-assisted Group Investigation model on the development of students' critical thinking can be seen from the t-test result. The assumption that should be accomplished is the normality test and the homogeneity variants test obtained from students' post-test results.

a. The normality test of the post-test
The result of the normality test using the Shapiro Wilk in the experiment class and the control class can be seen in Table 4. The table shows that the sig. value in the experiment class is 0.408 > 0.05 and in the control, class is 0.126 > 0.05. Thus, the data in both classes are normally distributed.

TABLE IV
NORMALITY TEST OF THE POST-TEST DATA

Class	Shapiro Wilk Statistic	df	Sig.
Experiment	0.956	22	0.408
Control	0.931	22	0.126

b. Homogeneity of variance test of the post-test data
The result of the homogeneity of variance test shows that the Sig. value is 0.981 > 0.05, which means that the variance of the data is homogeneous. Based on the normality test and homogeneity of variance test, the data is normally distributed, and the variance is equal. As the two assumptions were fulfilled, the t-test analysis has proceeded.

c. The t-test of the post-test data. By following per under the analysis result on Table V, The independent sample test outcome show that the Sig. (2 tailed) value are $0.000 > 0.005$. Thus, H_a is accepted. It implies that there is a difference in students' critical thinking in the experiment class and control class. This means that there is a positive influence of the WhatsApp-assisted group investigation model on student's critical thinking in learning the environmental pollution.

TABLE V
HYPOTHESIS TESTING OF POST-TEST DATA

N-Gain score		Equal variances assumed
Levene's Test for Equality of Variances	F	0.502
	Sig.	0.483
	T	4.899
	Df	42
t-test for Equality of Means	Sig. (2-tailed)	0.000
	Mean Difference	0.15591
	Std. Error Difference	0.03182
	95% Confidence Interval of the Difference	Lower: 0.0916 Upper: 0.22013

Students respond towards the learning with and without the WhatsApp-assisted group investigation model.

The questionnaire is used to gain data on students' responses to the experiment's learning process and control class. The questionnaire consists of indicators that have been determined as the benchmark for students after the learning process. The analysis result of students' responses can be seen in Table VI.

TABLE VI
THE RECAPITULATION OF STUDENTS' RESPONSES.

No	Aspect	Average Experiment	Control	Category
1	Biology study	4.12	4.06	High
2	Learning model	4.35	4.16	High
3	Questions on critical thinking	4.33	4.17	High
Average		4.27	4.13	High

The learning process with and without the WhatsApp-Assisted Group Investigation model

a. Teacher Observation
The implementation of the learning process using the Group investigation model was conducted three times. In the application, teacher activities in the learning process gain an average of 90% on a "very good" category. Moreover, in the other class, the controlled class's teaching activities reach 93% on a "very good" category. In the first learning process, several steps were forgotten. Some of them provide students with learning motivation, walking around the

groups in the classroom, facilitating students to give feedback, and providing students with reflection. Teachers' unfamiliarity caused these issues with the steps on the learning model and lack of time. On the second meeting, the teacher can give students a learning motivation but can still not reflect. At the third meeting, the teacher has completed all the steps because they are getting used to all the learning model steps.

In the controlled class, the teacher at first also missed several steps, such as giving appreciation towards the best group and letting students know about the next learning material. This happens because there is not a presentation on that day. At the next meeting, the teacher only misses the appreciation steps to the best group in class because they have limited time. On the last meeting, every step has fully completed and worked well. The average score of implementing teacher activities in the learning process without the group investigation model facilitated by WhatsApp is higher than the other class. As evidenced by both the learning model, the learning without the group investigation model aided by WhatsApp is easier to put into practice by the teacher. Thus, its implementation is higher. Nevertheless, if it was linked with the average post-test score gained by students, the result will be inverse. Even though learning without the WhatsApp group is quite easy, the improvement of students' critical thinking is much lower. Cook & Artino Jr [18] explained that the selection of the learning model would have a great influence on the success of the learning process. If the teacher chooses the right learning model, it would have a positive impact on students' learning outcomes.

b. Students Observation

The average score of implementing the students' activities in the learning process using the WhatsApp-assisted group investigation model is 92% in a "good" category. Moreover, the average score of students in the controlled class without the WhatsApp-assisted group investigation model reaches 85% in the "good" category. On the first meeting, the students did not receive motivation, did not prepare the group discussion results because the discussion had not started at the first meeting, and did not execute a reflection the teacher missed this step. The students missed the same steps as the previous second meeting, but they get to prepare the discussion result. Lastly, in the final meeting, they were able to complete all the steps of the meeting.

The missing steps in the controlled class on the first meeting are students did not answer teacher questions, students did not ask the teacher, and they did not do a presentation because it is not completed on the first meeting. In the second meeting, students did not ask questions and did not conclude the learning because they cannot deliver their opinion and idea yet. In the third meeting, the students can still not share their opinions and ideas, so they missed the chance to ask questions on the materials they have learned that day. This leads to a low level of student's critical thinking in a controlled class. This issue was caused

by a lack of steps in the teaching and learning process to lose their interest.

At the time of the research, some obstacles prevented the implementation of the learning process designed in the lesson plan. The experiment class issues were the deficiency of students' capability in sharing their ideas when they completed the evaluation steps. Hence, the teacher is the only one who gave feedback to the group that presents that day. Similarly, the control class also faces some problems. One of the issues is the lack of students' concentration due to the tedious learning process they had and class timing, which was at the end of the school time; thus, the class was not conducive. Bidabadi et al. [19] state that students' motivation and concentration in learning will disappear if the effective hours to study have passed. If the learning process is done at the end of the school hour, students' concentration will decrease. According to Pilkey et al. [20], students' concentration is impacted by internal and external factors. Feeling boredom, feeling anxiety, and seeking attention were internal factors that became the occurrence disruptive of students' concentration [21]. While fatigue was the external factor that causes the emergence of students' disruptive [22].

One of the steps completed by students is investigations. In an investigation skill, critical thinking skills and cooperation between every individual in the group are required [23]. Slavin [24] explains that group model investigation is learning that emphasizes students' participation and students' activity in finding information or learning material that will be studied.

Students' critical thinking skills with and without WhatsApp-assisted group investigation model

The calculation on the average score of students' critical thinking skills in the experiment class reaches 37 on the pre-test and 80 on the post-test. On the other hand, the control class average score is 39 on the pre-test and 71 on the post-test. The N-Gain on students' critical thinking skills in the experiment class reaches 0.68 (56%) and in the control class gain 0.53 (44%), both in the moderate category.

The outcome of the analysis demonstrates that the average students in the experiment class have better critical thinking skills than the students in the control class. The data portray that both classes have a higher score in the post-test than in the pre-test. The average scores of each students' pre-test and post-test results are different. This phenomenon indicates that there is an enhancement of students' skills in both classes.

The investigation outcome of Figure 2 displays the difference between the experiment class and the control class. The N-gain calculation result in the experiment class displays three sub-indicators with a high category, two sub-indicators with a moderate category. Conversely, in the control class, all five sub-indicators are in the moderate category. The data indicate that the critical thinking skill of students in both classes increases. The five sub-indicators

show that the average score of students' post-tests in the experiment class is 81 and in the control class is 71.

The N-Gain result of the experiment class reaches 0.68 in the "moderate" category. The outcome was collected from the analysis of the students' pre-test and post-test scores. The use of the WhatsApp-assisted group investigation model affects students' skills in critical thinking. This is proven by improving students' scores, from 37 in the pre-test to 80 in the post-test. In the experiment class, each indicator will gain an average score of 0.74 in the high category. However, the control class acquires only 0.52 in their moderate category.

Moreover, every student will have different critical thinking skills. This could be impacted by several factors, such as students' physical and mental, a good classroom atmosphere for learning, and a suitable learning model. Pratama & Kartikawati [12] describe that students' critical thinking in a class that integrates WhatsApp in group investigation is higher than students in the control class. The experiment class has 0.30 N-Gain, which belongs to the medium category, and the control class only has 0.16 N-Gain categorized as low.

The average N-Gain of the five sub-indicators are:

- **Providing a simple explanation.** The N-Gain result of the sub-indicator of responding to an explanation or challenge is 1, which is considered as a high category. Nonetheless, the N-Gain of the control class is 0.59, which also consider a high category. Students can differentiate between the air in the environment that is not contaminated and not contaminated during the learning process.
- **Building a basic skill.** The N-Gain result of the sub-indicator of considering the credibility of a source in the experiment class reaches 0.82 (high category). However, the N-Gain in the control class is only 0.45 (medium category). While learning, the students can consider the truth or precision of the data taken from various sources by presenting a justification on the given matter.
- **Giving a conclusion.** The sub-indicator of Inducting and considering the result of the induction in this research has obtained 0.76 (high category) N-Gain on the experiment class and 0.57 (medium category) N-Gain on the control class. Students utilize the information gained from various sources to create a precise conclusion in deciding to deal with waste management and the environment.
- **Providing further explanation.** The result for the sub-indicator of defining the term and considering it in the experiment class and control class is the medium category, in both. The result is only differentiated by 0,01. The N-Gain of the experiment class is 0.52 and in the control class is 0.51. Students study the collected information from books or the internet in the learning process, and then they discussed their findings with their group to describe the characteristic features of air pollution based on the clue or evidence that they found.

- **Establishing strategy and tactics.** The N-Gain of the sub-indicator of determining action in the experiment class is 0.62 (medium category), and 0.50 (medium category) in the control class. Students discussed with their group to solve a problem and established a proper way to handle organic waste and factory waste.

The average N-Gain of the sub-indicators in the experiment class' critical thinking is 0.74 (high category), and in the control class is 0.52 (medium category). Subsequently, students' skill in critical thinking is higher compared to students in the control class. This is because the group investigation model can train students' skills in critical thinking.

There is an investigation step on the group investigation learning model. In this step, students are required to analyze and create a conclusion in solving a teacher's problem. This step will help students become more active and think more in-depth in the learning process. In accordance, Abrami et al. [25] affirm that every step in the group investigation model will drive students to think critically. This is proven by the first indicator, which is providing a simple explanation with N-Gain 1 (high category). The other sub-indicators with a high N-Gain are building essential skills (N-Gain 0,82) and providing a conclusion (N-Gain 0,76), both considered high in the category. This indicator could increase because, in the learning process, students were given a discussion sheet. Inside the sheet, students were required to investigate different opinions made on the characteristic of polluted water. This is further explained by Slavin [26], which asserts that students' worksheets and discussion sheets can enhance students' critical thinking skills in problem-solving.

Students' critical thinking in control class also increases, with the N-Gain result of 0.53 (medium category). However, the N-Gain result is still lower than the experiment class that utilizes WhatsApp messenger in the group investigation model. Ku & Ho [27] explain that the lack of teaching variation will result in low critical thinking skills because students are less active in the learning process. Thaiposri and Wannapiroon [28] also explain that group investigation's cooperative model can develop critical thinking skills. The enhancement of N-Gain proves this from the pre-test to the post-test; 60% of the students are in the high category, 33% are in the medium category, and only 7% of students are in a low category. The class that does not utilize WhatsApp in the group investigation model does not have a high N-Gain category in any of the indicators because all the indicators are in the medium category. This is caused by a teacher who mostly gives the material. Thus, students become less active in sharing his or her opinion. Khalaf [29] describes that the teacher role in the conventional learning process is dominant; hence students are passive, and their skills to think critically are left untrained.

The influence of WhatsApp-assisted group investigation model on students critical thinking about environmental pollution

The result found that the WhatsApp-assisted group investigation learning model can positively and significantly impact students' critical thinking skills in learning about environmental pollution. This is in line with the outcome of research conducted by Pratama & Kartikawati [12] which found that the group investigation model that integrates WhatsApp as a learning aid can affect students' critical thinking skills. This learning model becomes successful because, in the learning process, students' engagement in the classroom was accentuated. The students were asked to actively participate in finding the learning material and connecting it to real-life situations to apply it in their daily lives. Moreover, Marhamah et al. [30] assert that the group investigation model's characteristics and steps can lead students to develop their whole ability or their ability in the learning process. The learning process with this model is student-centered and the teacher can make it optimal by acting as the facilitator and mediator. Howard et al. [31] state that the use of Group Investigation can increase students' critical thinking ability.

Based on research conducted by Akpan & Ezinne [32] found that WhatsApp's use in classroom activity has created a significant difference in students' retention skills. The research by Gillies [33] and Pransiska et al. [34] additionally found that the cooperative type of group investigation influenced the enhancement of students learning outcomes positively. Another research organized by Gultom [14] found that the group investigation model positively influenced students' activity and learning outcomes.

When learning takes place, students must discuss with their groups to solve problems; this can improve students' critical thinking skills. The group discussion will help students create an interaction with one another. Thus, they become more active within their group. Thaiposri & Wannapiroon [26] further explains the teacher can utilize the cooperative model of the group investigation to shape students' critical thinking skills, individually or in groups. Other than the factor of using the learning model, other contributing factors are influential in ensuring students' success in learning. According to Hart (2012) [35], there are two other factors, which are internal factors and external factors. The internal factors are those that exist within the individual while studying, including physical, psychological, and student learning activities [36]. In comparison, external factors come from outside the individual, namely family and the environment [37].

Students' response towards learning with and without WhatsApp-assisted group investigation model.

The response in all indicators in the experiment class is high in comparison to the control class (Table 6). Thus, it has been proven that most students in the experiment class have

responded to the learning activity positively. Student responses in using the WhatsApp-assisted Group Investigation model have a higher average score than the control class. This reveals that students in the experiment class have a more positive response to the learning process. Consequently, their critical thinking skill will increase. The higher the response, the greater students who enjoy learning in class. The average overall students' responses to the experiment class are 4.27 (high category) and the average students' responses in the control class are 4.13 (high category).

The explanation above shows that students enjoy learning using the WhatsApp-assisted group investigation model because it is student-centered. Students must find their information on topics that have been given by the teacher in each group so that it makes students more active. It also makes it easier for them to understand environmental pollution material compared to using conventional models. This shows that students give positive responses to the learning process. Based on other research show that mobile technology such as use WhatsApp can affect student attitudes, engagement, and learning (Heflin et al., 2017) [38]. The finding complies with Nilson's (2016) [39] research; they found that choosing the right learning model will lead to positive responses and raise students' activities in learning.

CONCLUSION

Based on the analysis that has been completed in this research, several conclusions can be made. 1) The implementation of teacher and student activities in learning with the WhatsApp-assisted Group Investigation model is in a very good category, while the implementation of teacher activities without using the WhatsApp-assisted Group Investigation model is in a very good category and student activity without using the WhatsApp-assisted Group Investigation model is in a good category. 2) Students' critical thinking skills with and without the WhatsApp-assisted Group Investigation model have a moderate N-Gain. 3) WhatsApp-assisted Group Investigation Model on environmental pollution material positively affects students' critical thinking skills. 4) Student responses to the learning process with and without using the WhatsApp-assisted Group Investigation model have a high category.

Based on the findings, discussion, and conclusions that have been stated, several suggestions are made. 1) For researchers and teachers who will use the WhatsApp-assisted Group Investigation model, there needs to be tighter supervision on the use of cell phones during the learning process. 2) For researchers and teachers who will use the WhatsApp-assisted Group Investigation model, the teacher must consider the time allocation before learning begins. Hence, it will be easier for teachers to deliver the material as a whole.

ACKNOWLEDGMENT

We thank all colleagues who encouraged us to publish. We also thank those anonymous reviewers for feedback on to improve the paper before publication.

CONFLICT OF INTEREST

We confirm that this work is original and has not been published elsewhere, nor is it currently under consideration for publication elsewhere. And we declare that we have no conflict of interest to disclose.

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