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IMPLEMENTATION OF COOPERATIVE LEARNING INDEX CARD MATCH ON SECONDARY STUDENTS' SCIENCE COGNITIVE LEARNING OUTCOMES

Andini Dwi Yulivia[1], Monica Prima Sari[2]
[1,2]Science Education Department, Universitas Negeri Padang, Indonesia

Abstract

Science learning is often associated with difficult topic to understand, lecture-dominated instructions, and low participation rate in classroom learning. Similar situation is observed at a secondary school in West Sumatra province, Indonesia. The observation also revealed that students' cognitive learning outcomes is still under the minimum passing criteria for the topic of the earth's layer. To the citizen of an area that is in high-risk of natural disaster occurrence, sound understanding on the topic is crucial. Since science lesson is designed to develop students' thinking and problem-solving ability, such understanding is important regarding students' survival rate. If this situation remains unaddressed, it is concerning that achieving the goals of science lesson, especially related to the topic of Earth's layer, will be constrained. Therefore, this study offers a solution by implementing the Cooperative Learning Index Card Match (CL-ICM) to see its impact on students' cognitive learning outcomes. This quasi-experimental research used non-equivalent control group design andh purposive sampling technique to select 67 seventh graders from two classes as experiment and control group. A set of 20 multiple-choice questions was validated and tested for reliability as research instruments to measure students' learning outcomes. Data was then analyzed with parametric statistics technique followed by hypothesis testing using independent sample t-test. The result of data analysis gave the sig. of 0.091, which led us to decide that the null hypothesis is accepted and research hypothesis (Ha) is rejected. Therefore, it can be summarized that the implementation of CL-ICM does not give significant impact on students' cognitive learning outcomes on the topic of the earth's layer.

Keywords: Index Card Match, Cooperative Learning, Science Learning, Secondary School, Learning Outcomes

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[1]**Correspondence Address:**
Science Education Department,
Universitas Negeri Padang, Indonesia
E-mail: primasarimonica@fmipa.unp.ac.id

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INTRODUCTION

Education is an activity that is carried out consciously and planned as the realization of active learning activities, so that students can develop their potential (Decree No. 20 on National System of Education, 2003). The importance of education in addressing the concerns of the day cannot be overstated. Burhanudin and Imran (2003) revealed that education system should be adjusted based on the advances in technology development and information system. In this 21st century, there are numerous changes that inevitably contribute to the increasing demand on what quality young generations should acquire. Wagner (Wagner, 2010) suggested that there are seven ability that 21st century civilization must possess, namely (1) critical thinking, (2) collaboration, (3) adaptability, (4) entrepreneurial spirit, (5) have curiosity, (6) able to analyse information, and (7) able to communicate orally. In fact, the tight challenges faced by society require a change in the paradigm of life, especially in the education system that can provide a set of 21st century skills. Therefore, learning reform is needed to implement 21st century education. The implementation of Kurikulum 2013 as national curriculum is one of the efforts that the government can implement in facing the challenges of the 21st century.

Indonesia's national curriculum, named Kurikulum 2013 (abbreviated K-2013), promotes student-centered learning (Mulyasa, 2009) which is considered ideal to achieve the goal of national education (Rahim et al., 2019). K-2013 expect students to be active in learning in the process of managing, building and applying their own knowledge in understanding surrounding natural phenomena and solving daily life problems (Santoso, 2017). K-2013 suggested the use of scientific approach in which consist of 5 activities, namely: observing, questioning, doing experiment, analyzing and building network (Purwanti, 2014). This scientific approach is believed to be an effective way to develop students' scientific attitudes, skills and knowledge systematically according to scientific methods (Susanti et al., 2019).

The real situation of science learning in Indonesia is yet to match the expectation stated in the national curriculum. Based on observations at SMPN 4 Payakumbuh, the so-called K-2103 based science learning based is still yet to be at the best state of implementation. Students' cognitive learning outcomes still fall under the minimum passing criteria (a.k.a. KKM), which was decided on 75 points. Table 1 below show the End-of-term assessment result at SMP N 4 Payakumbuh. The average score is 52.86, which is approximately 20 points below the minimum passing criteria (KKM) which is decided at 72. Among all students from four classes, 40.35% students managed to surpass the minimum passing criteria (a.k.a KKM in Bahasa), meanwhile the remaining 59.62% students have to work harder to understand the topic.

With more than half students fail to achieve the targeted score in the assessment, there is obviously an urgency to put in extra effort to facilitate students' better learning. Another issue that we found during observation is that students' participation in classroom activities were still below expectations. It is understood that covid-19 outbreak could be one contributing factors behind students' reluctance in participating but this issue needs to be resolved. Fortunately, K2013 provide a wide opportunity for teachers to design their learning with various methods, strategy, or learning models to help students learning. The solution we proposed to help the situation at SMP Negeri 4 Payakumbuh is to use a model of cooperative learning. According to a study by Piter (Piter, 2020), Index Card Match as one of the type of Cooperative Learning model could improve students' participations and eventually students' cognitive outcomes.

One of the factors that causes student of outcomes learning to increase is because students feel challenged in solving existing problems so that students are able to complete the given learning and learning with CL-ICM is more attractive and fun to students with the concept of playing while learning (Surya et al., 2022). This is supported by studies that found one of the advantages of CL-ICM is that students become more courageous to answer questions from the teacher because they feel challenged to answer questions from teachers (Hanim, 2017; Zaini, 2008). This study was supported by previous researchers by Piter (2020) who proposed that CL-ICM had a positive effect on improving students' biology learning outcomes. CL-ICM has also been found to increase students' cognitive learning outcomes for science lesson (Amir et al., 2021; Fua et al., 2015; Harefa et al., 2021; Nasution et al., n.d.; Sari et al., 2019).

The Cooperative Learning Model Index Card Match (CL-ICM) has the characteristic in using cards as media of instruction and matching cards activities (question and answer cards) which is expected to enhance students participations in learning (Annisa & Marlina, 2019). The advantage of this method is the creation of a pleasant learning atmosphere and help increasing students' learning outcomes (Ariza, 2018; Yonanada, 2017), and improve students' motivation (Zahwa & Erwin, 2022). In Indonesia, CL-ICM has been studied to address learning issues related to monotonous learning and students' boredom (Sari et al., 2019), lack of science content mastery (Surya et al., 2022), and lack of learning activity (Usman & Yunus, 2020). In this study, CL-ICM is being implemented to address the same issues on the topic of Earth's Layer.

From the interview with science teachers, we found that students' understanding on the topic is still below expectations. One contributing factor is that there are unfamiliar terms and similar in this topic, such as Atmosphere, Lithosphere, Hydrosphere, and so forth. Therefore, students easily get confused and unable to use each term appropriately and accordingly. This provides background for this study, in which we wish to facilitate student learning through fun activity so that they could actively learning and building sound understanding.

METHOD

This quasi-experimental research used non-equivalent control group design as matrixed in Table 1. The population in this study was all seventh grades students of SMPN 4 Payakumbuh enrolled in 2021/2022 Academic year. Two classes as sample were selected through purposive sampling technique to be assigned as control and experiment group. The consideration in selecting sample group are the classes that are taught by the same teacher, use the same textbook, and have the same time table at school for science lesson (i.e., both classes study in the morning). From the total sample of 67 students, 32 students in grade VII.3 were assigned in the experimental group and 35 students in grade VII.2 were assigned in the control group. Based on the result of previous assessment, control group has higher average score than the experiment group. To assess students' learning outcomes in cognitive domain, a set of 20-multiple choice items were prepared and tested for validity, reliability, index of difficulty and discriminating power.

Table 1. Non-equivalent control group design

Sample group	Pre test	Treatment	Posttest
Experiment	O1	X	O2
Control	O3	-	O4

(Fraenkel & Wallen, 2008)

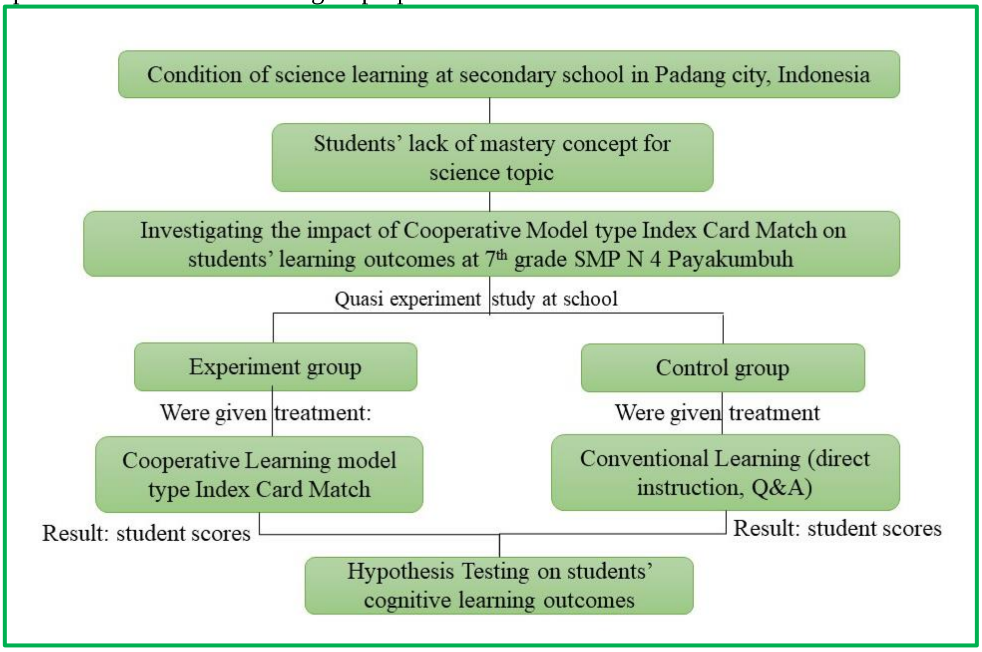

Figure 1. Conceptual framework of the study

RESULTS AND DISCUSSION

3.1. Cognitive Learning Outcomes from Pre-test and Post-test Scores

Students' cognitive learning outcomes were assessed through a set of multiple-choice items which was arranged to match learning indicators (Table 2). These learning indicators were derived from the basic competence 3.10 which states: *To explain the earth layer, earthquakes, and disaster risk-management before, during, and after disaster, according to the threat of disaster in the area*. From the basic competence, there are several disasters to be discussed in learning, namely: earthquake, volcano eruption, and flooding. To the citizen of West Sumatra province, there is a high possibility of occurrence for each disaster due to geographic condition. Therefore, the indicators were designed to measure students' understanding on the essential concept of earth layer, each disaster, and the disaster-risk management for each disaster. As can be seen in Table 2, each indicator is represented with more than one questions and set to assess different level of cognitive process.

Table 2. Instrument to assess students' cognitive learning outcomes

Indicators	Cognitive Level	Number of questions
1. To explain the characteristic of earth's layer	C1, C2	3
2. To explain the characteristic of the atmosphere	C2, C4	4
3. To explain the characteristic of the lithosphere	C2, C4	3
4. To explain the characteristics of earthquakes and relevant disaster management	C3, C4	4
5. To explain the characteristic of volcanos and relevant disaster management.	C1, C3, C4	4
6. To explain the characteristic of hydrosphere and relevant disaster management.	C2, C3	2
Total questions		**20**

The descriptive statistics of students' learning outcomes can be seen in Table 3, which includes several variables, i.e maximum score, minimum score, mean, median, mode, standard deviation, variance, and range. This data serves as a benchmark for comparing the scores between the two classes. The average score of the pre-test and post-test scores for the control group is 52,07 and 79,65 respectively with a 27,60-point in gap. Meanwhile, in experiment group, the average pre-test and post-test scores were 43,89 and 82,04 with a 38,15-poin gap. This clearly indicate that with different learning model, in this case CL-ICM, the experiment group achieved higher score on posttest with a 10,56-point gap compared to the control group.

On pretest, both control and experiment group have the same maximum score of 70, while the minimum score for the control class is 30, ten point higher than the experimental group. This shows that the control class is slightly superior. On posttest, both groups also achieve the same maximum score on 100, however the minimum score of experiment group in 60, 15 point higher than the control group. This shows that the range score for the experimental group is greater than the control group. This is also supported based on the average test results of the two classes.

In control group, the average of the pre-test and post-test scores is 52,06 and 79,65 respectively, with a 27,59-point gap. Meanwhile, in experiment group, the average pre-test and post-test scores were 43,88 and 82,03 respectively, with a 38,15-point gap. This clearly indicate that with the implementation of CL-ICM, the experiment group achieve higher score, with a 10,56-point gap compared to the control group.

Table 3. Data of pre-test scores

Data	Pre-test score		Post test score	
	Control group	**Experiment group**	**Control group**	**Experiment group**
Number of Students	29	27	29	27
Maximum score	70	70	100	100
Minimum score	30	20	45	60
Mean	52,06	43,88	79,65	82,03
Median	50	45	85	85
Mode	55	45	95	85
Std. Deviation	10,89	12.95	16,84	12,95
Variance	118,8	167,9	283,8	167,8
Range	40	50	55	40

3.1.1 *Analysis of post-test results on learning indicators*

Students' responses to each problem in posttest were tabulated and grouped based on learning indicators to see how the implementation of CL-ICM affect students' learning outcomes. Throughout the six indicators, the experiment group score constantly yet slightly higher than control group. (Figure 2). The score for each indicator differs within the range of 1 up to 5 points.

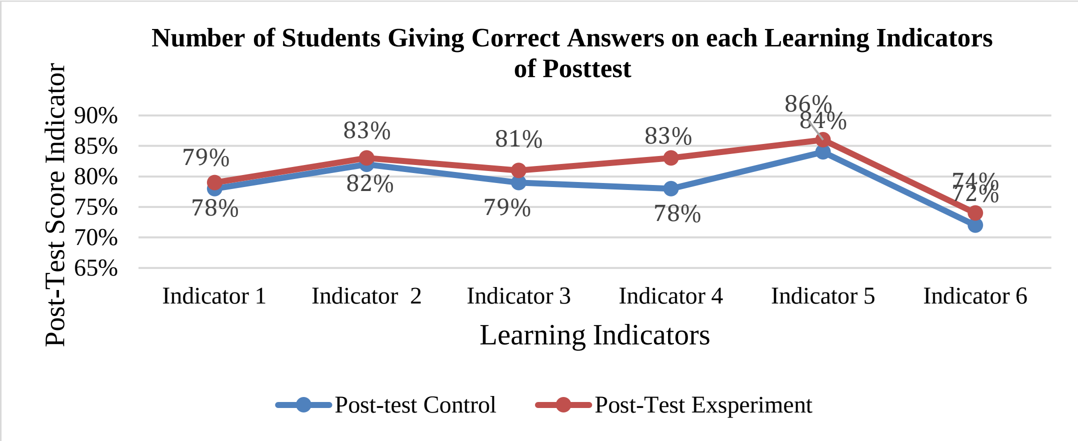

Figure 2. Percentage of students' correct answers for each learning indicators in post test

We analyzed further into the difference of student's learning outcomes in experiment and control group by calculating the percentage of correct answers per learning indicators. The trend shown in Table 2 is that experiment group score higher than control group in all indicators. The highest gap was found for the sixth indicator which is about the characteristics of the hydrosphere, 83% students manage to answer correctly compared to 78% in control group. The smallest gap is found for the first indicator, where experiment group only 1% higher than control group in explaining the characteristics of earth's layer.

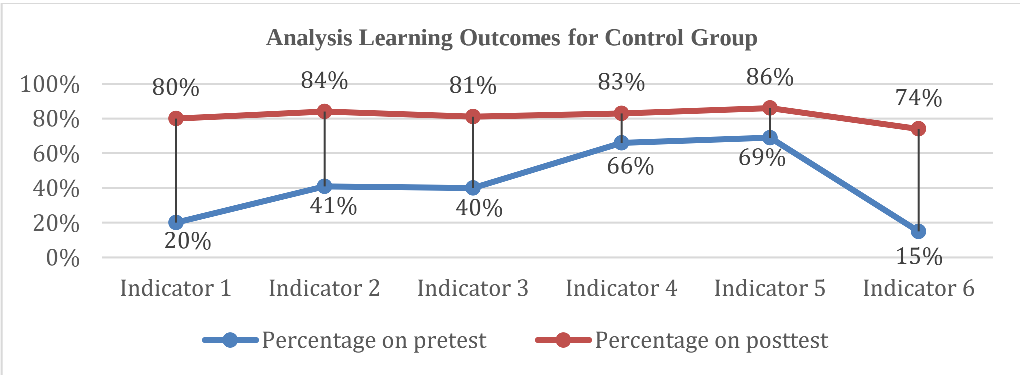

Figure 3. Analysis of control group's learning outcomes.

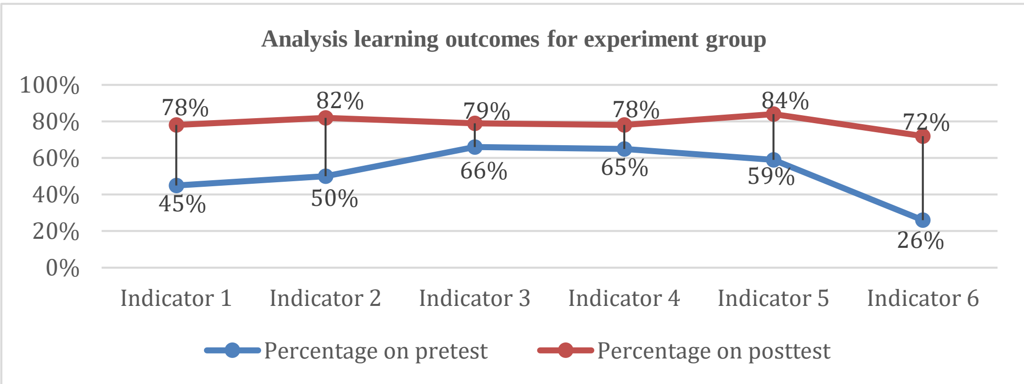

Figure 4. Analysis of experiment group's learning outcomes.

We look deeper into students' learning outcomes in each group by comparing the average score for pretest and posttest for each indicator. In control group (Fig.3), the highest gap between pretest and posttest are for indicator 1 (60%) and indicator 6 (59%) respectively. These gaps indicates that prior to the learning process, students had little knowledge on the characteristic of earth's layer (indicator 1) and the characteristic of hydrosphere (indicator 6). The other two highest gaps are for indicator 2 (43%) and indicator 3 (41%). These big gaps also indicate that students had little knowledge on the characteristic of atmosphere (indicator 2) and lithosphere (indicator 3). The smallest gaps are found for indicator 4 (17%) and 5 (17%) which could indicate that students had already have some knowledge about earthquakes and volcanic eruption prior to the learning process.

For the experiment group, the gaps are not as high as that of the control group. The highest gaps are found for indicator 6 (46%) regarding the concept of hydrosphere and relevant disaster-risk management. Other two indicators with high gaps are indicator 2 (32%) about atmosphere and indicator 5 (25%) about volcano. Meanwhile, the gaps which indicate students may have some knowledge prior to learning process are indicator 3 (13%) about lithosphere and indicator 4 (13%) about earthquakes.

One of the explanations regarding the gaps between pretest and posttest score is related to students' responses to pretest. During pretest administration, some students did not provide any answer to the questions that they think difficult. Therefore, the gaps do not necessarily indicate that students have no knowledge to answer the questions. To figure out students' reason behind providing or not providing answers, future research on this topic could administer in depth interview.

One interesting finding from this analysis is that the gap for indicator 4 is relatively small if not the smallest in both classes. This indicator assesses students' understanding about the type of earthquakes and its' mitigation plan. The small gap could indicate that students already understand the concept of earthquake and its mitigation before studying the topic in the class. It is a relieve to find that students at high-potential earthquake occurrence like West Sumatra province, already possess the required basic knowledge.

To ensure whether the different between experiment and control group is solely due to the implementation of CL-ICM, we conducted hypothesis testing followed by N-gain calculation. The result is as follows.

3.1.2 *Hypothesis Testing*

To see whether there was an impact on students' cognitive learning outcomes, the data of pre-test and post-test were analysed with normality test and homogeneity test prior to hypothesis testing (t-test). The statistical data is tested using SPSS version 25. Normality was tested with Liliefors test at a significant level of = 0.05 (Table 4). Homogeneity is tested with to figure out the similarity of variance between the two set of data (Table 5).

Normal distribution is declared when the significant value is higher than 0,05. Table 4 shows that three sets of data, other than the pre-test of experiment group, are not normally distributed. Despite the result of normality test, homogeneity test of all four sets of data gives homogeneous variance (Table 5). Both experiment and control group give significant value 0.370 and 0.373 respectively which are higher than 0.05. Since the data are not normality distributed, the hypothesis testing is done by nonparametric statistics using Man-Whitney U test on students' score from pre-test and post-test. The criteria of testing the hypothesis is: reject the null hypothesis if the significant value is lower than or exactly the same with significant value of 0.05. The result gave significant value 0.091, which is higher than 0.05 and lead to the conclusion that the null hypothesis is accepted. This result confirms the data in which control group's post-test scores are not too far different than that of the experiment group. All things considered, the implementation of CL-ICM help experiment group to score higher than control group during post-test, but not significant enough to claim that the difference is caused by the implementation of CL-ICM.

Table 4. Normality test results

Test Score of Sample group	Sig.value	Interpretation
Pre-Test of Experiment Group	0.200	Normally distributed
Post-Test of Experiment Group	0.007	Not Normally distributed
Pre-Test Control Group	0.019	Not Normally distributed
Post-Test Control Group	0.021	Not Normally distributed

Table 5. Homogeneity test result

Test Scores of Sampel group	Sig. Value	Interpretation
Pre-Test of Experiment group	0.370	Homogeneous
Pre-Test of Control group		
Post-Test of Experiment group	0.373	Homogenous
Post-Test of Control group		

Table 6. Results of hypothesis testing

Sample Group	Sig. Value	Conclusion
Experiment group	0,091	H_0 is rejected and H_a is Accepted
Control group		

Despite the small gap of cognitive learning outcome between experiment and control group, hypothesis testing does not support the claim that it is caused by the implementation of CL-ICM. Thus, this This finding is not in line with other studies that CL-ICM could improve student outcomes of learning (Piter, 2020; Rahmawati & Dadi, 2019; Sularsih & Muammar, 2020; Usman & Yunus, 2020).

As stated earlier, the average posttest score for control group was slightly lower than the experimental class, which is 79.65 and 82.03 respectively. The control group learned with conventional model with lecture and Q-&-A methods. Our findings regarding control group fall in line with the findings from (Harefa et al., 2021; Nasution et al., n.d.) and Ahmadi (2011) which explain that learning process in control group as a learning that relies mostly on rote memorization, the selection of information is more determined by the teacher, the learning time of students is mostly used to do assignments, listen to lectures and fill out exercises, students do not do something bad for fear of being punished, and students passively receive information. In this study, for the topic of earth's layer, conventional learning was proven to be quite effective to help students memorize essential terms, concept, and information.

On the other hand, the implementation of CL-ICM did not really live up to our expectation. CL-ICM did help experiment group to score higher but not significant enough. The CL-ICM consists of six stages, which begins with giving an appreciation in the form of questions to students, as an introduction so that students can get an idea of what material they will learn. After being given apperception, students are given motivation in the form of the benefits of studying the material. Even though these two stages are common based on K-2013 learning process, for CL-ICM implementation, studies have found that this model could improve students' motivation to learn. The questions put in the cards serve as challenges to the students (Harefa et al., 2021), so that they feel the urge to find the answer through the next syntax.

Furthermore, the teacher will deliver the material to be studied and students pay attention to what their teacher is saying. This syntax of CL-ICM has been found to improve students' awareness to teachers' instructions and more responsive to teachers' questions (Amir et al., 2021).

In the second syntax, students were divided into two groups, namely the group for question and the group for answer. After that each student will get a piece of paper questions and answers and then students are required to find a partner in the allotted time. This syntax has been found to allow students to work together with their partner, and provide more opportunities to express their opinions and give feedbacks (Amir et al., 2021). In our study, we did observe students in experiment group more enthusiast and participate more during the lesson compared to control group. The activity of finding the match allows students in experiment group to interact and communicate more among themselves.

On the next syntax, teacher and students evaluate the answers that have been matched. There is a significant increase of students' learning outcomes after the implementation of CL-ICM. This can be seen from the Pre-Test and Post-Test scores which have increased from 43.88 to 82.03. Supiyandi and Julung (2016) stated that when students become the center of learning, they will be able to increase their cognitive abilities thus affecting their cognitive test scores. Studies also suggest that the increase of learning outcomes are induced by the increase of students activities during classroom learning (Nasution et al., n.d.; Usman & Yunus, 2020).

Regarding the result of hypothesis testing, we would like to recommend an extended period to implement CL-ICM at school, with several topic covered to allow students to consume the learning experience, follow the pattern, and gain the benefit from the treatment. We believe there are two possibilities behind our findings. Firstly, the characteristics of the content of earth's layer may not emphasize the need for learning cooperatively. Since most concepts in this topic requires students to memorize terms and definition, which will work best with individual learning (Battino, 1992). Secondly, this study was conducted within the period of 4 weeks, including pre-test and post-test without any habituation. Therefore, it is possible that students in experiment group were not fully adapted to the learning syntax. Therefore, we recommend next study to conduct habitation period to help students getting used to the syntax and gain benefit from CL-ICM.

CONCLUSION AND SUGGESTION

Conclusion

The findings of this study lead to the conclusion that the implementation of Cl-ICM did not significantly improves students' cognitive learning outcomes on the topic of earth's layer. Experiment group achieve higher average score on the post-test However, hypothesis testing does not support to claim that the increase is due to the implementation of CL-ICM alone. CL-ICM seemed to enhance students' awareness to teachers' instruction participation during learning and eventually understanding on the topic. As the implication of this study, CL-ICM could serve as an alternative for teachers in designing learning activities when the students are not so active.

Suggestion

Based on our findings, we would like to recommend CL-ICM implementation when the topic contains a lot of terms that requires memorization before comprehension. When students are involved in classical learning activities, they are more likely to memorize what they have learned. However, when it comes to higher thinking process such as analysis or higher, students need to be provided with more times to elaborate their thinking either through individual task or group work.

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