Does Remap GI-based Flipped Classroom Enhance Students Generic Science Skills?

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Abstract. The importance of generic science skills has rapidly expanded in senior high school. The research regarding how students enhance these skills or how they should be taught still needs to be discovered. This study aimed to investigate the effectiveness of the Reading Concept Mapping-Group Investigation (Remap-GI)-based flipped classroom in enhancing students' generic science skills. We conducted a quasi-experiment that employed a nonequivalent pretest-posttest control group design. The study participants were sixty students from twelfth grade in the Natural Science Program in one of the High Schools, Malang. The experimental class used the Remap-GI-based flipped classroom, while the control class used the GI-based flipped classroom. Generic science skills were assessed using an assessment rubric. The data were analyzed using one-way ANCOVA analysis. Our results showed that the high school students generic science skills increased in all two classes, but the Remap GI-based flipped classroom group experienced the most significant increase. Specifically, the increasing generic science skills in Remap-GI-based flipped classrooms showed a significant difference in each indicator. Those indicators are direct observation, awareness of scale, logical inference, and mathematical modeling. These findings concluded that the Remap-GI-based flipped classroom could be the alternative learning model to enhance generic science skills for senior high school students

Keywords: Reading-Concept Mapping – Group Investigation, Flipped Classroom, Generic Science Skills, Quasi-Experimental, COVID-19.

1 Introduction

Education must facilitate the development of student in 21st-century skills. Therefore, it is necessary to make efforts to improve the quality of education. The best way to enhance education quality is to use strategies that can accommodate knowledge and skills to effectively address problems during a pandemic, such as online learning [2]. Online learning strategies rely on technology [3], [4]. Then, one of the science skills that the students should improve is generic science skills.

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Generic science is a fundamental skill that encourages the quality of 21st-century skills in students, especially during a pandemic. Generic skills can accommodate science lessons, which include theoretical and practical learning. Indicators of generic science skills can assist students in making decisions to solve problems [5], [6]. Decision-making requires scientific reasoning and multidisciplinary abilities in science learning [5]. Generic science is often applied to high school students, but a few still need to learn how to improve it.

Generic science can be an alternative to improving students scientific attitudes [7], and optimizing active attitudes, such as cooperating and communicating. Generic science skills provide opportunities for improving the quality of performance [8]–[10] of students during online learning. However, online education is still insufficient to empower students knowledge and skills during a pandemic. Because of that, learning strategies need renewal, such as blended learning (BL) [11], [12]. BL learning combines face-to-face learning inside and outside the class by introducing computer-based, distance, or mobile learning [13], [14]. One of the BL learning processes is learning with a flipped classroom (FC) [12], [15]. In addition, the learning model used in schools is still less effective in applying students generic science skills.

Innovative learning models must be applied to encourage students generic science skills, especially in generating new ideas. Generic science skills can be trained using flexible learning methods. Multi-directional interaction and communication in cooperative learning [6] allows the exchange of information to improve students generic science processes. Broadening of horizons can occur from listening to much information and opinions. One of the studies stated that students need to improve in cooperating and deciding arguments that consider the logic of each student [16].

Remap-Coople is a learning model that can empower students to encourage generic science. Remap-Coople facilitates students reading as the first activity [17]–[20]. Students can obtain much information about instructional content from reading activities. Then the second activity of Remap-Coople is the concept mapping activity [20]. Concept mapping activity allows students to present the discussion results from the information they have read.

Cooperative learning can facilitate each group's responsibility for the learning process of all team members. Group members are expected to participate in organized learning and report discussions in groups. There were several combinations of Remap and Coople learning, such as Remap-STAD [21], [22], Remap-NHT [23], [24], and Remap-GI, that have proven to improve students knowledge and skills [25]. In addition, one of the high schools provided information that class twelve biology lessons had yet to carry out practical activities.

Several high schools in Malang found it challenging to conduct online practicum during the pandemic. This difficulty made biology learning seem only in theory. An alternative solution to this problem is to apply a learning model that can rely on technology [26] and encourage increased student performance assessments such as generic science skills [27], reading, concept mapping, and combinations with GI (Group Investigation) [28].

Combining Remap-GI with flipped classrooms can encourage students to work with their peers. Thus, students can significantly improve generic science skills to promote the optimization of 21st-century skills. The GI learning model consists of five groups: forming groups, identifying topics, planning investigations, carrying out investigations, preparing final reports, presenting final reports, and evaluating. Applying the Remap-GI-based flipped classroom learning model can provide different but interrelated information and ideas [29]. Therefore, the Remap-GI-based flipped classroom can facilitate students in forming a concept, enabling them to broaden their knowledge horizons further to decide and solve problems.

Group discussion activities can facilitate meaningful learning experiences during a pandemic, from online to blended learning [30]. Applying the Remap-GI-based flipped classrooms was expected to enhance students basic skills, such as generic science skills. During the pandemic, learning was carried out in full online, so theoretical activities and scientific practicum needed to be reviewed for their abilities. According to several studies, this study aimed to discover the potential of Remap-GI-based flipped classrooms in improving students generic science skills.

2 Research Method

2.1 Design

This research is a quasi-experimental type of research. The method of this study used a quasi-experimental science class in one of the high schools in Malang. The research design used a nonequivalent pre-test and post-test control group design. The learning model used in this research was a Remap-GI-based flipped classroom and a GI-based flipped classroom. Table 1 shows the different stages of the two learning models in the class experiment and control, and Table 2 shows the indicator of generic science skills.

Table 1. The Differences Learning Model in Class Experiment and Control

Learning Model	The stages of Learning
Remap-GI-based Flipped Classroom (Experiment Class)	1. Reading 2. Creating a concept map 3. Selecting topics 4. Planning cooperation 5. Implementing and investigating 6. Analyzing and synthesizing 7. Presenting the final report 8. Evaluating

Table 2. The indicator of generic science skills

Learning Activity	Sub-Indicator of Generic Science Skills
Theory	1. Describing the results of direct observation with the five senses (direct observation) 2. Predicting the size of an object without using measuring instruments (scale awareness) 3. Conveying arguments with logical thinking in understanding the problem (logical inference) 4. Explain the relationship between 2 or more variables for the ability to construct a frame of mind (logical framework) 5. Communicating the results of observations using pictures or modeling, such as making tables from the results of observational data (mathematical modeling)
Practicum	1. Describing the results of direct observation with the five senses (direct observation) 2. Describing the results of direct indirect observations with specific measuring instruments using the five senses (indirect observation) 3. Predicting the size of an object without using a measuring instrument (scale awareness) 4. Conveying arguments with logical thinking in understanding the problem (logical inference) 5. Explain the relationship between 2 or more variables for the ability to construct a frame of mind (logical framework) 6. Communicating the results of observations using pictures or modeling, such as making tables from the results of observational data (mathematical modeling)

2.2 Participants

In determining the respondents in this study, SMA Negeri 8 Malang was first selected as the research setting. The research population consisted of five classes in grade twelve. The sample was determined using a simple random sampling technique based on the one-way ANOVA equivalence test results. The experimental class involved 30 students who were taught using the Remap-GI-based flipped classroom, while the control class involved 30 students who were taught using the GI-based flipped classroom.

2.3 Data Collection

Data collection took place between August and October 2022. The instrument for collecting data on generic science skills was observation with an assessment rubric developed by Brostosiswoyo [31]. Then, the data was tested by ANCOVA through the SPSS program. We analyze the hypothesis by using normality, homogeneity, and one-way ANOVA.

3 Results and Discussion

3.1 Results

The results of statistical tests on the generic science skills variable were normally distributed, and the data were homogeneous. The Remap-GI-based flipped classroom learning model affects generic science skills in theoretical and practical activities. The results of the ANCOVA test analysis on generic science skills in theoretical activities and practicum activities are presented in Table 3.

Table 3. ANCOVA Test Results of Generic Skills Science in Theoretical Activity and Practicum Activity

Source	*Type III Sum of Squares*	*Df*	*Mean Square*	*F*	*Sig.*	*Partial Eta Squared*
Class Thesretical	2.070	1	2.070	1.226	.027	.021
Class Practicum	30.662	1	30.662	4.533	.038	.072

Table 3 shows significant differences in the generic science skills of the experiment and control classes in the student's theoretical activities [p = 0.027<0. 05]. Table 3 also shows significant differences in the generic science skills of the experimental and control classes in the student's practicum activities [p = 0.038<0. 05]. This means that the learning model influenced generic science skills. Specifically, the results show the increased average percentage in the Remap-GI- and GI-based flipped classrooms (see Fig. 1).

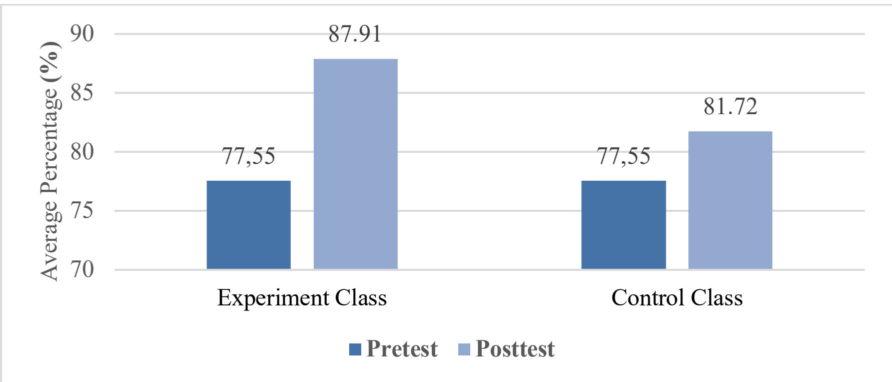

Fig. 1. The differences average percentage of generic skills science in theoretical activity

Figure 1 shows the graph of the average percentage increase of generic science skills in the experimental and control classes. Figure 1 indicated that the Remap-GI-based flipped classroom had a higher average (87.91) than the GI-based flipped classroom (81.72). The results show that Remap-GI-based flipped classroom biology learning can improve generic science skills in practicum activities. In addition, the average percentage of each indicator of generic science skills in practicum activities is shown in Figure 2 (see Fig. 2).

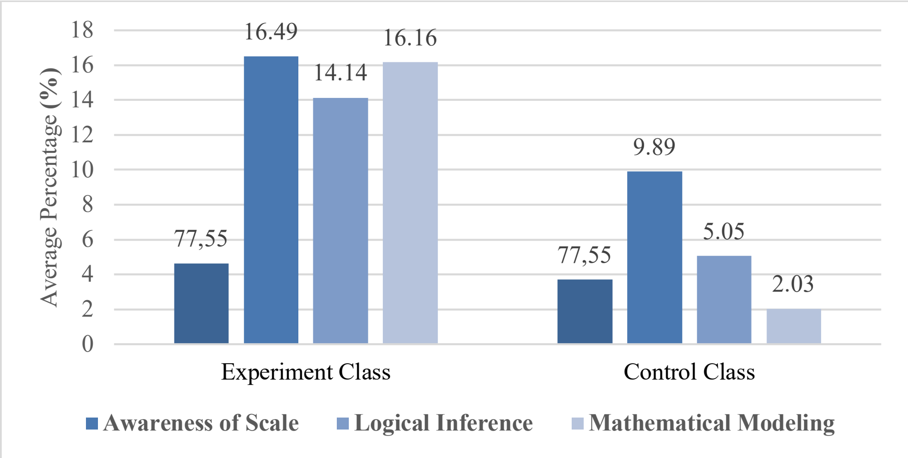

Fig. 2. The differences average percentage of generic skills science in practicum activity

Figure 2 shows a graph of the average percentage increase in practicum activity indicators in the experimental and control classes in the Remap-GI-based flip classroom. Increased practicum activity indicators in Remap-GI-based flipped classrooms, namely direct observation (4.64%), awareness of scale (16.49%), logical inference (14.14%), and mathematical modeling (16.16%). Meanwhile, there was an increase in indicators of practicum activity in GI-based flipped classrooms, namely direct observation (3.70%), awareness of scale (9.89%), logical inference (5.05%), and mathematical modeling (2.03%). The following is an example of a concept map in the Remap-GI-based flipped classroom material on heredity patterns presented in Figure 3.

Fig. 3. The example concept map of heredity pattern material

Figure 3 shows that the heredity patterns already have several elements in the concept map with excellent criteria, namely elements of the breadth of the net, use of descriptive links, layout, and good criteria, namely elements of embeddedness and interconnectedness, and efficient links. An example of a concept map in the Remap-GI-based flipped classroom cell division material by students is presented in Figure 4.

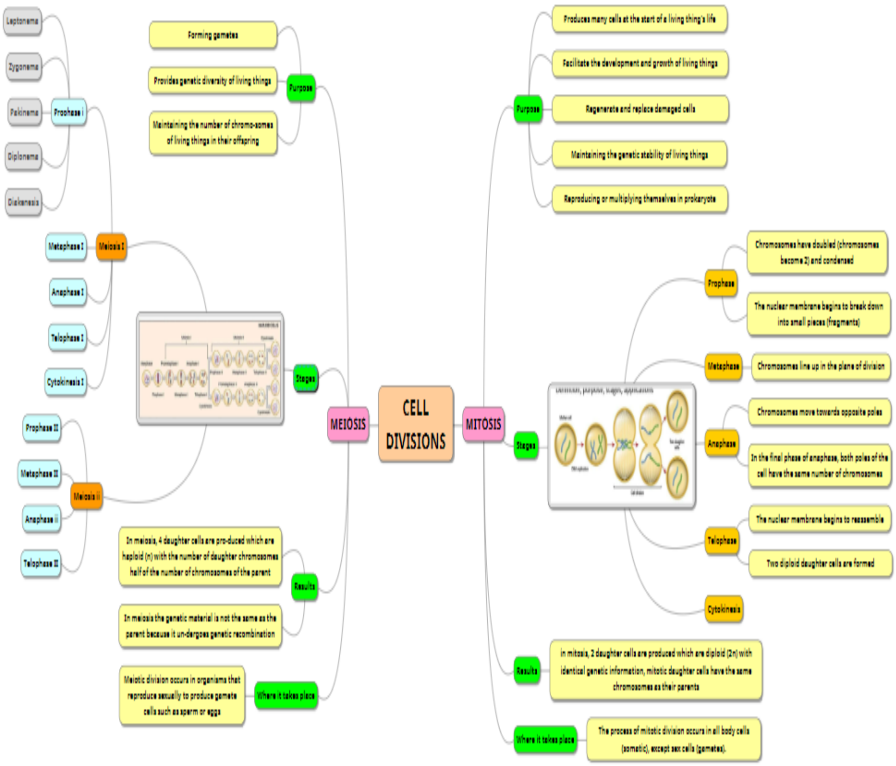

Fig. 4. The example concept map of cell division material

Figure 4 shows an example of a concept map in the Remap-GI-based flipped classroom material on cell division material that already has several elements in the concept map with excellent criteria, namely elements of the breadth of the net, use of descriptive links, and layout, as well as good criteria, namely elements of embeddedness and interconnectedness, and efficient connections.

3.2 Discussion

The results showed that Remap-GI-based flipped classrooms influence generic science skills. Generic science skills in this study apply theoretical and practical activities to biology subjects. Generic science skills include basic skills. The results proved that basic skills are still worthy of development as alternative skills because of their high flexibility [32]. The difference between the generic science skills in each sub-indicator in theoretical activities and practicum showed whether there was an indicator of indirect observation or not. The generic science skills indicators that have improved are direct observation, awareness of scale, logical inference, and mathematical modeling. The four indicators of generic science skills can encourage students to practice reading skills and structural information from direct observation through theoretical and practical activities.

In addition, indicators of awareness about scale and logical inference help students develop skills in observing and managing information in the form of words or sentences in the form of numbers through text or video. Obtaining information through direct observation, namely listening to informative learning videos [33], [34]. Mathematical modeling indicators can also help understand mathematics's dynamics within the scope of science [35]. This can empower information management logically to decide on a problem through student performance [36].

The results of statistical testing of generic science skills indicators in theoretical and practicum activities stated that there were significant influences in Remap-GI-based flipped classrooms. A learning model that can adapt to the needs and conditions of a pandemic. One learning model that can potentially empower students' skills is the stages of reading concept-mapping cooperative learning (Remap-Coople) from Zubaidah [17], [19]. The Remap-Coople learning model can empower students' skills, such as reading, concept mapping, and cooperative learning [37], [38].

The Remap-Coople learning model comes from a combination of Remap stages and cooperative learning one of the results of developing the Remap learning model with Group Investigation (GI). The Remap-GI learning model is an alternative for training students to work in groups [37], [38]. Research on the Remap learning model shows a high percentage of reading interest [18], [39]. The Remap-GI learning model based on flipped classrooms can be an alternative to improve and optimize biology learning after the COVID-19 pandemic. The first stage of a Remap-GI-based flipped classroom is reading.

Reading stages provide benefits such as gaining new knowledge, improving memory, training thinking skills, and gaining insight. According to Hayati et al.[28], students are required to have the ability to understand implied meanings, understand causal relationships between events and actions, and distinguish facts and opinions. Reading stages carried out before the start of learning time can make learning more efficient, and students have more time outside of learning hours. The reading stage from Remap can be an alternative learning innovation to improve basic science skills [40], [41].

In addition, the reading stages will assist students in finding keywords from a reading and summarize and arrange questions based on the reading text [42]. Reading materials in research are integrated with a flipped classroom using the Learning Management System (LMS). Reading material has been provided at least one week before the learning activities are carried out. The next learning activity was summarizing and making concept maps. Concept maps are an effective pedagogical tool to develop concepts, compare and contrast, improve factual recall, and have a deeper level of understanding through interlinking [43].

Concept maps are graphical tools that illustrate the relationship between concepts and other concepts arranged hierarchically. The application of concept mapping can increase its accessibility in the use of technology [44]. Students conduct reading activities to conclude information, then compile and make a structural concept map.

Concept maps help students better clarify concepts and integrate knowledge into chart form to learn, think, and understand concepts. Concept maps can be a means to understand the structure of knowledge when analyzing the learning level of flipped classrooms [45].

The concept mapping stage can facilitate students' creation of concept map elements used in the concept mapping stage, namely breadth of the net, embeddedness, interconnectedness, use of descriptive links, layout, and development over time [46]. Based on Figures 3 and 4 the results of making concept maps students already have indicators from Bhatia et al. [46] namely (1) breadth of net, the concept map has explained important domains at various levels which can be seen from the existence of components of cell division material, namely mitosis and meiosis (Figure 3) and material heredity patterns in Figure 4; (2) embeddedness and interconnectedness, all interrelated concepts can be seen from the relationship between the material components and the connecting lines between words and the connecting lines have a different color for each word point hierarchy in Figures 3 and 4; (3) use of descriptive links, the connecting words have used concise and accurate points in Figure 3 and 4; (4) layout, the concept map has a clear hierarchy of each word on cell division material and human heredity patterns in one page in Figures 3 and 4; and (6) development over time, students have shown the development of basic skills from reading texts to graphical forms, namely concept maps. Each criterion for making a concept map provides an innovative strategy for improving students' generic skills.

The results of the concept maps are collected in the form of images in the LMS. The potential for concept mapping to demonstrate more persistence and learning effort while engaging in meaningful learning that includes a type of relational reasoning [47] and as a tool for the assessment of knowledge structure and its measurability has grown [48]–[50]. In addition to knowledge, Remap-GI-based flipped classrooms influence students' performance processes toward generic science skills. The increase in the percentage of generic science concept indicators evidences this. At the same time, the percentage results of four out of six generic science skills indicators and the average increase in the percentage of generic science skills in practicum learning are more significant with the Remap-GI-based flipped classroom presented in Figures 1 and 2.

The stages of learning applied to the experimental and control classes are the GI stages in Table 1. The first stage was selecting topics provided by the teacher. Topics on cell division and heredity patterns were given to students randomly. The collaborative planning stage includes the acquisition of the topics for each group. However, each student must also have individual information and share the main tasks of tracing cell division material and heredity patterns. Furthermore, the stages of investigation carried out by students seek and collect information from reference sources or reading materials provided, followed by the stages of analysis and synthesis, namely discussing the information obtained by group members. Next, the group presented to get input, suggestions, and additions from other groups.

Overall, this study proved that the Remap-GI-based flipped classroom has significantly improved each indicator of generic science skills in theoretical and practical learning. Remap-GI-based flipped classrooms towards generic science skills can encourage progress in empowering 21st-century skills. Thus, Remap-GI-based flipped classrooms can improve generic science skills in high school because they have flexibility and are an alternative learning innovation during a pandemic.

4 Conclusion

Our research showed the influence of the Remap-GI-based flipped classroom learning model on increasing generic science skills in biology learning. Based on the findings of this study, Remap GI-based flipped classroom learning model can be proposed as a learning model that can improve generic science skills. The application of the learning model can be adapted to the subject matter of science, especially biology, which is taught to high school students because the sub-indicators are implemented optimally in theoretical and practicum activities. The Remap-GI-based flipped classroom learning model can be an alternative for increasing students generic science skills. However, the limitation of this study is that the application of the Remap-GI-based flipped classroom has been carried out only on two subjects of biology, namely cell division and heredity patterns for high school classes so other researchers can develop material on biology and other fields of science.

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