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# Remap-GI: A Learning Model to Enhance Students' Science Process Skills and Biology Cognitive Learning Outcomes

Ikramina Yusti Amina[1], Siti Zubaidah[2], Abdul Gofur[3], Azizul Ghofar Candra Wicaksono[4]
[1,2,3]Universitas Negeri Malang
[4]Doctoral School of Education, University of Szeged

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*Correspondence Address:*

Ikramina Yusti Amina
Universitas Negeri Malang
E-mail: ikramina.yusti.2103418@students.um.ac.id

**ABSTRACT**

**Abstract:** The purpose of this study is to investigate the effects of the Remap-GI (Reading, Concept-Mapping, Group Investigation) learning model on students' cognitive learning outcomes and Science Process Skills (SPS). The Biology class at SMA Negeri 8 Malang was used as the research sample for the quasi-experimental research design over the course of 60 students in the 12th grade. This study used the blended learning-based Remap-GI learning model opposed to the GI (Group Investigation) learning model. SPS data were collected using non-test data (observation) and cognitive learning outcome variables in the form of multiple-choice questions. The Ancova test was used to analyze cognitive learning outcome variable data and SPS. The findings revealed that the blended learning-based Remap-GI learning model had an impact on SPS and cognitive learning outcomes. The Remap-GI learning model is based on blended learning as a learning model that can be used to improve SPS and students' cognitive learning outcomes, especially after the outbreak of the COVID-19 pandemic.

The COVID-19 pandemic has affected all fields, including education in Indonesia (Amina & Susilo, 2022; Malahayati et al., 2021). One of the consequences is that offline learning processes are now conducted online (Sharma et al., 2022; Spunei et al., 2022). Both before and after the pandemic, more people are adopting online learning. Specifically, the adoption of learning through a pedagogical approach known as the learning process by blended learning (Gómez-García et al., 2020; Jiang et al., 2021). Blended Learning (BL) is the combination of face-to-face learning in the classroom with learning outside of the classroom using technology such as computer-based, distance, or mobile learning (Batista-Toledo & Gavilan, 2022; Christensen et al., 2013; Mahmoud Saleh et al., 2022; Platonova et al., 2022) One of the ways to learn with BL is through flipped classroom (FC) (Christensen et al., 2013; Gómez-García et al., 2020).

The flipped classroom is an innovative pedagogy that is based on BL and involves reversing traditional teaching methods through reverse activities with knowledge from the teacher to students, such as giving lectures or instructions outside of the classroom and engaging in active learning activities inside (Cevikbas & Kaiser, 2022). The findings of the study on BL learning combined with FC can help to improve online learning (Rahmani & Samira Zitouni, 2022). The COVID-19 pandemic poses a challenge to teachers and students who are fully ready for learning pembelajaran (Salakhova et al., 2022). In the field of science, for example, readiness to overcome obstacles still focuses on methods and ignores processes from scientific performance (Mahdy, 2020; Saputri & Pradana, 2021; Serdyukov, 2017). Science learning processes that employ scientific methods, attitudes, and knowledge, such as SPS, remain relatively low (Andini et al., 2018; Idris et al., 2022; Rusmini et al., 2021). SPS results in the acquisition of high-level, complex science learning skills (Athuman, 2022). Through SPS empowerment, science learning can present an ideal process.

According to the findings of Putri, *et al.* (2019), the highest SPS indicators are observing, classifying, and measuring, while the lowest indicator is making inferences. Other research findings from Husniyyah (2022) claimed that switching from offline to online learning can reduce SPS indicators such as formulating hypotheses, experimenting, identifying variables, and interpreting data. High school students are expected to improve their science process performance, particularly in decision making, by applying SPS to biology learning during the post-pandemic period. Biology learning can be held through blended learning with SPS, both theoretically and practically. Biology learning with SPS is expected to improve essential skills. Aside from skills, students must consider cognitive learning outcomes from technological assistance. This was influenced by the increased use of technology from the time of the COVID-19 pandemic until now. It is backed up by Ilma et al. (2020) that agreed that the relationship between student learning outcomes and SPS in the field of biology can be considered when integrating SPS into learning. Students' cognitive learning outcomes reflect the outcomes of the learning process.

Cognitive learning outcomes during a pandemic that use online learning must still divide the volume of learning material into several parts (Nurhadi, et al. 2022). Learning outcomes in cognitive biology in high school have decreased penurunan (Tuzzahra & Rahmat, 2022). Furthermore, the cognitive learning outcomes of fully online high school students have a classical KKM score of 60,4%, indicating that they still need to be improved (Sari et al., 2021). This calls for change, preferably in the form of a post-COVID-19 pandemic learning system with blended learning and a variety of learning models. Combining a blended learning system with a flipped classroom can increase the effectiveness and efficiency of the approach, enhancing both theoretical and practical skills (TAS, Erol, Guler, 2022). During the COVID-19 pandemic, students with blended learning achieved an average score of 85,50 (good) (Banila et al., 2021). Other studies' findings, such as Rizaldy et al. (2021) and Surahman & Surjono (2017), showed that cognitive learning outcomes in biology concepts have achieved KKM mastery scores, and Cahyono (2019) claimed that blended learning learning can increase student independence and cognitive learning outcomes in science. Improving cognitive learning outcomes necessitates a review of science learning process skills. Science learning implementation is also aided by appropriate learning models.

Innovation is required to improve and optimize biology learning in the aftermath of the COVID-19 pandemic. This causes educators to consider how to increase student motivation through a variety of learning models. Reading Concept-Mapping Cooperative Learning (Remap-Coople) syntax stages from Zubaidah (2018) can be used in learning models that can adapt to the needs and conditions of the COVID-19 pandemic. The Remap-Coople learning model has the potential to improve students' reading, concept mapping, and cooperative learning skills (Mahanal et al., 2016).

The Remap-Coople learning model is a blending of the Remap stages and cooperative learning. One of the outcomes of the REMAP learning model development with Group Investigation (GI). The Remap-GI learning model is a different approach to teaching students how to work in groups (Mahanal et al., 2016). According to research on the REMAP learning model, 74,68% of people are interested in reading (Zubaidah et al., 2018). Research findings from Nugraha, et al. (2016) showed that cooperative learning takes the form of structural assignments completed with group members. The stages of the Remap-GI syntax are expected to be an effort to improve learning quality following the COVID-19 pandemic by leveraging the benefits of Remap. It is also expected to have a positive impact on the meaning of learning through blended learning learning models.

The Remap-GI learning model, which is based on blended learning, is hoped to be used as a form of learning process effort in process skills and cognitive learning outcomes to be optimal during the post-COVID-19 pandemic. Because the GI learning model with a scientific approach can help with decision making keputusan (Suryani et al., 2020), it is included in the SPS outcome factors. The presence of innovation in biology learning can serve as a quality control for Indonesia's national education goals. Educational quality control of cognitive learning outcomes and skills must be balanced and interrelated seimbang (Annisa, *et al.*, 2017). Based on this explanation, the purpose of this study is to determine the impact of the blended learning-based Remap-GI learning model on students' science process skills and cognitive learning outcomes.

## METHODS

The quasi-experimental research design was applied to Biology subject in Class XII MIPA SMA Negeri 8 Malang class. A pretest-posttest nonequivalent control group design was utilized in the study. The research was conducted from August to October 2022. The research population consisted of all five Class XII students. The sample selection employed the simple random sampling technique based on the results of the One Way Anova equivalence test. The research sample for class XI MIPA 4 involved 30 students taught using the Remap-GI learning model model based on blended learning as an experimental class, and 30 students of Class XI MIPA 5 taught using the GI learning model as a control class. The SPS data collection instrument was observation and cognitive learning outcomes in the form of a 20-item multiple-choice test on cell division and heredity patterns with cognitive levels C3-C6. Data on cognitive learning outcomes were collected using the Ancova test and analyzed using the rubric by Mutlu (2020), which was then tested by Ancova. Normality and homogeneity tests were used to analyze data for hypothesis testing. The REMAP-GI and GI learning models were used in the learning activities, with the SPS as the dependent variable. Table 1 presents the SPS indicators in theoretical and practicum activities.

**Table 1. Indicators of Science Process Skills (SPS) Used in Research**

| Learning Activities | Sub Indicators of SPS |
|---|---|
| Theories | 1. Defining the problem precisely |
| | 2. Formulating a hypothesis |
| | 3. Collecting data |
| | 4. Organizing / managing data |
| | 5. Using scientific terms correctly in the stage of defining the problem |
| | 6. Using scientific terms correctly in the stage of formulating hypotheses |
| | 7. Using scientific terms correctly in the data collection stage |
| | 8. Using scientific terms correctly in the stage of interpreting the results |

| | |
|---|---|
| Practicums | 1. Defining the problem precisely<br>2. Formulating a hypothesis<br>3. Achievement of designing experiments<br>4. Trial achievement<br>5. Collecting data<br>6. Organizing / managing data<br>7. Using scientific terms correctly in the stage of defining the problem<br>8. Using scientific terms correctly in the stage of formulating a hypothesis<br>9. Using scientific terms correctly in the data collection stage<br>10. Using scientific terms correctly in the stage of interpreting the results |

Source : Mutlu (2020)

The research learning model employed Remap-GI in conjunction with GI. The Remap-GI syntax was derived from Remap-Coople developed by Zubaidah (2014), as shown in table 2.

**Table 2. Learning Models in Research**

| **Learning Models** | **Learning Stages** |
|---|---|
| Remap-GI (Experimental Class) | 1. Reading<br>2. Creating a concept map<br>3. Selecting topics<br>4. Planning cooperation<br>5. Implementation/ investigation<br>6. Analysis and synthesis<br>7. Presenting the final report<br>8. Learning evaluation |
| GI (Control Class) | 1. Selecting topics<br>2. Planning cooperation<br>3. Implementation/investigation<br>4. Analysis and synthesis<br>5. Presenting the final report<br>6. Learning evaluation |

Source: Zubaidah (2014)

## RESULTS

The results of statistical tests with SPSS on the SPS variable and cognitive learning outcomes were normally distributed, and the data was homogeneous. The Remap-GI and GI learning models for science process skills (SPS) combined theoretical and practical activities. Table 3 shows the results of the Ancova test analysis on SPS theoretical activities, and Table 4 depicts the findings of the practicum activities.

**Table 3. Science Process Skills Ancova Test Results (SPS) in Theory Activity**

| ***Source*** | ***Type III Sum of Squares*** | ***df*** | ***Mean Square*** | ***F*** | ***Sig.*** | ***Partial Eta Squared*** |
|---|---|---|---|---|---|---|
| Class | 72.719 | 1 | 72.719 | 10.487 | .002 | .151 |
| Error | 409.127 | 59 | 6.934 | | | |
| Total | 55913.514 | 62 | | | | |
| Corrected Total | 579.338 | 61 | | | | |

**Table 4. Science Process Skills Ancova Test Results (SPS) in Practicum Activities**

| ***Source*** | ***Type III Sum of Squares*** | ***df*** | ***Mean Square*** | ***F*** | ***Sig.*** | ***Partial Eta Squared*** |
|---|---|---|---|---|---|---|
| Class | 250.906 | 1 | 250.906 | 17.606 | .000 | .230 |
| Error | 840.818 | 59 | 14.251 | | | |
| Total | 90252.624 | 62 | | | | |
| Corrected Total | 1641.863 | 61 | | | | |

The Ancova test results revealed a significant difference between the SPS experimental and control classes in students' theoretical activities [p = 0.002] in Table 3 and students' practicum activities [p = 0.000] in Table 4. Thus, the significance level was <0.05, indicating that the research hypothesis, namely that there is an influence of the learning model on SPS, was accepted. Table 5 displays the results of the Ancova test analysis on cognitive learning outcomes.

**Table 5. Ancova Test Results on Cognitive Learning Outcomes**

| *Source* | *Type III Sum of Squares* | *df* | *Mean Square* | *F* | *Sig.* | *Partial Eta Squared* |
|---|---|---|---|---|---|---|
| Class | 825.007 | 1 | 825.007 | 15.492 | .000 | .208 |
| Error | 3142.006 | 59 | 53.254 | | | |
| Total | 396224.000 | 62 | | | | |
| Corrected Total | 6115.548 | 61 | | | | |

The Ancova test results in Table 5 show that there is a significant effect on cognitive learning outcomes in the experimental class at a significance level of 0.000 < 0.05, indicating that the research hypothesis that the learning model influences cognitive learning outcomes was accepted. Figure 1 depicts the average cognitive learning outcomes of the entrance test (pretest) and posttest (posttest) in the experimental and control classes.

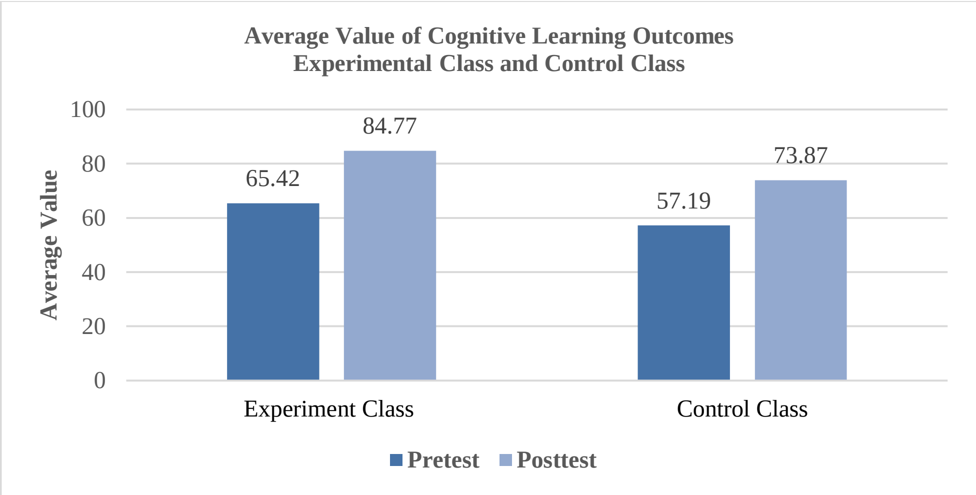


**Figure 1. Graph of Average Cognitive Learning Outcomes in Experiment Class and Control Class**

According to Figure 1, the average value of cognitive learning outcomes in the experimental and control groups is 84,77 for the Remap-GI learning model based on blended learning, and 73,87 for the GI learning model. This demonstrates that blended learning-based Remap-GI biology learning can improve cognitive learning outcomes. Figure 2 depicts a screenshot of blended learning-based learning activities at the reading and concept-mapping stages of the Remap-GI learning model in Google Classroom.

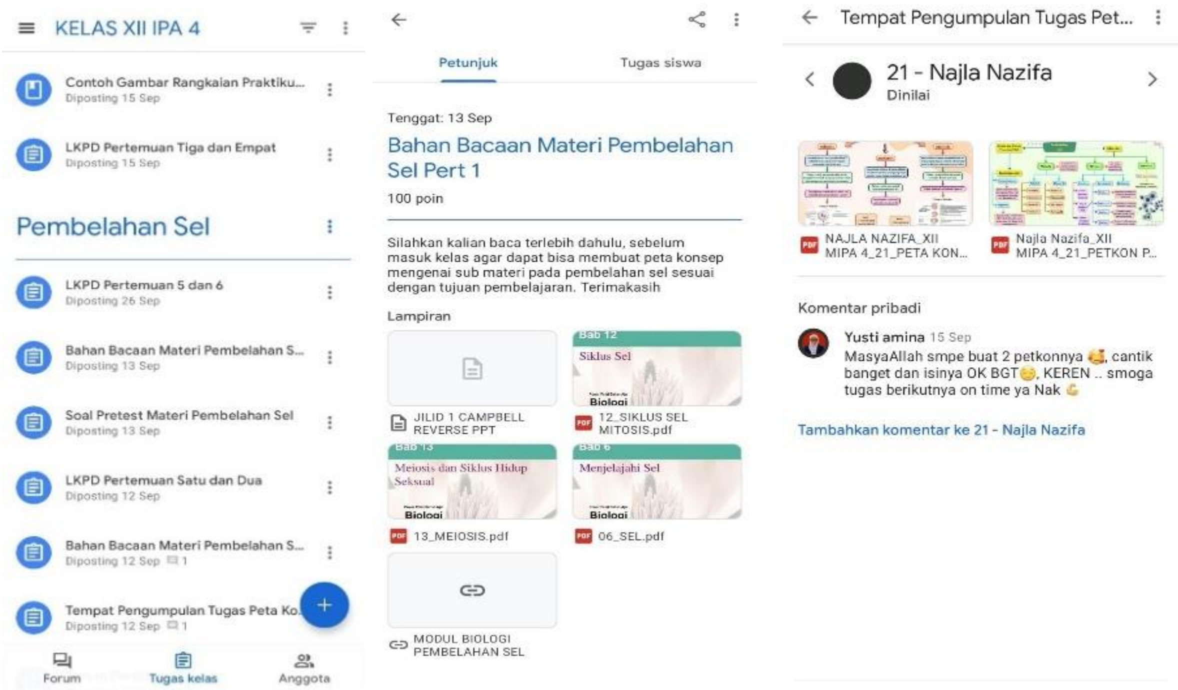


**Figure 2. Screenshots of Learning Activities based on Blended Learning Stages of Reading and Concept-Mapping of Remap-GI Syntax in Google Classroom**

According to Figure 2, the reading stages can help students become more knowledgeable about the information needed to solve practical problems. The concept-mapping phase aims to improve PPP indicators, such as data collection, organization, and appropriate use of scientific terms. In order to enhance students' cognitive learning outcomes, the stages of reading and concept-mapping are also used to deepen the material. Figure 3 and 4 show an example of a concept map created by students that explains the concepts related to cell division.

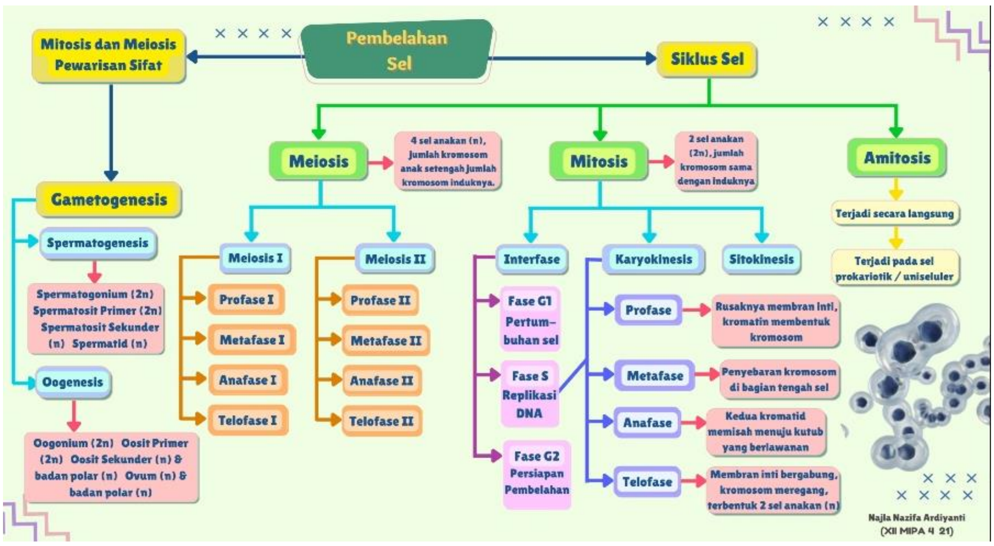


**Figure 3. Concept Map 1 of Cell Division Material by Student A**
**(All the concept maps were created in Indonesian language by students)**

According to Figure 3 on material on cell division, student A has every element in the concept map that meets the very good criteria, including the elements of breadth of net, use of descriptive links, and layout, as well as the criteria of embeddedness and interconnectedness, and effective links.

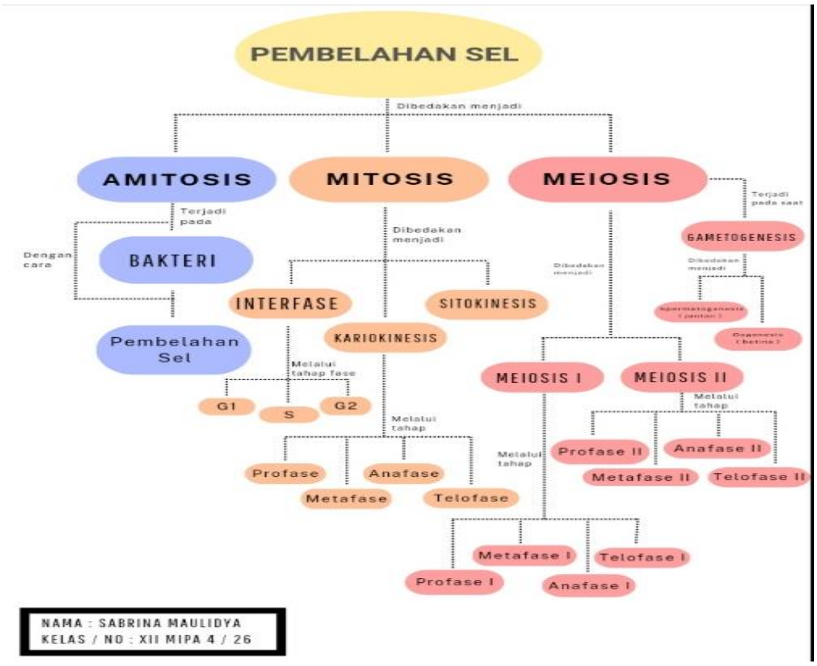


**Figure 4. Concept Map 2 of Cell Division Material by Student B**
**(All the concept maps were created in Indonesian language by students)**

Based on Figure 4 on cell division material, student B already covers all of the elements in the concept map with very good criteria, namely the elements of net breadth, use of descriptive links, embeddedness and interconnectedness, layout, and good criteria for elements of efficient links. Figures 3 and 4 possess different directions for each arrow direction, so Figure 4 is occupied by very good criteria in creating a concept map of cell division material. Figure 5 depicts an example of a concept map of heredity patterns created by students.

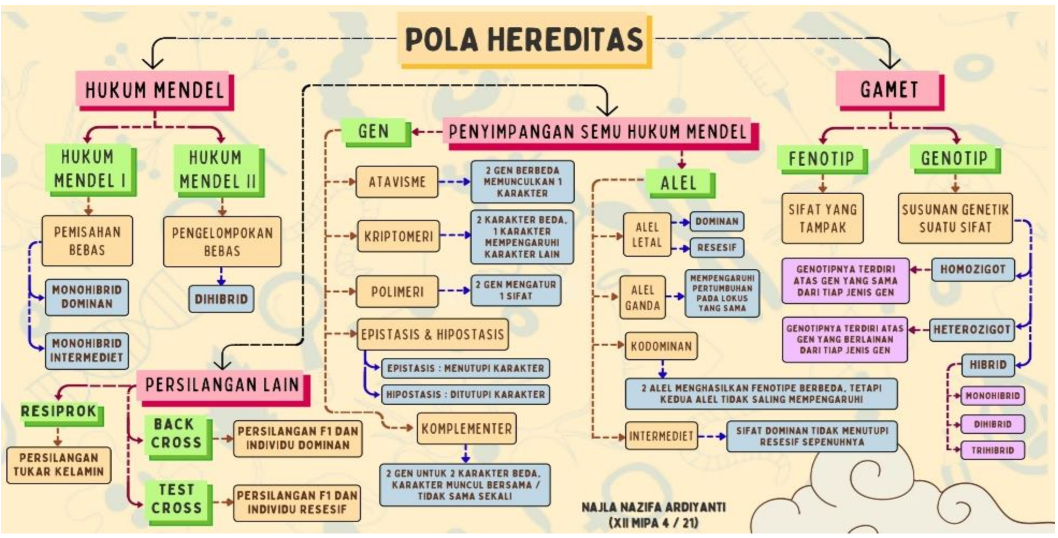


**Figure 5. Concept Map 3 of the Material of Heredity Patterns by Student A**
**(All the concept maps were created in Indonesian language by students)**

## DISCUSSION

The impact of the blended learning-based Remap-GI learning model on SPS and students' cognitive learning outcomes has been studied. In this research, SPS has applied theoretical and practical activities to biology subjects. The distinction between SPS indicators in theoretical activities and those in practicum is whether indicators for designing and conducting experiments exist. The use of scientific terms is one of the most important indicators. Scientific terms encompass knowledge and insight in the practice of scientific literacy. Scientific literacy is a critical skill in technological advancements that can support SPS indicators. The findings of survey research on students demonstrate that students' performance in scientific literacy is still low (Fausan et al., 2021). Science is one area that requires a scientific term. Science is a component of the perception of continuity in scientific processes, particularly in the field of biology (Suciati et al., 2022).

Indicators of SPS were statistically tested on theoretical and practical activities, and the results showed that applying the Remap-GI learning model had an effect on raising SPS. The results of the percentage of SPS students in five senior high school Banjarmasin encouraged the opposing view, demonstrating that these indicators for creating graphs, interpreting data, and designing experiments are still quite low (Inayah et al., 2020). SPS can be established in practicum activities such as planning and conducting investigations, as well as interpreting data in Biology lessons, to make them more meaningful if students participate intellectually, physically, and socially (Kurniawati, 2018). Other research from Senisum (2021) indicated that the student SPS was at a moderate level, and based on the SPS indicators tested on students, communication skills received the highest score, while completion skills reached the lowest. SPS results using the t-test by Ernawati et al. (2021) showed that there were differences in attitudes with students' SPS, indicating a relationship between attitudes and SPS. The Remap-GI learning model also had an impact on students' cognitive learning outcomes.

The increased cognitive learning outcomes of students with the average score from cycle I to cycle II with the Remap-GI learning model demonstrate this (Prasmala et al., 2014). Remap-GI, which is based on blended learning, is heavily reliant on ICT, particularly in the education sector. One of the technologically advanced blended learning and flipped classroom combinations. Technology has been integrated into education, and most teachers are now better trained in the use of educational tools and technology. The use of ICT in a flipped classroom is an active methodology that can be used throughout the learning process. ICT can be used to motivate students through collaborative learning, and communication between classmates and teachers is preferred because it results in significant learning (Cueva & Inga, 2022). One of the reflections during the COVID-19 crisis as a variety of learning models is the benefits of Remap-GI, which is based on blended learning with a flipped classroom combination.

The stages of the Remap syntax learning model, which has a learning process that begins with reading activities, also contribute to the improvement in cognitive learning outcomes. Reading stages will provide new information, improve memory, train thinking skills, and provide broad insights (Ester et al., 2022). Reading activities require readers to understand implied meaning, understand causal relationships between events and actions, and distinguish facts and opinions, according to Hayati et al. (2020) and Setiawan et al. (2014). Reading stages completed prior to the start of learning time can improve learning efficiency and provide students with more time outside of learning hours. Reading stages in the Remap syntax include learning innovations as an alternative to increasing students' low interest in reading, so they can expect low cognitive test results and improve basic science skills (Zirconia et al., 2018).

Furthermore, the stages of reading will find keywords in a reading, summarize, and arrange questions based on the reading text, assisting students in improving their learning outcomes (Tendrita et al., 2017). This study's reading material employed a learning model based on flipped classrooms using Google Classroom LMS and WhatsApp Group (WAG) communication media (Figure 2). Reading materials had been provided at least seven days before the learning activities began. The following learning activity involved summarizing and creating concept maps.

Concept maps are graphical tools that describe the relationship between one concept and another in a hierarchical order (Zubaidah et al., 2018). Students engage in reading activities to draw conclusions, after which they compile and create a structural concept map. Concept maps can assist students in better clarifying a concept and integrating knowledge into chart form to learn, think, and understand concepts. Understanding the concept has an impact on cognitive learning outcomes as well.

The advantages of reading results include the ability to develop concepts based on individual language and how to strengthen concepts read to implement them in concept mapping activities. Reading activities and concept mapping are examples of graphic presentations that can show relationships between material concepts, allowing knowledge to be constructed more meaningfully in the material studied bermakna (Annisa et al., 2017; Damopolii et al., 2019). Concept maps are used as a learning evaluation tool (Zubaidah et al., 2015) and include student center learning (Sholihah et al., 2016). The use of mapping from Alsuraihi's results (2022) via a survey demonstrated that there is consistency about strong online learning satisfaction during the pandemic.

The concept-mapping stage includes elements of the concept map, such as net breadth, embeddedness and interconnectedness, use of descriptive links, efficient links, layout, and development over time (Bhatia et al., 2021).The results of creating student concept maps already have indicators from Bhatia et al. (2021) as shown in Figures 4, 5, and 6. They are: (1)

breadth of net, namely the concept map has explained important domains at various levels, as evidenced by the presence of components of cell division material, namely amitosis, mitosis, and meiosis in Figures 3 and 4; (2) embeddedness and interconnectedness, indicating that all concepts are interconnected, as made evident by the relationship of the material components with the connecting lines between words and the connecting lines in Figure 2 having a different color for each word point hierarchy; (3) the use of descriptive links, conjunctions have used concise and accurate points in Figure 3 and Figure 4, as well as words outside the connecting box for material points in Figure 4; (4) efficient links, the links on the concept map have described a clear and consistent relationship in Figure 2; (5) layout, the concept map has a clear hierarchy of each word in cell division material on one page in Figures 3, 4, and 5; and (6) development over time, students have shown cognitive development from the depth of understanding of the domain as seen from the subtitles with the content components of Figure 3 and Figure 5. Each criterion for creating a concept map represents a novel approach to improving student learning outcomes. According to Redhana et al. (2021), concept maps can help improve learning outcomes.

The process of creating a concept map is not limited to how it is done. The concept map results were saved as images in the form of photos or files on the LMS or WAG. Furthermore, the GI syntax stage was used for the experimental and control classes. Table 2 describes the six GI stages. The first step is to select topics suggested by educators. The topics assigned to students are chosen at random from the basic competencies of cell division and heredity patterns. Obtaining topics for each group is intended to plan collaborative activities, but also obtain information that will be discussed among group members. Furthermore, the stages of investigation carried out by students include searching, gathering information from reference sources on the internet, and reviewing reading material that has been provided. The following stage of analysis and synthesis is to discuss the results of searching for information on topics among members, followed by the presentation of reports for each group to obtain input, suggestions, and additions from other groups. According to Manu & Nomleni (2018), each method implemented through the discussion learning method with the group work learning method has a different effect on the ability of the science process skills. Based on the explanation above, a blended learning variation of the Remap-GI learning model may be an option for improving SPS and students' cognitive learning outcomes, particularly in the post-COVID-19 pandemic.

## CONCLUSION

The study's findings suggested that the Remap-GI learning model's blended learning (BL) foundation had an impact on Biology learning's cognitive learning outcomes and science process skills (SPS). Based on the study's findings, blended learning-based Remap-GI learning can be proposed as a learning model for improving science process skills (SPS) and cognitive learning outcomes. Because the sub-indicators are optimally implemented in theoretical and practicum activities, the application of the learning model can be adapted to the subject matter of science, particularly Biology, which is taught to high school students. It is hoped that additional researchers will further develop the Remap-GI model on other biology content since it has only been applied to 2 (two) biology topics for class XII high school, namely cell division and heredity patterns.

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