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Using Remap-STAD Learning Assisted by The GitMind Application to Improve Students' Problem-Solving Skills in Biology Education

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Abstract

Several studies have highlighted the essential nature of students' problem-solving skills. However, these studies have also revealed that students' problem-solving skills in Indonesia are currently lacking. Consequently, there is a need to empower and improve these skills. This research aims to investigate the impact of implementing the Remap-STAD learning model, with the assistance of the GitMind application, to enhance students' problem-solving abilities in the field of biology. The research design employed in this study is a pretest-posttest non-equivalent control group design. The research sample comprises 70 students from class X MIPA at SMAN 9 Malang, East Java. The experimental group was taught using the Remap-STAD learning model, supplemented with the GitMind application, while the control group was taught using the STAD learning model alone. Problem-solving skills were assessed through a description test comprising eight questions. Greenstein's (2012) scoring rubric was employed for scoring, which encompasses eight indicators including problem identification, application of problem-solving steps, identification and evaluation of solutions, defense of solutions, real-world applications, inductive reasoning, and deductive reasoning. ANCOVA was utilized to analyze the data on problem-solving skills, with a significance level set at 5%. The Kolmogorov-Smirnov test was conducted to assess the normality of the data, while Levene's Test of Equality of Variances was used to evaluate homogeneity. The data analysis findings indicate significant treatment effects for the learning model ($p < 0.05$), thereby accepting the research hypothesis. The results demonstrate that the Remap-STAD learning model, combined with the GitMind application, can notably enhance students' problem-solving skills in the context of biology education. Consequently, the implementation of Remap-STAD, with assistance from the GitMind application, necessitates developing instructional tools tailored to the chosen learning model and the specific skills being measured. This approach will promote and enhance learning activities, particularly in improving students' problem-solving capabilities.

Keywords: Remap-STAD; GitMind; Problem Solving Skills; Biology Education

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INTRODUCTION

Problem-solving skills are considered to be crucial abilities that should be prioritized in 21st-century education (Md, 2019). These skills are deemed essential competencies that students need to possess (Greiff et al., 2013). The ability to solve problems plays a critical role in overcoming challenges and fostering innovation. These challenges require both professional content expertise and proficient problem-solving abilities (Özreçberoğlu & Çağanağa, 2018). Problem-solving involves a

cognitive process that utilizes knowledge, skills, and personal experiences to identify issues, discover solutions, and effectively resolve conflicts (Hoi et al., 2018). In modern society, which is highly technical, scientific, and complex, problem-solving skills serve as a key indicator of an individual's quality of life (Araiza-Alba et al., 2021; Puspita et al., 2020). Furthermore, a more meaningful learning experience can enhance problem-solving skills (Badrïah et al., 2023).

Problem-solving skills are essential for students to acquire, but multiple research findings indicate that these skills are currently inadequate and require improvement. This aligns with the research findings of Hidayanti et al. (2023); Simatupang and Ionita (2020); and Palennari et al. (2021), which revealed that students' problem-solving skills are still categorized as insufficient or low. This is further supported by the problem-solving index, where a significant number of students still fall below 75%, indicating a lack of problem-solving skills (Nikat et al., 2018). Insufficient ability to identify problems, develop and implement solutions, as well as evaluate results, contributes to this lack of skills (Fitriani et al., 2020). This deficiency can lead to students engaging in various activities without fully comprehending their purpose and rationale (Chiang & Lee, 2016).

Based on interviews conducted with Biology teachers at SMA Negeri 9 Malang in July 2023, it was reported that problem-solving skills are essential for students to effectively address challenges in their daily lives. However, the problem-solving skills of 10th-grade students in biology learning are currently categorized as low, indicating a need for improvement. The current classroom learning methods have not adequately facilitated the development of 21st-century skills, including problem-solving abilities. Therefore, it is necessary to explore alternative teaching approaches that can better support students in achieving competency. This need for improvement is further supported by the results of a preliminary study conducted at SMA Negeri 9 Malang, which revealed that students still fall into the low category, particularly in the subject of biology. The average scores for problem-solving skills were measured using a description test that comprised eight questions and was accompanied by a scoring rubric based on Greenstein's (2012) indicators. The results indicate that students scored 61.3% (sufficient) in identifying the problem, 62.1% (sufficient) in applying problem-solving steps, 61.3% (sufficient) in identifying solutions, 58.9% (less) in evaluating solutions, 62.1% (sufficient) in defending solutions, 56.5% (less) in real-world applications, 58.1% (less) in inductive reasoning, and 60.5% (enough) in deductive reasoning. These findings highlight the need for further improvement in these areas.

Enhancing problem-solving skills in biology education is imperative for improving teaching methods. Traditional approaches that focus solely on knowledge transfer may hinder effective learning. The inadequate development of problem-solving skills can be attributed to passive student engagement, difficulties in problem identification, and lack of interest in reading (Muhlisin et al., 2022). Consequently, students struggle to acquire these essential skills. It is also crucial to diversify learning experiences and enhance student engagement in educational activities (Purwaningsih et al., 2020). Empowering problem-solving skills in learning activities is expected to equip students to excel in the era of globalization and leverage technological advancements (Bahri et al., 2018).

Learning innovation should aim to enhance active and collaborative student engagement, guiding them towards systematic and planned problem-solving. This

approach ensures that learning becomes more meaningful (Baran & Sozbilir, 2018). The adoption of innovative learning models can greatly contribute to achieving learning objectives and fostering students' problem-solving abilities (Novkovic-Cvetkovic & Stanojevic, 2017). Group activities that promote problem-solving skills have been found to be more effective than individual activities (Aslan, 2021). These findings align with the research conducted by Irawan et al. (2023), which highlights the importance of measuring 21st-century skills through the Remap-STAD Learning model and the implications and innovations it brings.

One learning model with the potential to enhance problem-solving skills is Reading Concept Mapping-Student Teams Achievement Divisions (Remap-STAD). Planned activities involving reading and creating concept maps are expected to address the limitations of the STAD learning model. This is because these activities can assist students in acquiring and expanding their knowledge (Xu & Pang, 2020). Learning models that emphasize reading activities and concept mapping are referred to as Remap. Reading activities are considered a crucial component of learning because reading serves as the foundation for students in the preparation of concept mapping. This approach involves cooperative learning, both before the instructional session and during the classroom learning process (Zubaidah, 2014). The cooperative learning model that can be combined with Remap is STAD, thus resulting in the Remap-STAD learning model (Zubaidah, 2014). The Remap-STAD learning model is integrated with important technology or devices to support the progression of learning activities and student development. Concept maps can be created manually or using software (Agustin et al., 2022). The use of technology or software can facilitate an innovative learning process, and one of the applications to be utilized is the GitMind application (Bhattacharya & Mohalik, 2020).

GitMind is a tool that facilitates the creation of concept maps, making it easier for students to access and effectively apply them to various learning areas, including skill acquisition (Abd Karim & Mustapha, 2022). The online concept mapping program GitMind appears to be intriguing for the learning process, as it can help students systematically organize information (Wu & Wu, 2020). Several studies have explored innovative learning methods and models to enhance students' problem-solving skills (Yu et al., 2015). However, no research is currently available on the Remap-STAD learning model assisted by the GitMind application. Previous studies have focused on the application of the Remap-STAD Learning model to improve student learning outcomes (Sari et al., 2023) and to empower skills (Zubaidah et al., 2018). Additionally, the influence of Student Teams Achievement Divisions (STAD) on problem-solving skills and critical thinking has been examined (Lantajo & Tipolo, 2019). Therefore, this research aims to investigate the impact of implementing the Remap-STAD learning model assisted by the GitMind application on students' problem-solving skills in biology learning.

METHOD

Research Approach

This study employs a Mixed Methods research approach. The research design utilized is the Pretest-Posttest Non-Equivalent Control Groups Design (Leedy et al., 2019). The design entails conducting a pretest prior to the treatment and a posttest following the treatment. The pretest is administered at the onset of the learning process for both the experimental and control groups. The experimental group is

instructed using the Remap-STAD learning model with assistance from the GitMind application, whereas the control group is taught using the STAD learning model, as illustrated in Table 1, with O_1 and O_1: experimental group pretest-posttest; O_3 and O_4: control group pretest-posttest; X_1: Treatment with the Remap-STAD learning model assisted by the GitMind application; and X_2: Treatment with the STAD learning model.

Table 1. Research Design Pretest - Posttest Non-Equivalent Control Groups Design

Group	Pretest	Treatment	Posttest
Experiment	O_1	X_1	O_2
Control	O_3	X_2	O_4

Research Participant and Procedure

This research has obtained approval from the participating schools and students. The study was conducted at SMA Negeri 9 Malang, located on Jl. Puncak Borobudur No.1, Mojolangu, Lowokwaru District, Malang City, East Java. The research was carried out from August to October, during the odd semester of the academic year 2023/2024. The population of this study consisted of all class X MIPA students at SMA Negeri 9 Malang, East Java. The sample used included 70 class X MIPA students who had previously undergone equality testing and were analyzed using the Anova test. The sampling technique employed was random sampling, resulting in class X.8 as the experimental group taught using the Remap-STAD learning model assisted by the GitMind application, comprising 35 students, and X.9 as the control group taught using the STAD learning model, also comprising 35 students. The detailed learning activities of both classes are presented in Table 2.

Table 2. Experimental and Control Group Learning Activities

Learning model	Syntaxis	Material	Time Allocation
Remap-STAD assisted by the GitMind application	The *Remap*-STAD learning model assisted by GitMind application consists of the following stages: 1. Pre-learning Stage: First, Reading; Second, *Concept Mapping* with the assistance of the *GitMind* application 2. In-class Learning Stages: First, Classroom Presentation; Second, Group Formation; Third, Group Discussion; Fourth, Quiz Administration; Fifth, Scoring; Sixth, Group Recognition	The Biology material includes: 1) Classification of Living Organisms, 2) Levels of Biodiversity, 3) Distribution of Flora and Fauna in Indonesia, 4) Conservation and Benefits of Biodiversity, 5) Issues and Solutions Regarding Biodiversity	Pre-learning Stage: Free In-class Learning Stages: 2 lesson hours X 45 minutes
STAD	The STAD learning model involves the following stages: First, Class Presentation; Second, Group Formation; Third,	Just like the material in *Remap*-STAD assisted by the *GitMind* application	In-class Learning Stages: 2 lesson hours X 45 minutes

Learning model	Syntaxis	Material	Time Allocation
	Group Discussion; Fourth, Quiz Administration; Fifth, Scoring; Sixth, Group Recognition		

Each indicator provided by Greenstein has the capability to measure students' problem-solving skills. The problem-solving skills are assessed using a descriptive test comprising of eight questions. This test is accompanied by a scoring rubric, as mentioned by Greenstein (2012), consisting of eight indicators. These indicators include: problem identification, application of problem-solving steps, solution identification, solution evaluation, solution defense, real-world applications, inductive reasoning, and deductive reasoning. The problem-solving skill test questions used in this study can be found in Appendix 1.

The validity and reliability of the problem-solving skills instrument are initially analyzed. The validity of the questions is assessed using the Pearson product-moment correlation. Subsequently, a reliability test is conducted using the Cronbach's Alpha formula, resulting in a value of 0.748. A problem-solving skills test can be considered reliable if the Cronbach's Alpha value is greater than 0.6. The obtained value indicates that the problem-solving skills test instrument is reliable in measuring the variables. The assessment of the problem-solving skills test is conducted using the scoring rubric presented in Table 3.

Table 3. Problem Solving Skills Scoring Rubric (Greenstein, 2012)

Indicator	Scoring Rubric			
	4 (Exemplary)	3 (Proficient)	2 (Basic)	1 (Novice)
Identifies theProblem	I clearly described a problem with supporting details in relation to the situation	I described the basics of the problem with some supporting information	I explained parts of the problem but not the complete problem	I had difficulty defining the problem
Applies Problem Solving Steps	I used the full range of steps and strategies I learned to solve problems	I was able to use most of the problem steps and strategies	I used a few of the problem steps that I learned	I think I missed some of the steps in problem solving
Identifies Solutions	I came up with at least four feasbile and clearly described solutions	I offered two to three plausible solutions	I described one or two possible solutions	I was unable to give any solutions
Evaluates Solutions	I was able to thoughtfully evaluate and analyze all the	I was able to make a reasoned judgments	I was able to compare my options and	I picked one, but I wasn't sure it was a good choice

Indicator	Scoring Rubric			
	4 (Exemplary)	3 (Proficient)	2 (Basic)	1 (Novice)
	possible choices before selecting the most feasible one	about the choices and pick one that makes sense	pick one to start with	
Defends solutions	I analyzed all the solutions and picked one that shows my understanding of the problem and the outcomes.	I evaluated the solutions and explained why I picked one that seems to be feasible.	I gave a simple explanation for one choice.	I wasn't able to explain my solution. I just thought it was a good one.
Real World Applications	I can demonstrate my problem solving skills successfully even when they are not part of school assignments	I try to use my problem solving skills outside of school and usually succeed I'm successful	I sometimes think about how I would solve a problem away from school	I do best at school when there is a structured format and someone can help me
Inductive Reasoning	I can accurately identify and interpret relevant facts and information that helps draw logical conclusions	I can select relevant information that will lead me reasonable conclusions.	I can use selected information and facts to draw some conclusions.	I'm not sure what information to use and how to use it to draw conclusions.
Deductive Reasoning	I can work with fundamental principles of a topic and use relevant generalizations to draw logical conclusions.	I can use basic principles and generalizations to draw a conclusion and predict outcomes.	I think I draw logical conclusions but I'm not understand the core principles	The conclusions I draw don't have direct bearing on the generalizations and principles I chose to use

Data Analysis

Data on problem-solving skills were analyzed using Analysis of Covariance (ANCOVA) at a significance level of 5%. If the significance value is greater than 0.05, the hypothesis is rejected; if it is less than 0.05, the hypothesis is accepted. ANCOVA was used due to the presence of one covariate, which is the pretest. A covariate is a variable that needs to have its influence eliminated in order to make the effect of the variable under investigation more apparent. Before conducting the ANCOVA analysis, the data must meet the assumptions of normal distribution and homogeneity. The normality test, specifically the Kolmogorov-Smirnov test, was performed to assess normal distribution, while the homogeneity test, using Levene's Test of Equality of Variances, was conducted on the scores before and after the test to

assess homogeneity. After obtaining significant results in the hypothesis test, further LSD tests were conducted. The Least Significant Difference (LSD) test is used when the test results are significant, indicating that the independent variable has an effect on the dependent variable. All data testing was performed using the SPSS version 23.0 program for Windows. Additionally, the data was qualitatively explained based on the results of student answers. Qualitative research was conducted to describe the influence of the Remap-STAD model assisted by the GitMind application on improving students' problem-solving skills. The focus of the qualitative research was Class X.8, which served as the experimental group. In this study, 8 students were selected as research subjects based on their highest scores in problem-solving skills.

Ethical Statement

The research was conducted in strict adherence to ethical standards, with full permission granted by the principal of SMA Negeri 9 Malang. The study was carried out from August to October during the odd semester of the academic year 2023/2024 and involved the participation of students from class X MIPA. Prior to the commencement of the study, appropriate consent was obtained from all participating students. Moreover, the research procedures were designed to ensure the well-being and confidentiality of the participants, in line with the principles of informed consent and voluntary participation. All data collection and analysis processes were carried out with utmost integrity and transparency, with careful consideration for the privacy and dignity of the individuals involved. The findings of this research are intended solely for academic and educational purposes, with full respect for the rights and interests of the participants and the institution involved.

RESULTS AND DISCUSSION

The Remap-STAD learning model, assisted by the GitMind application, demonstrates that the experimental group has witnessed significant advancements in students' problem-solving abilities. The statistical tests conducted on problem-solving skills indicate that the data follows a normal distribution and is homogeneous. The detailed results of the ANCOVA test analysis for the Remap-STAD learning model, supported by the GitMind application, are presented in Table 4.

Table 4. ANCOVA analysis results: Remap-STAD learning model assisted by the GitMind application

Tests of Between-Subjects Effects						
Dependent Variable: Problem-Solving Skills						
Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	956.621[a]	2	478.311	18.571	.000	.357
Intercept	5554.152	1	5554.152	215.642	.000	.763
Group	356.264	1	356.264	13.832	.000	.171
XPSS	671.511	1	671.511	26.072	.000	.280
Error	1725.679	67	25.756			
Total	429655.000	70				
Corrected Total	2682.300	69				

The findings of the data analysis presented in Table 4 indicate that the treatment effect on the learning model is statistically significant ($p < 0.05$). This implies that the

research hypothesis has been accepted, demonstrating a notable disparity in problem-solving abilities between students in the experimental and control groups. Consequently, the implementation of the Remap-STAD learning model, supported by the GitMind application, has been found to enhance students' problem-solving skills. Additional details regarding the Least Significant Difference (LSD) test can be found in Table 5.

Table 5. Corrected Least Significant Difference (LSD) mean of learning models on students' problem-solving skills

Learning model	Pretest		Posttest		Difference	Enhancement	Corrected Mean	Notation
	m	(SD)	m	(SD)				
Remap- STAD assisted by the GitMind application	48.34	7.74	81.03	5.76	32.69	67.63%	81.03	a
STAD	49.46	6.51	75.17	5.29	25.71	51.98 %	75.17	b

The data analysis results presented in Table 5 demonstrate that the experimental group instructed using the Remap-STAD learning model, with the assistance of the GitMind application, achieved a corrected average score of 81.03 for problem-solving skills. This score differs significantly from the corrected average score of 75.17 achieved by the control group that taught using the STAD approach. The LSD test results further confirm the significant difference between the two treatments, as indicated by the non-identical LSD notations. Additionally, Table 6 displays the problem-solving skills test results for both the experimental group and the control group.

Table 6. Results of Student Problem-Solving Skills Tests

Category	Experiment Group (Remap - STAD- GitMind)		Control Group (STAD)	
	Percentage (%)			
	Pretest	Posttest	Pretest	Posttest
Very good	0.00	20.00	0.00	0.00
Good	0.00	65.71	0.00	34.29
Enough	5.72	14.29	5.71	65.71
Not enough	17.14	0.00	14.29	0.00
Very less	77.14	0.00	80.00	0.00
Average value	48.00	81.00	49.00	75.00

Based on Table 6, the test results indicate that the percentage of scores and categories of students' problem-solving skills in the pretest is lower compared to the posttest. The research findings revealed that out of the 35 students who studied Remap-STAD with the assistance of the GitMind application, 20% achieved a very good category, 65.71% achieved a good category, and 14.29% achieved a fair category. On the other hand, 34.29% of the 35 students taught with the STAD model obtained a good category, while 65.71% achieved a sufficient category. The increase in problem-solving skills is supported by the higher average posttest score of 81.00 for students taught with the Remap-STAD model assisted by GitMind, compared to the STAD model score of 75.00. The increased percentage of problem-solving skills indicators in

the experimental group (Remap-STAD assisted by the GitMind application) can be observed in Figure 1 and Figure 2. The increase in the percentage of problem-solving skills indicators in the control group (STAD) is also evident.

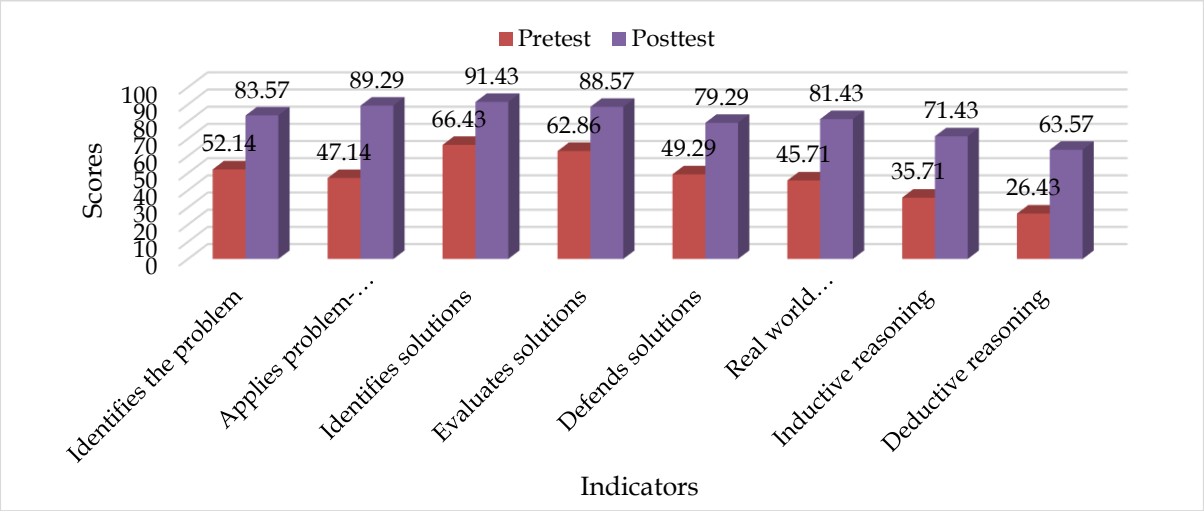


Figure 1. Percentage of increase in students' problem-solving skills in the experimental group (Remap-STAD assisted by the GitMind application)

Figure 1 illustrates the observed enhancements in problem-solving skills within the experimental group. This is evidenced by the disparities in percentage improvements between the pretest and posttest results. Specifically, these improvements are identified in the following areas: problem identification (66%), application of problem-solving steps (80%), solution identification (74%), solution evaluation (69%), solution defense (59%), real-world applications (66%), inductive reasoning (56%), and deductive reasoning (50%).

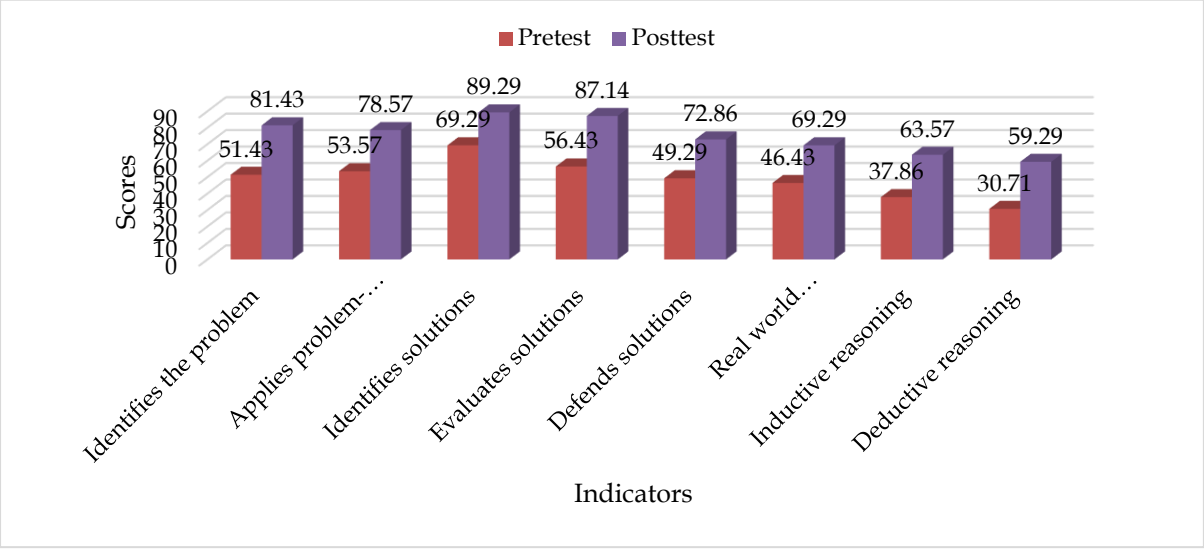


Figure 2. Percentage of increase in students' problem-solving skills in the control group (STAD)

Figure 2 illustrates the observed enhancements in problem-solving skills indicators within the control group. This is evidenced by the disparity in percentage improvement between the pretest and posttest assessments. These indicators encompass the identification of problems (62% improvement), the application of problem-solving steps (54% improvement), the identification of solutions (65%

improvement), the evaluation of solutions (70% improvement), the defense of solutions (46% improvement), real-world applications (43% improvement), inductive reasoning (41% improvement), and deductive reasoning (41% improvement). The students' responses to various questions based on these problem-solving skills indicators are as follows.

Question number 1 (*identifying the problem)*: MFK students provide explanations and facts about the problem that underlies the incident: *The phenomenon, and problems underlying the occurrence of several animals predicted to become extinct in 2050, including orangutans, are habitat destruction, illegal hunting and climate change. First, habitat destruction is an essential factor in the decline in the population of these animals. Human activities such as deforestation and forest encroachment for agriculture or infrastructure development have destroyed the natural habitat of orangutans and other animals. With difficulty finding food can find their environment a suitable habitat. Second, illegal hunting also poses a severe threat to the survival of these animals. Orangutans and other animals are being hunted for illegal trade, either for meat, bones or as pets. This illegal hunting causes a decline in population numbers and disrupts the balance of the ecosystem. Finally, climate change also plays a vital role in this problem. Global warming and climate change are causing increases in temperature and changes in unusual weather patterns. This can cause damage to the habitat and difficulty for animals to adapt to these changes. Analysis of this problem shows the need for rapid and effective action to protect endangered animals. Steps such as better habitat protection, strict law enforcement against illegal hunting, and efforts to reduce greenhouse gas emissions must be taken to keep people alive. Forest and other animals. Additionally, awareness and education are essential to change human behavior in respecting and protecting the biodiversity on earth.*

MFK's response has offered detailed explanations and factual information regarding the underlying issues of the incident. This allows students to recognize phenomena that occur in their daily lives. Problem-solving activities enhance comprehension by prompting students to concentrate, investigate, and reflect upon a given matter in order to analyze it effectively (Utaminingsih et al., 2022). The identification of a problem serves as the foundation for the problem-solving process (Von Hippel & Von Krogh, 2016).

Question number 2 (*applies problem-solving steps*): MMI students design problem-solving steps, several animals are predicted to become extinct in 2050: *Based on an analysis of the problem, several animals are predicted to become extinct in 2050, including orangutans; several steps or efforts can be taken to solve the problem: First, increase public awareness about the importance of conserving orangutans and other endangered animals. Education and information campaigns can be spread so that people better understand their actions' impact on these animals' lives. Second, habitat preservation can be done by stopping deforestation, which destroys the forests where they live, and strengthening and expanding existing conservation areas. Third, preventing illegal trade. For example, orangutans are often the target of illegal trade, both as pets and for their body parts, which have a high selling value. Law enforcement and efforts to prevent this illegal trade are essential in protecting the orangutan population. Fourth, rehabilitation and conservation populations can be established to help orangutans injured or trapped in illegal trade. Restoring and maintaining endangered orangutan populations can be done by strengthening existing conservation and breeding programs. International cooperation on the issue of animal extinction knows no national borders. Therefore, international cooperation is essential. Various countries and organizations can work together to overcome the problem of extinction of orangutans and other animals by sharing knowledge, resources and effective strategies. By implementing these steps,*

it is hoped that we can reduce the risk of extinction of orangutans and other animals in the future. However, this effort requires collaboration and commitment from all parties.

The answers provided by MMI students, along with indicators of applied problem-solving steps, are already capable of formulating problem-solving steps related to the given event. The problem-solving process involves utilizing available information to identify and generate solutions to issues (Yurtseven et al., 2021).

Question number 3 (*identifying solutions*): TMR students mention several alternatives or solutions that can be given as a student: *As a student, are there several solutions that can be offered to overcome several animals predicted to become extinct in 2050, including orangutans? The four solutions that can be considered, namely (1) Environmental Education and Awareness; (2) Law Enforcement and Habitat Protection; (3) Providing education and outreach; and (4) Reducing the use of products from endangered animals.*

The answers provided by TMR students to questions with indicators of multiple ideas are presented with several alternatives or solutions that can be considered by students. This allows students to enhance their critical thinking skills and develop a deeper understanding of problem situations, enabling them to make informed decisions in real-life scenarios (Mahanal et al., 2022).

Question number 4 (evaluation solutions): LKL students provide several ideas which are explained in detail by adding several existing facts about the solutions that have been created.

1. *Environmental education and awareness: as a student, it is important to raise awareness about preserving nature and wildlife, including orangutans. By increasing our understanding of the importance of the orangutan's natural habitat, we can better appreciate and protect this endangered animal.*
2. *Law enforcement and habitat protection: It is essential to increase law enforcement against illegal activities such as poaching, habitat destruction and orangutan trafficking. By ensuring strong habitat protection and taking firm action against violations, we can help reduce conflict between humans and orangutans as a students' report crimes against endangered animals.*
3. *Providing education and outreach: as a student, providing education and outreach to the public about the types of animals protected by the government is an important step. People who live on sea coasts and around forests need to be told not to kill or hunt protected endangered animals.*
4. *Reducing the use of products from endangered animals: as a student, reducing the use of products from endangered animals, such as exotic animal skins or products from rare woods, can help reduce the demand for and illegal trade in endangered species.*

In evaluating environmental education and awareness, law enforcement and habitat protection, providing education and outreach and reducing the use of products from endangered animals. These four solutions are essential to pay attention to the positive and negative impacts of each solution implemented. This aims to ensure that the solutions taken are genuinely sustainable and provide long-term environmental and societal benefits.

LKL students present their answers by proposing multiple ideas, supported by providing elaborate explanations and including relevant facts about the solution that has been devised. The process of learning equips students with the necessary skills to apply, analyze, synthesize, and evaluate their thinking abilities when it comes to problem-solving (Ristiana et al., 2017).

Question number 5 (*defends solutions*): GGK students provide appropriate and relevant solutions for problem-solving: *Environmental education and awareness: as students, it is important to raise awareness about the importance of preserving the*

sustainability of nature and wildlife, including orangutans and increasing understanding of the importance of orangutans' natural habitats to appreciate better and protect them. Environmental awareness to protect and restore natural ecosystems in Indonesia. A healthy and balanced ecosystem is significant for the survival of animals and plants, and protecting and restoring ecosystems can provide a suitable environment for endangered animals to survive and reproduce.

The answers provided by GGK students offer suitable and pertinent solutions for addressing issues encountered at events. Problem-solving skills refer to an individual's capacity to utilize their cognitive abilities in order to tackle problems by gathering facts, analyzing information, considering various alternative solutions, and selecting the most effective problem-solving approach for the challenges they encounter, thereby enabling its application in daily life (Ardithayasa et al., 2022).

Question number 6 (*real world applications*): YAZ students design a method Apply these solutions in everyday life: *By applying solutions in everyday life and inviting local communities to preserve endangered species actively.*

1. *How to apply solutions in everyday life regarding the problem of animal extinction: several steps can be taken by reducing the use of animal-based products and supporting conservation organizations that focus on protecting and restoring endangered animal populations. Reduce the use of plastic. Excessive use of plastic can hurt the environment and animals. Educating about preserving biodiversity and the negative impacts of animal extinction can help increase public awareness and understanding.*
2. *How to encourage local communities to apply solutions in overcoming endangered species by taking the following steps: Parking, providing straightforward and easy-to-understand information about the problem of animal extinction, its causes, and its impact on the ecosystem and humans. Second, by providing accurate information, we can help increase public awareness about the importance of protecting and preserving endangered species. Third, hold campaigns and events to increase public awareness and participation in animal conservation efforts. Fourth, invite the public to participate in conservation activities, such as planting trees, cleaning the environment, or becoming volunteers in national parks or conservation areas. Fifth, by actively participating, the community can feel the positive impact of animal conservation efforts, become agents of change in the surrounding environment and utilize social media to disseminate information and invite the public to apply solutions to overcome animal extinction. Furthermore, applying solutions in everyday life and inviting local communities to participate can contribute to efforts to preserve and protect endangered species.*

YAZ students provide answers that describe how these solutions can be applied in everyday life. Problem-solving skills are utilized to address scientific problems that manifest as everyday life phenomena (Savitri et al., 2021).

Question number 7 (*inductive reasoning*): MCR students explain several efforts to preserve living things that occur in endangered species: *Efforts to conserve living creatures, including endangered species such as orangutans, are significant to maintain the sustainability of living creatures. Some of the conservation efforts for species, including orangutans, threatened with extinction by 2050, include habitat regulation. Conservation efforts involve regulating the natural habitat of orangutans to ensure that they have a suitable environment to live and reproduce. Legal protection is provided to protect the orangutan species from illegal hunting, wildlife trade, and habitat destruction. Education and awareness, conservation efforts also involve education and public awareness about the importance of maintaining the sustainability of the orangutan species and their habitat. Habitat conservation is carried out by preserving forests and reducing deforestation, which can threaten orangutan*

habitat. International cooperation between countries with orangutan populations is also essential to maintain the sustainability of this species. With ongoing conservation efforts, it is hoped that the orangutan species will continue to survive and not become extinct by 2050.

The MCR student provides a comprehensive list of various conservation efforts undertaken to protect endangered species. This process necessitates the capacity to define and analyze problems, explore alternative solutions, and effectively implement the most appropriate course of action in novel situations (Araiza-Alba et al., 2021; Yu et al., 2015). Problem-solving skills encompass cognitive processes that enable individuals to comprehend and resolve issues, employing both direct and indirect problem-solving approaches (Shute et al., 2016).

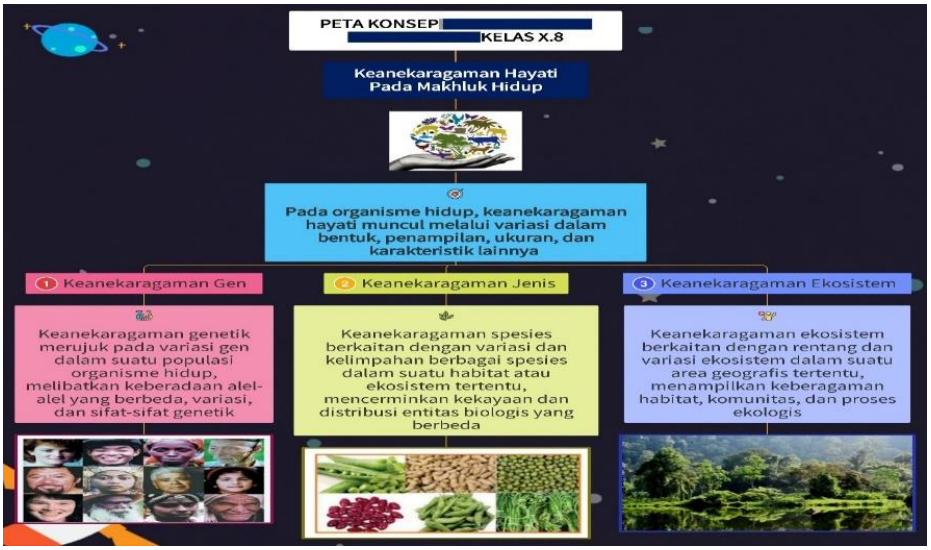
Question number 8 (*deductive reasoning*): DMR students can conclude the event in endangered species: *According to the IUCN and the World-Wide Fund for Nature (WWF), the "critically endangered" category describes species with a very high risk of extinction. These species experienced rapid population declines, ranging from 80 to more than 90 percent in the previous 10 years (or three generations). In addition, the current population size is less than 50 individuals, or other factors exist that cause a high risk of extinction. Many animal species are currently in the critically endangered category. If events such as illegal logging are carried out by irresponsible parties, disease, competition between animals, and the inability to adapt to natural changes persist for long. These species may not be able to survive until 2050. Illegal logging carried out by irresponsible parties can cause loss of habitat and food sources for animal species. This can result in rapid population decline and increase the risk of extinction. The disease can also pose a severe threat to animal species. If these species do not have sufficient immunity or cannot defend against rapidly spreading diseases, their populations could be threatened with extinction. Competition between animals can also affect the survival of critically endangered species. If these species have to compete with other more dominant or aggressive species, they may not be able to survive, and their populations will continue to decline. The inability to adapt to natural changes can also be a factor that threatens the survival of animal species. If the species cannot adapt to climate change, habitat change, or other changes in environmental conditions, then they may not be able to survive in the long term. In a situation where these events last for a long time, and no action is taken to protect these species, it is unlikely that they will survive until 2050.*

Students' responses should include appropriate and logical conclusions regarding events related to endangered animals. The process involves understanding the difference between the current situation and the desired outcome of a problem, formulating and verifying hypotheses about the cause of the problem, developing a solution to address the problem, and implementing the solution to achieve the desired conditions (Kök & Duman, 2023).

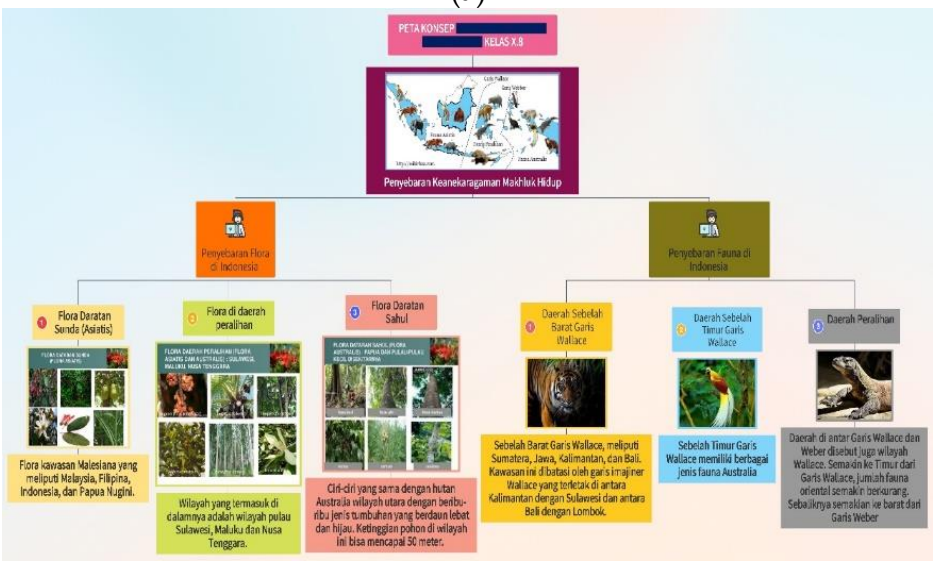
The improvement in problem-solving skills can be attributed to the use of Remap-STAD, supported by the GitMind application, which provides a structured approach to the learning process. This includes reading activities, creating concept maps using the GitMind application, and employing the STAD learning method. The incorporation of additional Remap activities with the GitMind application serves as a solution to address weaknesses in the STAD approach. Reading activities offer significant benefits to individuals, such as self-development, increased self-confidence, improved problem-solving abilities, access to references, enhanced concentration, and the cultivation of calmness and wisdom (Rintaningrum, 2019). According to Harahap et al., (2020), reading plays a crucial role in learning because a large portion of knowledge is presented in written form, thus students must engage in reading to acquire knowledge. By reading texts and information, students become

more adept at developing knowledge and skills (Krauja & Birzina, 2018). Problem-solving skills are closely linked to reading comprehension (Öztürk et al., 2020). Reading is a fundamental activity that is central to the learning process (Alsaeedi et al., 2021).

The next learning activity involves creating a concept map. Concept maps are a valuable tool for facilitating meaningful learning as they allow students to visualize scientific concepts from the learning content, enhancing their long-term retention (Dhull & Verma, 2020). In 21st century education, the use of technology has made it possible to create concept maps digitally. Applications like GitMind are particularly helpful in organizing these concept maps effectively. It is worth noting that a well-designed concept map goes beyond mere graphic arrangement; it should also exhibit high-quality content (Canas et al., 2015). According to Lambiotte and Dansereau, students who create concept maps possess a broader knowledge base and excel in problem-solving compared to those who rely on rote learning (Singh & Moono, 2015). Figure 3 displays the outcomes of students' concept maps created using the GitMind application, focusing on the topic of biodiversity.



(a)



(b)

Figure 3. Concept Map assisted by the *GitMind* application (a) material on level of biodiversity in living things and (b) material on the distribution of flora dan fauna.

Figure 3 illustrates the relationship between the concepts that students grasp through the process of reading materials on the diversity of living things. Students can identify the main concept as the central point of the concept map and expand to more specific concepts. They are also able to adjust the links of the concept map both horizontally and vertically. Active reading is required for students to synthesize all the information, simplify vocabulary, and develop ideas in their own language that is appropriate for the context or learning topic.

According to Nurlia (2023), free online concept maps can be created using GitMind. This platform enables users to generate mind maps, concept maps, diagrams, and various types of flowcharts. It also allows users to formulate new theories, specify objectives for assignments, and provide introductions. GitMind is a versatile program that is compatible with all major operating systems, including Windows, Linux, and Mac. Being an online software, it offers a free service, as most online applications perform similar functions.

Concept maps have a positive impact on the quality of student learning (Kinchin et al., 2019). In the groups involved in this research, student learning is applied through the use of the Student Teams Achievement Divisions (STAD) cooperative learning model. STAD involves a series of cooperative procedures consisting of six stages: articulating objectives and inspiring students, delivering information, arranging students into study groups, guiding the activities of these groups, assessing performance, and acknowledging achievements (Togatorop & Dito, 2023). The benefits of STAD include the enhancement of students' academic standing, enthusiasm, engagement in learning activities, motivation, and group collaboration. Consequently, students are able to enhance their problem-solving skills in the domains of science and social learning (Muhfahroyin & Santoso, 2020). STAD has been found to be more effective than lecturing learning and several other strategies (Purnawan, 2018). The STAD cooperative learning model increases students' self-confidence in asking questions, answering inquiries, or presenting their work results, as it fosters a spirit of mutual cooperation within each group member to improve learning outcomes (Zb et al., 2022). This aligns with research by Hidayatulloh et al. (2020), which suggests that integrating problem-solving into the learning process helps students build new knowledge, making problem-solving skills an essential aspect to be focused on and developed.

Enhancing problem-solving skills is essential, particularly in the context of biology education. Biology education encompasses topics that are directly applicable to everyday experiences and interactions with living organisms (Wegner & Schmiedebach, 2020). The study of biology enables students to gain a deeper understanding of natural processes (Shen et al., 2018). Problem-solving skills are highly suitable for the learning process as they necessitate active engagement from students, moving beyond passive listening, note-taking, and memorization. Through problem-solving, students actively engage in critical thinking, information assimilation, communication, data retrieval and processing, and ultimately reaching conclusions (Palennari et al., 2021). Moreover, the implementation of appropriate learning models serves as an effective strategy for educators to facilitate students' comprehension of both subject matter and skills.

Research conducted has demonstrated that the Remap-STAD learning model is a valuable tool for enhancing students' problem-solving abilities. However, it should be noted that the Remap-STAD learning model, specifically in the form of the GitMind

application, has limitations in its focus on problem-solving skills and diversity within the realm of living organisms. Furthermore, there are certain challenges associated with students' ability to differentiate between concept maps and mind maps, thus requiring a more comprehensive explanation and illustrative examples to clarify the distinctions. Additionally, time constraints during presentations and group discussions can impede the effectiveness of these activities. To overcome these obstacles, students should prioritize time management to optimize the learning process and foster a deeper understanding of the study materials.

CONCLUSION

Problem-solving skills are paramount for achieving success in the biology learning process, particularly in the realm of biodiversity. The utilization of the Remap-STAD learning model, aided by the GitMind application, serves as an effective means to enhance these skills. By implementing an active learning approach, students are encouraged to explore problem-solving techniques and actively participate in group discussions. Based on the research findings, it is evident that the problem-solving skills of the students in the experimental group have significantly improved, with a value of $0.000 < 0.05$. Therefore, it can be concluded that the implementation of the Remap-STAD learning model, with the assistance of the GitMind application, has a positive impact on students' problem-solving abilities in the field of biology.

RECOMMENDATION

The Remap-STAD, assisted by the GitMind application, can be utilized to enhance students' problem-solving skills in biology education. The successful implementation of Remap-STAD, assisted by the GitMind application, necessitates the use of tailored instructional tools that align with the chosen learning model and the specific skills being assessed. Schools can consider Remap-STAD, assisted by the GitMind application, as a valuable resource for implementing a new instructional model that facilitates learning activities, particularly in the improvement of students' problem-solving abilities. However, careful attention must be paid to time allocation during classroom implementation, as the application of the Remap-STAD learning model, especially during group quiz activities, may require a substantial amount of time.

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All authors have sufficiently contributed to the study and have read and agreed to the published version of the manuscript.

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Conflict of Interests
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APPENDIX 1
Problem solving skills test questions

DISCOURSE

Several animals are predicted to become extinct in 2050, including orangutans?

Jakarta, CNN Indonesia -- Researchers say a number of animals on Earth are threatened with extinction by 2050. Of these animals, 3 of them come from Indonesia and are seriously threatened with extinction. Five mass extinctions have occurred in Earth's history, and many experts have warned of the possibility of a sixth mass extinction. Researchers say this mass extinction could occur as a result of human activities since the Age of Exploration. Some scientists say a near mass extinction could wipe out 40 percent of the species currently on the planet by as early as 2050. However, this theory is said to be the worst possible scenario. Director of the Otago Palaeogenetics Laboratory and senior lecturer in ancient DNA in the Department of Zoology at the University of Otago in New Zealand Nic Rawlence said a sixth mass extinction was very likely. "And, if species do not become globally extinct, it is likely that species that cannot adapt to our rapidly changing world will experience range shrinkage, population bottlenecks, local extinctions, and become functionally extinct. "The current extinction crisis may not have reached the peak of the five extinctions that occurred, but this phenomenon is already on track if it is not stopped," he added.

According to *the International Union for Conservation of Nature* (IUCN) *Red List of Threatened Species,* around 41,000 or nearly a third of all species studied are threatened with extinction. Many well-known species and subspecies, such as the Sumatran orangutan (*Pongo abelii*), Amur leopard (*Panthera pardus orientalis*), Sumatran elephant (*Elephas maximus sumatranus*), black rhinoceros (*Diceros bicornis*), hawksbill turtle (*Eretmochelys imbricata*); The Sunda tiger (*Panthera tigris sondaica*) and Cross River gorilla (*Gorilla gorilla diehli*) are classified as critically endangered. This means that these animals are at a very high risk of extinction in the wild. They are "classified 'critically endangered,' meaning that they are at a very high risk of extinction in the wild," according to the IUCN and the *World Wide Fund for Nature* (WWF). For information, the IUCN describes critically endangered as "a category containing species that have a very high risk of extinction as a result of a rapid population decline of 80 to more than 90 percent over the previous 10 years (or three generations), at the current population size fewer than 50 individuals, or other factors." Many animal species are currently categorized as so threatened that they may not survive until 2050. For example, only 70 Amur leopards remain in the wild, while the vaquita (*Phocoena sinus*), a species of porpoise that is considered the most endangered marine mammal rare in the world, its population has decreased to only 10 individuals. Then there are also many animal species that are less well known but are at great risk of extinction. A 2019 review published in the journal Biological Conservation found that more than 40 percent of insect species are now threatened with extinction. Researchers say more sustainable, ecologically based practices need to be adopted worldwide. This is necessary to slow or reverse current trends, allowing the recovery of insect populations while preserving important surrounding ecosystems.

A number of insect species are included on the IUCN critically endangered list, namely the white-tipped grasshopper (*Chorthippus acroleucus*), the Southern Alpine bush cricket (*Anonconotus apenninigenus*), the Swanepoel's blue butterfly (*Lepidochrysops swanepoeli*), the Franklin's bee (*Bombus franklini*) and the Seychelles winged leafhopper. (*Proocytettix fusiformis*). Previously, the Minister of Environment and Forestry, Siti Nurbaya Bakar, claimed that Sumatran, Tapanuli and Kalimantan orangutans would not become extinct. "Our optimism that these three types of orangutans will not become extinct is not imaginary, but is supported by evidence in the field," he said, quoted from the Forest Hints website in English. Researcher Eric Meijaard then denied this claim while presenting

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detailed data. As a result, he and several of his colleagues were prohibited from entering national parks in Indonesia. Source: CNNIndonesia.com.(https://www.cnnindonesia.com/technology/20220921152053-199-850819/cepat-lawan-dipreksi-punah-di-2050-cepat-orang-utan).
Question indicators
1. Identifies The Problems
From this phenomenon, what problems underlie the events in the article above and provide your analysis of these problems!
2. Applies Problem Solving Steps
Based on the problem analysis that has been carried out in question no. 1, how to make steps or problem solving efforts that can be done!
3. Identifies Solutions
What solutions do you offer to address endangered species? Create solutions (at least 4) that you can provide as a student!
4. Evaluates Solutions
Based on the 5 solutions you have chosen, evaluate each solution carefully and calculate its positive and negative impacts. Next, choose the most appropriate solution!
5. Defends Solutions
Researchers say a number of animals on Earth are threatened with extinction by 2050. Of these animals, 3 of them come from Indonesia and are seriously threatened with extinction. Five mass extinctions have occurred in Earth's history, and many experts have warned of the possibility of a sixth mass extinction. Researchers say that this mass extinction could occur as a result of human activities since the Age of Exploration. As students, analyze the 1 solution that has been chosen and give your reasons why this solution is appropriate and relevant for solving problems in this event!
6. Real World Applications
Regarding the answer to question No. 5, then: a. How do you apply the solution you chose in your daily life? b. How do you invite local communities to apply solutions to overcome endangered species?
7. Inductive Reasoning
According to *the International Union for Conservation of Nature* (IUCN) *Red List of Threatened Species,* around 41,000 or almost a third of all species studied are threatened with extinction, so one of the efforts to conserve living things is in situ and ex situ. Analyze several efforts to preserve living things that are taking place in endangered species around the area where you live?
8. Deductive Reasoning
According to IUCN and *the World Wide Fund for Nature* (WWF). For information, the IUCN describes critically endangered as "a category containing species that have a very high risk of extinction as a result of a rapid population decline of 80 to more than 90 percent over the previous 10 years (or three generations), at the current population size fewer than 50 individuals, or other factors." Many animal species are currently in the highly threatened category so they may not be able to survive until 2050, can you conclude that this event will last a long time if some people carry out illegal logging carried out by irresponsible parties, disease, competition between animals and inability to adapt to natural changes?