

Analysis of Student Problem-Solving Skills in XI Class Biology Learning at State Senior High Schools Sleman Regency

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Abstract: Problem-solving skills are considered essential for students to have because they can help students make appropriate, careful, systematic, logical decisions and weigh various viewpoints. High school students must have problem-solving skills because biology subjects are developed through analytical, inductive, and deductive thinking to solve problems related to nature. This research aims to determine students' problem-solving skills in class XI biology learning at State High Schools in Sleman Regency. This research is a type of descriptive research using a survey approach. The population in this study were all Sleman Regency State High Schools, namely 17 schools with a sample of 9 schools so the subjects in this study were 249 students. Research subjects were selected using probability sampling with cluster sampling techniques. The data collection technique uses tests in the form of problem-solving questions. The results of the research show that the level of problem-solving skills of class XI students at state SMA Sleman Regency was in the medium category with a percentage of 43.21%. The percentage of each indicator, namely understanding the problem, is 65.8% in the capable category, evaluating alternatives is 37% in the less category, and creating a problem-solving plan is 29% in the less category.

Keywords: Analysis; High school biology learning; Problem-solving skills

Introduction

The purposes of education from year to year has developed very rapidly. Education at this time is expected to be able to produce superior human resources (HR), have strong communication and collaboration skills, be experts in the field of technology, able to think creatively and innovatively, and solve problems (Mardiyah et al., 2021). The various competencies needed by students in the age of globalization are often referred to as the skills of the 21st century (Purwanti et al., 2022).

The 21st century was called the age of knowledge, the age of information technology, globalization, the industrial revolution 4.0, and so on (Darise, 2019). In the 21st century, the role of education is to prepare the generations to master the skills that are needed (Jufriadi et al., 2022). According to Trisnawati et al. (2019), these

skills are known as 4C (critical thinking, communication, collaboration, creativity). 4C skills is a soft skill which in its daily implementation is far more useful than mastering hard skills (Azmi & Rahmi, 2024).

In addition, the development of sciences and is an inevitable phenomenon in the 21st century (Hidayatulloh et al., 2020). However science and technology can also be a disaster if we can't adapt to these developments. So to be able to adapt to the rapid development of science and technology and to be able to compete globally, every individual must have 21st century skills (Jayadi et al., 2020). The ability to solve problems is very necessary in the current learning development process (Rahmanto & Wilujeng, 2024). Putri et al. (2022) explained to dealing with the era of society 5.0, human resources must be fully prepared to adapt to future changes, one of which is problem-

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solving skills. This skills needed to find accurate information and analyze existing information or data.

According to Yanti et al. (2016) problem-solving skills are the ability of the individual to find the right way to find solutions to a problem. Mahardika et al. (2021), claim that one of the essential skills that students must have is the ability to solve problems. Students can benefit from new experiences by solving problems and developing problem-solving (Puspita et al., 2022). Moreover, students' problem-solving abilities may have a positive effect on other skills like critical thinking and creative thinking (Anugraheni, 2020) creative thinking skills (Putri et al., 2022), communication abilities, and scientific literacy abilities (Sutrisna, 2021).

Students who have problem-solving skills are also able to apply their knowledge in the context of the problem at hand (Suryani et al., 2020). Problem-solving is very appropriate when integrated into the learning process because problem-solving not only expects students to just listen, take notes, then memorize the subject matter but also discover a way of looking for the correct problem-solving solution so that students become active in thinking and searching, communicating, searching and processing both information and data until the final stage is concluding (Palennari et al., 2021). According to Ati et al. (2020) problem-solving activities that are integrated into the learning process can help students build new knowledge so that problem-solving skills become an aspect that must be considered. According to Paidi (2011) students, particularly high school students, view problem-solving skills as essential because they can assist them in making accurate, systematic, logical decisions and weighing various points of view. Students will develop the habit that engaging in various activities without knowing the purpose and reason for doing so.

To optimize problem-solving abilities, educators need to first collect data regarding students' problem-solving abilities (Lin, 2019). This process involves exploring various aspects that can influence the good and bad of students' problem solving abilities. According to research by Ningsih et al. (2024), problem-solving abilities are still not well documented. Educators often focus on overall learning outcomes, while problem-solving abilities have the potential to influence those learning outcomes.

Biology subjects are developed through analytical, inductive, and deductive thinking to solve problems related to events that exist in nature (Ministry of National Education, 2006). In high school biology subjects, problems can be related to materials that involve a lot of scientific discipline in their strategy, such as ecosystems (Ule et al., 2021), the environment (Hanifa et al., 2018), biotechnology (Hendriana, 2023), and human organ systems (Irfan et al., 2019). This material is

related to everyday human life. Biology as one of the sciences has a close relationship with human life on earth so its learning focuses on process skills (Novianti, 2021, Mahdi et al., 2023).

Problem-solving skills, help students make appropriate, systematic and logical decisions and consider different perspectives (Mardiyah et al., 2021). Based on research on problem-solving skills analysis conducted by Hidayatulloh et al. (2020) shows that the score is only 44% of the expected ideal score. In addition, the PISA survey (2018), which includes a section on problem-solving skills, reveals 70% contains a component of problem-solving skills, appearing that 70% of Indonesian understudies are incapable to total level 2 within the PISA system, indeed in spite of the fact that as it were 23% of understudies in 79 PISA partaking countries (OECD, 2019) are unable to master level 2 reading skills (Hidayatulloh et al., 2020). This shows that Indonesian students still lack both literacy and problem-solving skills (Ilmi, 2019).

So it is important to conduct research related to students' problem solving abilities seen from the cognitive aspect, as explained previously that the cognitive aspect is related to problem solving (Herawati & Wilujeng, 2023). When students face problems, they tend to look for solutions with different approaches (Dung & Bao, 2021). Students' problem solving strategies are greatly influenced by the way they receive and process information. Therefore, research that considers cognitive aspects can provide deeper insight into how students solve problems in a way that suits their respective cognitive characteristics (Ubaidillah et al., 2023)

In light of the findings of PISA and some of the preceding research, it is necessary to measure students' problem-solving skills and to carry out additional research so that appropriate learning can be developed in the future to support students' problem-solving skills. As previously stated, the research aims to investigate problem-solving skills of eleventh-grade students at state high schools in Sleman Regency in the subject of biology.

Method

This research used descriptive research with the survey approach which has the result of a description of students problem-solving. Surveys are one of the information-gathering techniques related to the ability, opinions, behaviors, confidence, and knowledge of a population (Nuriyah et al., 2020). The incident surveyed in this research was the ability to solve the problem of public high school education in Sleman Regency. The research procedure consists of three chapters, namely the preparation chapter, the implementation chapter,

and the data analysis chapter. The following research flow is presented in Figure 1.

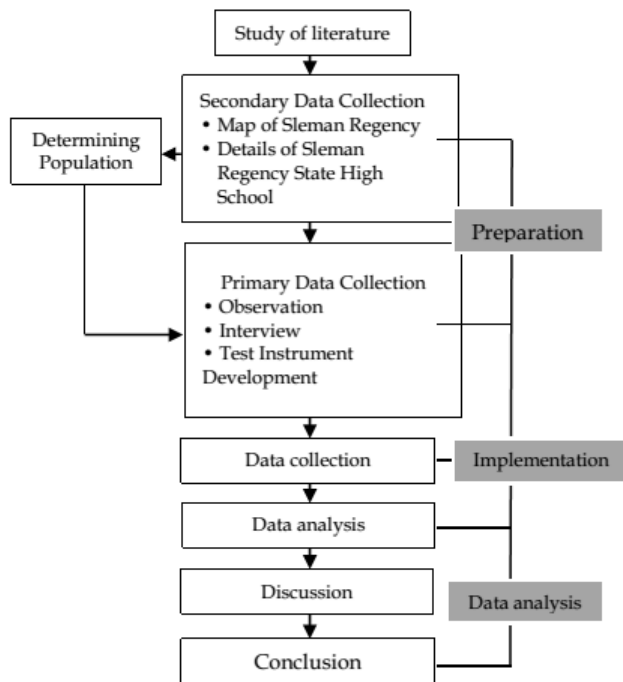


Figure 1. Research flow

The population in this research is students of class XI at 17 high schools in Sleman Regency with a sample of 9 high schools namely 249 people. The sample was selected through probability sampling using a sampling technique of cluster sampling (Hidayatulloh et al., 2020). Data collection through problem-solving ability test questions in the form of multiple choices and essay. The research was conducted from May until June 2023.

The problem-solving test uses test questions consisting of 8 multiple-choice and 2 description questions, adopted from research (Rini & Budijastuti, 2022). Questions of number 1-8 represent indicators of connecting information or data to understand the problem, description questions of number 9 represent indicators of evaluating alternative solutions to problems presented and description questions of number 10 represent indicators of deciding to solve the problem.

Data analysis techniques for problem-solving skills are carried out using SPSS (Statistical Package for Social Science). Descriptive statistical analysis which includes averages, is then presented in the form of diagrams concerning categories. The percentage of achievement for each indicator derived from the students' scores on each item using a predetermined scoring rubric is then used to process the data's outcomes. The following formula can be used to determine the level of

achievement of students' problem-solving skills (Yuanari, 2011; Hidayatulloh et al., 2020).

$$\text{Value} = \frac{\text{Scores Obtained}}{\text{Maximum Score}} \times 100 \quad (1)$$

(Yuanari, 2011)

The following formula is used to determine the average percentage of each indicator of problem-solving skills:

$$\text{NP} = \frac{R}{\text{SM}} \times 100\% \quad (2)$$

(Hanifa, Akbar & Abdullah, 2019)

Information:

NP : Percent Value Wanted

R : Raw Score Derived

SM : Maximum Score

The results of calculating the value for problem-solving skills are then categorized according to (Arikunto, 2009). The qualitative analysis of the percentage of students who achieved these scores is categorized following Table 1.

Table 1. Criteria for Percentage of Student's Problem-Solving Skills (Arikunto, 2011)

Achievement percentage	Criteria
80 < PK ≤ 100	Very capable
60 < PK ≤ 80	Capable
40 < PK ≤ 60	Currently
20 < PK ≤ 40	Not enough
0 < PK ≤ 20	Very less

Result and Discussion

According to the data obtained, the ability to solve the problem of the grade XI high school student in Sleman Regency is categorized on a moderate estimate of 43.21%. The current categories acquired by learners are caused by a number of factors: the lack of thoroughness with which learners are working on matters, the lack of learners analyzing, formulating, and evaluating what is being done, the lack of focus on what is being done, and based on the claims of some learners, they are rarely trained to do problem solving. This is in line with research Nugraha et al. (2021) that the factors that cause students difficulties in solving problems are that students do not understand the questions, are not careful in reading and checking answers, lack skills in planning solutions, loss of motivation and lack of confidence in solving problems. In general, the results of the achievement of students' problem-solving skills from working on all problem-solving questions can be seen in Figure 2.

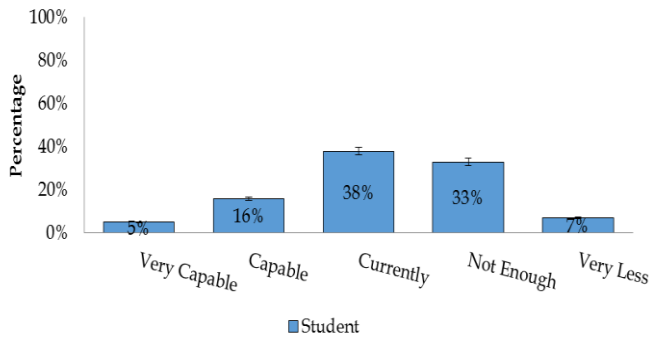


Figure 2. Achievement of student problem-solving skills

Meanwhile, data from the average results of problem-solving skills for each indicator can be seen in Figure 3.

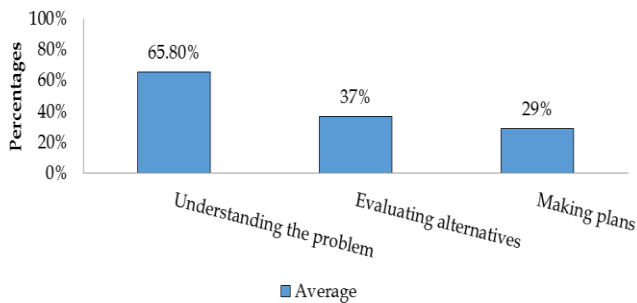


Figure 3. Average value of each indicator

According to Figure 3, making plans has the lowest average value and the indicator of understanding the problem has the highest average value. This demonstrates that one indicator of problem-solving skills remains capable. Based on Figure 3 the categories for each indicator are presented in tabular form in Table 2.

Table 2. Level of Achievement Indicator of Students Problem Solving Skills

Indicator	Percentage of student answers	Category
Understanding the problem	65.8%	Capable
Evaluate alternative solutions to problems	37%	Not enough
Make plans for the finish problem.	29%	Not enough

Understanding the Problem Indicator

This indicator, which indicates the highest average percentage of achievement 65.8% is regarded as capable. Skills in correctly forming an understanding of a problem and recognizing relevant information are indicators of understanding a problem. The overall profile of students' problem-solving skills

on the indicator of problem comprehension is depicted in Figure 4.

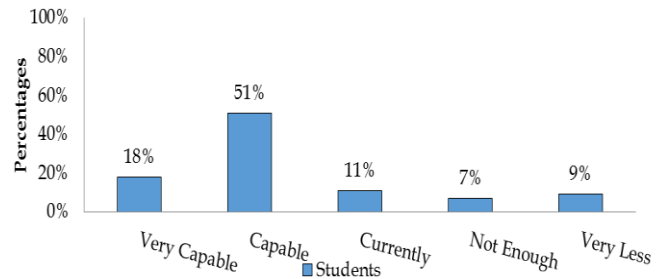


Figure 4. Students' achievement on the comprehension problem index

Capable categories at the indicator of understanding of the problem show that students are able to understand and search for information on the problem well. This result also indicates that an indicator of understanding of the problem is one of the most effective indicators by students in problem-solving skills. Aji et al. (2023) reveals that some of the trainees during their intake of materials had little difficulty working on number 1-8. Even though the fact is that not all participants get a perfect score on item number 1-8.

Evaluating Alternatives Indicator

The indicator evaluates alternatives. This indicator shows the average percentage of achievement which is 37% which is categorized as not enough. Skills in connecting knowledge with alternative solutions to problems that will be designed and planning approaches and strategies to solve a problem are indicators of evaluating alternatives (Yanto & Enjoni, 2021). Indicators for evaluating alternatives are presented in item number 9. Figure 5 shows the profile of students' problem-solving skills on the indicator of understanding the problem.

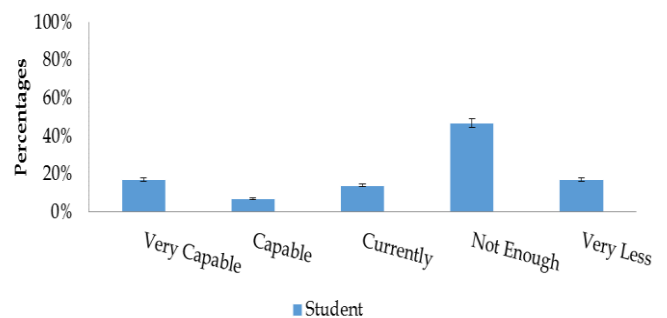


Figure 5. Level of achievement students on indicators evaluating alternatives

Several factors are thought to be responsible for this indicator's lack of problem-solving skills. The first factor is the student's expressions when working on item

number 9 in the learning process. Students are less trained to find ideas because they are rarely taught how to work on questions that require problem-solving. This is supported by research Aydogdu et al. (2012) who were not accustomed to solving problem-based questions during their learning carry off significantly worse than those who participated in problem-based learning. In this case, students need to be accustomed to problem-based learning because the solution-based learning process has a positive influence on critical thinking and perception of problem solving (Perdani et al., 2023). The second factor is the students' poor comprehension of the questions. Students are less thorough when they answer questions with lengthy texts, which results in less optimal and illogical problem planning. The third factor is being too hasty when answering questions, which also makes it harder to solve problems to their fullest extent. This was also revealed in research (Rosydiana et al., 2023) which stated that students tend to feel confident and satisfied with a solution being developed without the need to look for other solutions or alternatives.

Make Problem-Solving Plans Indicator

When compared to the other indicators, this one has the lowest average percentage of achievement, 29% in the less category. The indicator for making a solution plan is presented in item number 10. Figure 6 shows the overall profile of students' problem-solving skills on the indicator for making problem-solving plans.

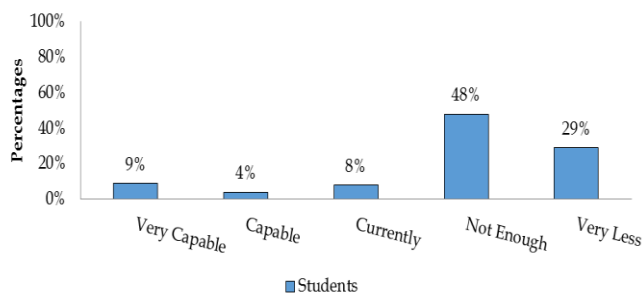


Figure 6. Level of achievement students on indicators of making problem-solving plans

According to the findings of research conducted by Hidayatulloh et al. (2020) based on the indicators of making a problem-solving design, the weak point of students' problem-solving skills is making a plan or the appropriate steps to solve a problem, that students' indicator weakness is alternative problem-solving planning. This is due to some factors, one of which students discovered while working on the problem was the difficulty in determining the independent and dependent variables. Students also have trouble coming up with strategies for resolving issues. So many students write answers that are illogical and not in line with the

topic of discussion. A research result by Yanti et al. (2016) which states that students who design problem-solving but are illogical will not follow proper planning and will make the students' plans inappropriate to implement. Research conducted Fikri et al. (2023) wrote that solving problems using the problem solving stage requires quite a long time in the process and cannot be done in a hurry. Even though the indicators make the problem-solving design fall into the less category, some students get maximum scores.

Analysis of the average value of problem-solving skills was also carried out at each school, namely as many as 9 SMAN in Sleman Regency. Based on the data obtained, the value of each school has an average value of different problem-solving skills. In this case, it is analyzed using the SPSS, namely conducting a normality test first to determine the statistical test to be used.

In this study, the Kruskal-Wallis test was used. The Kruskal-Wallis test is a non-parametric statistical exam that can be used to stretch whether there's a considerable change between the free variables and the conditional changeable. This test is utilized to examine comparisons of more than two population groups using data in the form of rankings to detect significant differences between groups (Brabar et al., 2021). The results of the Kruskal Wallis test can be seen in Table 3.

Table 3. Kruskal Wallis Rest Results Using SPSS

Statistics test	Learners
Chi-square	79.46
Df	8
Asymp. Sig	.000

Based on the results of the Kruskal Wallis test, value < 0.05 then H0 is rejected so it can be concluded that there is an average difference in problem-solving skills between SMA A, SMA B, SMA C, SMA D, SMA E, SMA F, SMA G, SMA H, and SMA I. More details can be seen in Figure 7.

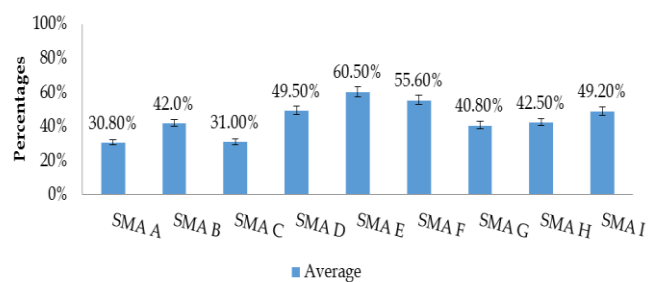


Figure 7. Average score of each school

According to Figure 6 above, SMA E has the best common rating with a rating with a score of 60%, while SMA A has bad common rating with a score of 30.80%.

With an average score of 43.21% students at SMA N Sleman Regency fall into the medium category when it comes to their ability to solve problems. After being analyzed with the SPSS program, the results of the descriptive statistical analysis of the biology class XI high school students' problem-solving skills regarding motion systems are presented in Table 4.

Table 4. Description of the Value of Solving Skills for Class XI High School Students in the District

Descriptive statistics	Problem-solving skills
Deviation standard	18.21
Average	43.21
Min value	5
Max value	90
Number of samples	249

The data from 249 students who participated as subjects in the study had an average value of 43.21 for problem-solving skills, as shown in Table 3. Students' problem-solving abilities receive a score between 5 and 90 as a minimum and as a maximum.

Based on the analysis that has been done, it can be said that the problem-solving skills of class XI SMA students in Sleman Regency are in the moderate category, so they still need to be improved to reach the very capable category. This category can be achieved by improving the learning process by applying problem-based learning so that later students will get used to identifying problems, formulating problems, organizing information, finding solutions to solve problems, and choosing alternative solutions to solve problems (Ella, 2019).

Conclusion

Research findings analyzing the problem-solving abilities of class The percentage of each indicator of problem solving skills, namely the indicator for understanding problems, is 65.8% in the capable category, the indicator for evaluating alternatives is 37% in the poor category and the indicator for making problem solving plans is 29% in the poor category. Suggestions for future researchers are that when conducting research on problem solving skills use more indicators of problem solving skills so that the results obtained are more optimal.

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Author Contributions

Conceptualization, A.D.A, H.H, N.A.A; Data Collection, A.D.A ; Analysis Data, A.D.A ; Writing-review and editing, A.D.A ; Guides the improvements. H.H, N.A.A. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest

The authors have stated that there are no competing interests.

References

- Aji, R., Mahmudi, A. (2003). Efektivitas Pembelajaran Matematika Dengan Strategi Problem Solving Untuk Meningkatkan Kemampuan Pemecahan Matematis Siswa Kelas VIII SMP. *Jurnal Pendidikan Matematika Dan Sains*, 7(3), 1–9. <https://doi.org/10.21831/jpm.v7i3.11169>
- Anugraheni, I. (2020). Analisis Kesulitan Mahasiswa dalam Menumbuhkan Berpikir Kritis Melalui Pemecahan Masalah. *Jurnal Cendekia: Jurnal Pendidikan Matematika*, 4(1), 261–267. <https://doi.org/10.31004/cendekia.v4i1.197>
- Arikunto, S. (2011). *Prosedur penelitian, suatu pendekatan praktik*. Jakarta: Rineke Cipta.
- Ati, T. P., & Setiawan, Y. (2020). Efektivitas Problem Based Learning-Problem Solving Terhadap Kemampuan Berpikir Kritis dalam Pembelajaran Matematika Siswa Kelas V. *Jurnal Cendekia: Jurnal Pendidikan Matematika*, 4(1), 294–303. <https://doi.org/10.31004/cendekia.v4i1.209>
- Azmi, U., Safrizal, & Rahmi, M. (2024). Analysis of 4C Skills (Critical Thinking, Creativity and Innovation, Collaboration, and Communication) of Physics Education Students in Facing the Industrial Revolution 4.0. *Jurnal Penelitian Pendidikan IPA*, 10(2), 695–703. <https://doi.org/10.29303/jppipa.v10i2.5584>
- Brabar, V., Hikoyabi, G., & Langowoyu, A. (2021). Analisis Kruskal Wallis untuk Mengetahui Tingkat Kosentrasi Belajar Mahasiswa Berdasarkan Program Studi. In *Prosiding Konferensi Nasional Matematika* XX.. <https://doi.org/10.30598/PattimuraSci.2021.KN MXX>
- BSNP. (2006). *Panduan Penyusunan Kurikulum Tingkat Satuan Pendidikan*. BSNP Depdiknas.
- Darise, G. N. (2019). Implementasi Kurikulum 2013 Revisi Sebagai Solusi Alternatif Pendidikan Di Indonesia Dalam Menghadapi Revolusi Industri 4.0. *Jurnal Ilmiah Iqra'*, 13(2), 41-53.

- <https://doi.org/10.30984/jii.v13i2.967>
- Dung, T. M., & Bao, P. M. (2021). Vietnamese students' problem-solving skills in learning about error of measurements. *International Electronic Journal of Mathematics Education*, 12(3), 463–474. <https://doi.org/10.29333/iejme/625>
- Fikri, F., & Adlini, M. N. (2023). Discovery Learning Based Ecosystem Student Work Sheet to Improve Problem Solving Ability of Students in Class X MA. *Jurnal Penelitian Pendidikan IPA*, 9(6), 4551–4557. <https://doi.org/10.29303/jppipa.v9i6.3858>
- Hendriana, F. (2023). Meningkatkan Kemampuan Memecahkan Masalah dalam Pembelajaran Biologi Materi Bioteknologi dengan Model PBL pada Siswa Kelas XII MIPA 1 di SMAN 3 Mataram Tahun Pelajaran 2022/2023. *Jurnal Pembelajaran Dan Pengembangan Diri*, 3(2), 333–342. <https://doi.org/10.47353/bbj.v3i2.166>
- Herawati, N. I., & Wilujeng, I. (2023). Improving Problem Solving Ability Through Problem Based Learning E-Modules. *Jurnal Penelitian Pendidikan IPA*, 9(9), 6787–6794. <https://doi.org/10.29303/jppipa.v9i9.4622>
- Hidayatulloh, R., Suyono, & Azizah, U. (2020). Analisis keterampilan pemecahan masalah siswa SMA pada topik laju reaksi. *Jurnal Penelitian Pendidikan Sains*, 10(01), 1899–1909. <https://doi.org/10.26740/jpps.v10n1.p1899-1909>
- Ilmi, A. R. M. (2019). Model Pembelajaran Creative Problem Solving (CPS) untuk Meningkatkan Performa Pemecahan Masalah Siswa. *Jurnal Rekayasa, Teknologi, dan Sains*, 3(1), 34–41. <https://doi.org/10.31316/j.derivat.v5i1.149>
- Irfan, M. K., Yelianti, U., & Muhaimin. (2019). Pengembangan E-Modul Pembelajaran Biologi Berbasis 3D Pageflip pada Materi Klasifikasi Makhluk Hidup untuk Siswa Kelas VII SMP Development. *Jurnal Edu-Sains*, 8(1), 9–16. <https://doi.org/10.22437/jmpmipa.v8i1.8891>
- Hanifa, N. I. (2018). Analisis Kemampuan Memecahkan Masalah Siswa Kelas X IPA pada Materi Perubahan Lingkungan dan Faktor yang Mempengaruhinya. *Jurnal Penelitian Pendidikan Biologi*, 2(2), 121–128. <https://doi.org/10.32502/dikbio.v2i2.1895>
- Jayadi, A., Putri, D. H., & Johan, H. (2020). Identifikasi Pembekalan Keterampilan Abad 21 Pada Aspek Keterampilan Pemecahan Masalah Siswa SMA Kota Bengkulu dalam Mata Pelajaran Fisika. *Jurnal Kumbaran Fisika*, 3(1), 25–32. <https://doi.org/10.33369/jkf.3.1.25-32>
- Jufriadi, A. (2022). Analisis Keterampilan Abad 21 Melalui Implementasi Kurikulum Merdeka Belajar Kampus Merdeka. *Jurnal Pendidikan Dan Kebudayaan*, 7(1), 39–53. <https://doi.org/10.24832/jpnk.v7i1.2482>
- Lin, Y. T. (2019). Impacts of a flipped classroom with a smart learning diagnosis system on students' learning performance, perception, and problem solving ability in a software engineering course. *Elsevier*, (95), 187–196. <https://doi.org/10.1016/j.chb.2018.11.036>
- Mahardika, A. I., Pertiwi, H., & Miriam, S. (2021). Pengembangan Emorish Untuk Meningkatkan Keterampilan Pemecahan Masalah Pada Pembelajaran Fisika. *Jurnal Kependidikan: Penelitian Inovasi Pembelajaran*, 5(2), 194–205. <https://doi.org/10.21831/jk.v5i2.40251>
- Mahdi, Raharjo, T. J., & Widiasih. (2023). Analysis of Problem Solving Ability in Natural Sciences and Life Skills through Guided Discovery Learning in the View of Student Learning Independence in the Subject Matter of Changes in Energy Forms. *Jurnal Penelitian Pendidikan IPA*, 9(12), 11093–11100. <https://doi.org/10.29303/jppipa.v9i12.5289>
- Mardiyah, R. H. (2021). Pentingnya Keterampilan Belajar di Abad 21 sebagai Tuntutan dalam Pengembangan Sumber Daya Manusia. *Jurnal Pendidikan*, 12(1), 29–40. <https://doi.org/10.31849/lectura.v12i1.5813>
- Ningsih, P. W., Putri, D. H., & Purwanto, A. (2024). Development of Student Worksheets based on Problem- Solving of Temperature and Heat to Improve the Students Problem-Solving Ability. *Jurnal Penelitian Pendidikan IPA*, 10(2), 940–950. <https://doi.org/10.29303/jppipa.v10i2.6524>
- Novianti, R. (2021). Model Pembelajaran Untuk Menumbuhkan Karakter Peduli Lingkungan Mata Pelajaran IPA. *JPB - Jurnal Pendidikan Biologi*. 2(2), 16–23. <https://doi.org/10.55719/jpb.v2i2.550>
- Nugraha, M. R., & Basuki, B. (2021). Kesulitan Kemampuan Pemecahan Masalah Matematis Siswa SMP di Desa Mulyasari pada Materi Statistika. Plusminus. *Jurnal Pendidikan Matematika*. 1(2), 235–248. <https://doi.org/10.31980/plusminus.v1i2.1259>
- Nuriyah, D., Sutarto, & Prihatin, J. (2020). The development of environmental change textbook based on STEM-Cp to improve problem-solving skills in high school biology learning. *Journal of Physics: Conference Series*, 1563(1), 1–8. <https://doi.org/10.1088/1742-6596/1563/1/012054>
- OECD. (2019). *PISA 2018 Results: Executive summary*. Columbia University.
- Paidi. (2011). Development of Problem-Based Learning Kits for Biology. *Jurnal Kependidikan*, 41(2), 185–201. <https://doi.org/10.21831/jk.v41i2.1932>
- Palennari, M., Lasmi, & Rachmawaty. (2021). Keterampilan Pemecahan Masalah Peserta Didik :

- Studi Kasus di SMA Negeri 1 Wonomulyo. *Jurnal Pendidikan dan Pembelajaran Biologi*, 5(2), 208–216. <https://doi.org/10.33369/diklabio.5.2.208-216>
- Perdani, A. S., Hernani, H., & Ramalis, T. R. (2023). Examining the Correlation between Critical Thinking and Problem-Solving Skills of Junior High School Students Against Climate Change. *Jurnal Penelitian Pendidikan IPA*, 9(9), 6904–6910. <https://doi.org/10.29303/jppipa.v9i9.4438>
- Purwanti, A. (2022). Analisis Keterampilan Berpikir Kritis Mahasiswa Melalui Model Blended-Project Based Learning Terintegrasi Keterampilan Abad 21 Berdasarkan Students Skill Level. *Jurnal IPA & Pembelajaran IPA*, 6(3), 235–245. <https://doi.org/10.24815/jipi.v6i3.25128>
- Putri, R. (2022). Pentingnya Keterampilan Abad 21 Dalam Pembelajaran Matematika. *SICEDU: Science and Education Journal*, 1(2), 449–459. <https://doi.org/10.31004/sicedu.v1i2.64>
- Rahmanto, T., & Wilujeng, I. (2024). Development of Student Worksheets Using the Engineering Design Process to Practice Physics Problem-Solving Skills for Vocational School Students. *Jurnal Penelitian Pendidikan IPA*, 10(2), 545–556. <https://doi.org/10.29303/jppipa.v10i2.4969>
- Rini, A. F., & Budijastuti, W. (2022). Pengembangan Instrumen Soal HOTS untuk Mengukur Keterampilan Pemecahan Masalah pada Materi Sistem Gerak Manusia. *BioEdu*, 11(1), 127–137. <https://doi.org/10.26740/bioedu.v11n1.p127-137>
- Rosydiana, E. A., Sudjimat, D. A., & Utama, C. (2023). Effect of Digital Learning Media Using Scratch Game Based Learning on Student Problem Solving Skills. *Jurnal Penelitian Pendidikan IPA*, 9(11), 10010–10015. <https://doi.org/10.29303/jppipa.v9i11.4876>
- Suryani, M., Jufri, L. H., & Putri, T. A. (2020). Analisis Kemampuan Pemecahan Masalah Siswa Berdasarkan Kemampuan Awal Matematika. *Mosharafa: Jurnal Pendidikan Matematika*, 9(1), 119–130. <https://doi.org/10.31980/mosharafa.v9i1.605>
- Sutrisna, N. (2021). Analisis Kemampuan Literasi Sains Peserta Didik SMA Di Kota Sungai Penuh. *Jurnal Inovasi Penelitian*, 1(12), 2683–2694. <https://doi.org/10.47492/jip.v1i12.530>
- Trisnawati, W. W., & Sari, A. K. (2019). Integrasi Keterampilan Abad 21 dalam Modul Sociolinguistics: Keterampilan 4C (Collaboration, Communication, Critical Thinking, dan Creativity). *Jurnal Muara Pendidikan*, 4(2), 455–466. <https://doi.org/10.52060/mp.v4i2.179>
- Ubaidillah, Ananto, N., Efendi, Sappaile, B. I., & Lumingkewas, C. F. (2023). Efforts to Overcome Students' Difficulties in Understanding the Concept of Story Problems with the Problem-Solving Method and the Question and Answer Method in Science Learning. *Jurnal Penelitian Pendidikan IPA*, 9(7), 5236–5241. <https://doi.org/10.29303/jppipa.v9i7.4011>
- Ule, K. N., Bunga, Y. N., & Bare, Y. (2021). Pengembangan Modul Pembelajaran Biologi Berbasis Jelajah Alam Sekitar (JAS) Materi Ekosistem Taman Nasional Kelimutu (TNK) SMA Kelas X. *Diklabio: Jurnal Pendidikan Dan Pembelajaran Biologi*, 5(2), 147–156. <https://doi.org/10.33369/diklabio.5.2.147-156>
- Yanti, N. R., Suharto, B., & Syahmani, D. (2016). Implementasi Model Problem Based Learning Berbantuan Tes Superitem Terhadap Kemampuan Pemecahan Masalah Materi Kelarutan Dan Hasil Kali Kelarutan. *Jurnal Inovasi Pendidikan Sains*, 7(2), 147–155. <https://doi.org/10.20527/quantum.v7i2.3580>
- Yanto, F., & Enjoni, E. (2021). Penerapan Model Pembelajaran PBL (Problem Based Learning) Untuk Meningkatkan Kemampuan Pemecahan Masalah Siswa Di Kelas V Sekolah Dasar. *Jurnal Cerdas Proklamator*, 9(1), 9–19. <https://doi.org/10.37301/jcp.v9i1.74>
- Yulianto, D. (2022). Analisis Kemampuan Pemecahan Masalah Siswa Sma Se-Kabupaten Tangerang Pada Penyelesaian. *GeoMath*, 3(1), 1–22. <https://doi.org/10.55171/geomath.v3i1.871>