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# The Conceptual Framework for Problem and Research-Based Learning (PRBL) Model in Learning The Natural Sciences to Empower Students' Analytical Thinking Skills

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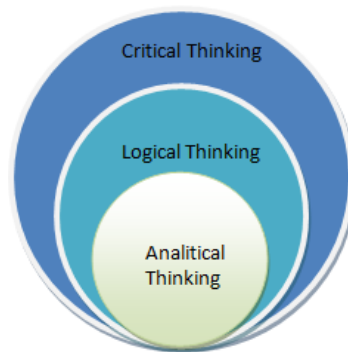
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**Abstract.** Analytical thinking skills are part of critical thinking skills and higher-order thinking skills that are the demands of students in the 21st century. This study aims to produce a conceptual framework for a model in science learning to empower students' analytical thinking skills. The method used in this study was a qualitative method, with the primary source was literature review. Data collection techniques employed literature study which collected data through books and journals. The data obtained from the literature were collected and processed by editing, organizing, and finding the results. Data analysis in this research was content analysis to analyze in-depth the contents of the literature being studied. The results of this study consisted of: 1) The conceptual framework of the modified science learning model is called the problem and research-based learning (PRBL) model, 2) The modified PRBL model has the potential to empower students' analytical thinking skills. This study illustrates to lecturers and subsequent researchers that the modified PRBL model demonstrates the potential to empower analytical thinking skills. The researcher suggests the next researchers conduct research on the application of the PRBL model in the field to test the validity and practicality of the model.

## 1. Introduction

Three types of skills: study skills, literacy skills, and life skills, the learning skills needed by students consist of: creativity and innovation, critical thinking and problem solving, communication and collaboration [1]. According to Ennis [2] critical thinking skills are reasonable and reflective thinking that focuses on deciding what to perform. Elements of critical thinking skills according to [3] consist of: analytical, inference, explanation, evaluation, self-regulation and interpretation. Analytical skills are part of critical thinking skills; meanwhile critical thinking skills are part of higher-order thinking skills that are the demands of students in the 21st century. This is reinforced by the opinion of [4] as in Figure 1, which shows that analytical thinking represents a core part of critical thinking.





**Figure 1.** Analytical thinking is the core of critical thinking

The analytical thinking skills of students from several universities in the world and especially in Indonesia still need improvement. The results of research at the National University of Malaysia (UKM) concluded that students' analytical thinking skills were at a moderate level even though their academic achievement was high [5]. The results of research conducted at Yogyakarta State University (UNY), concluded that the problem-solving method could improve students' analytical thinking skills, as evidenced by the achievement of an individual score of at least B as much as 58% of the subjects. This ability was higher than in the first cycle, where the minimum value of B- was only 33.33% [6]. In addition, research conducted by the State University of Surabaya (UNESA) concluded that students' analytical thinking skills for indicators distinguished 3.01 from good categories, organized 2.93 in good categories, and attributed 2.47 with poor categories [7].

Based on the researcher's preliminary research, the subject was 30 students of the PGMI IAIN Surakarta Study Program, in Basic Concept of Science, which obtained analytical thinking skills as seen in Table 1.

**Table 1.** Student analytical thinking skill

No	Indicators of Analytical Skill	Mean Score
1	Differentiate	52.5
2	Classify	53.3
3	Organize	56.6
4	Attribute	54,4

Based on Table 1, it shows that students' analytical thinking skills still need to be improved, because they are still below 60 with an average score of 54.2, a maximum of 100.

Various attempts were produced to improve students' analytical thinking skills, including by adopting a learning model. From the results of research conducted at IKIP PGRI Pontianak, it was concluded that the discovery learning method contributed to improving students' critical and analytical thinking skills [8]. Likewise, the results of research at the University of PGRI Madiun which linked between analytical abilities and learning models, it was concluded that the inquiry learning model could improve students' analytical thinking skills [9]. The two studies illustrated that students' analytical thinking skills were influenced by the learning model applied in lectures.

The problem-based learning (PBL) model is a learning model oriented to improve thinking skills, including analytical thinking skills [10]. The application of PBL learning refers to the syntax formulated by Arends [10]: 1) problem orientation, 2) organizing learning, 3) guiding individuals or groups in investigations, 4) presentation of results, 5) analyzing and evaluating the learning process. The syntax of the PBL model is applied in learning; the result is that learning with the PBL model is effective for improving analytical thinking skills [11]. These results are reinforced by Schmidt, et al., [12] [13] which states that problem-based learning is effective teaching and learning, especially applied over an extensive period.

In addition to the PBL Model, the research-based learning (RBL) model is a learning model oriented to thinking skills, especially scientific discovery. Scientific activities in learning include adopting the RBL model. The RBL model is a learning model that prioritizes the process of scientific

discovery and develops the independent thinking of students [14]. Students, with the RBL model, can develop problem-solving skills, gain substantial knowledge and concepts from the subject matter [15].

The PBL and the RBL model are suitable learning models to be implemented in science learning. Science learning seeks to motivate students to increase their intelligence and understanding of nature, which is full of secrets [16]. This is reinforced by the opinion of Fatimah [17], which states that science is knowledge with diverse characteristics from other sciences. Science is obtained through various empirical discoveries process by employing scientific methods.

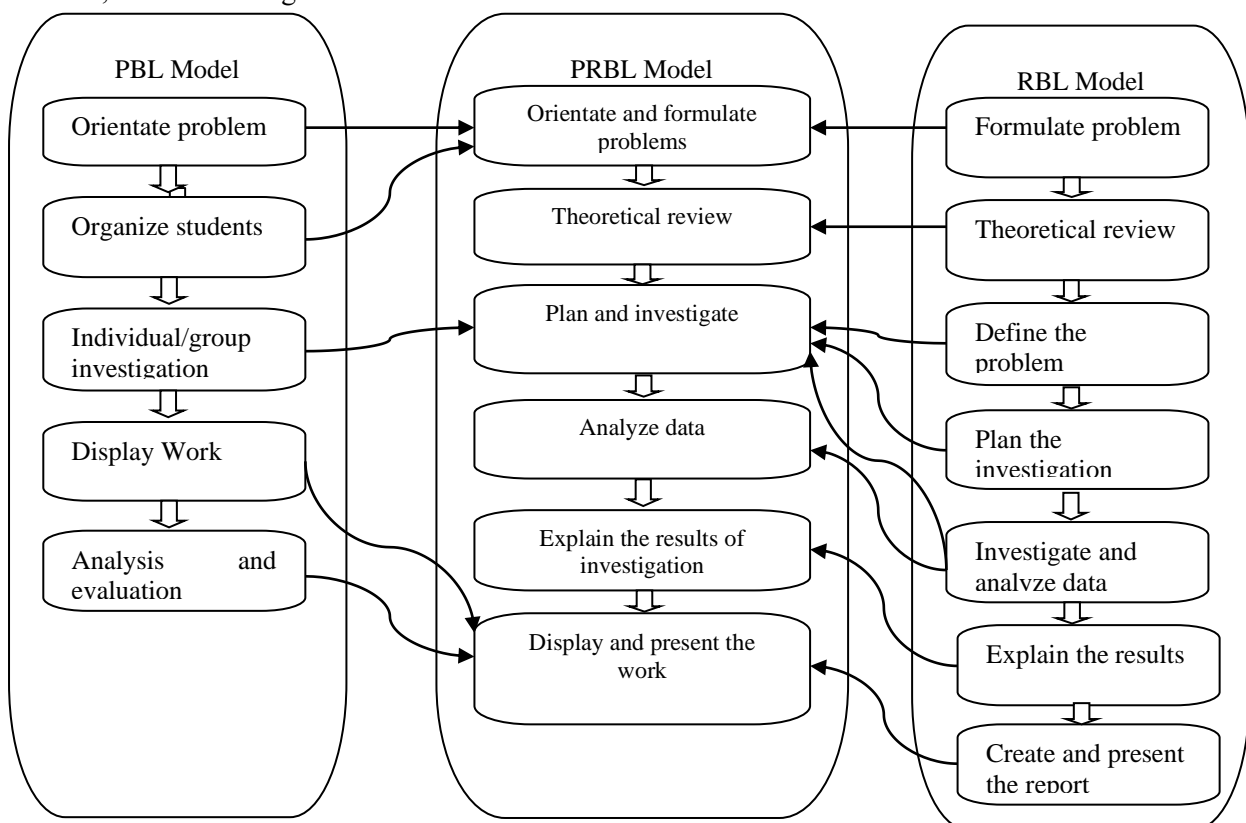
Based on the background of the problem, students' analytical thinking skills were still low, even though analytical thinking skills are one skill demanded in this 21st century. To provide a solution to this problem, this study aims to produce a conceptual framework for a model in science learning to empower students' analytical thinking skills.

## 2. Methods

The method used in this study was a qualitative method, with the primary source was literature review. Data collection techniques employed literature study which collected data through books and journals. The data obtained from the literature were collected and processed by editing, organizing, and finding the results. Data analysis in this research was content analysis to analyze in-depth the contents of the literature being studied. The steps taken the content analysis were: determining problems, developing a framework of thought, developing operational concepts and interpreting data. In this study, the PRBL model was developed based on the literature reviews of the PBL and the RBL model to empower students' analytical thinking skills.

## 3. Results and Discussion

From the literature study, the PRBL model syntax, which is a combination of the PBL and the RBL model, is shown in Figure 2.



**Figure 2.** The PRBL model syntax framework

In Figure 2. It can be seen that the PRBL model is a combination of the PBL and RBL models, for example in stage one, orientation and problem formulation are the first steps in starting the implementation of the PRBL model. Problem orientation is the first stage in the PBL model, as in the PBL syntax by Yahya & Fitriyanto [18], namely 1) orienting students to problems, 2) Organizing students to start learning, 3) Helping investigations independently and groups, 4) presenting the work and displaying it, and 5) analyzing and evaluating the learning process carried out. The results of the researchers' observations, when the student's problem orientation was not focused, so that additional activities were needed to focus it, namely formulating problems. Formulating the problem is the first step in applying the RBL model, as stated by Tremp [19] namely: 1) formulating the problem, 2) reviewing the literature, 3) defining the problem formulation, 4) planning research activities, 5) conducting investigations and data analysis, 6) explaining the results of the investigation, and 7) creating reports and presentations.

The PRBL model syntax, which is a sequence of stages in learning, accompanied by the activities of lecturers and students were listed in table 2.

**Table 2.** PRBL model syntax and the activities of lecturer and students

No	Syntax	Activity of Lecturer	Activity of Students
1	Orientate and formulate problem	Convey the learning objectives and encourage students to participate in the learning process	The orientation of the problem agreed upon with the group and continued by formulating the problem
2	Review basic theory	Answer students' questions if there are concepts that have not been understood when studying the theory.	Read and understand the theory used as a basis for conducting investigations.
3	Plan and investigate	Monitor and provide guidance when students have difficulties	Prepare tools and materials to be used in the investigation. Carry out investigations with the experimental module guide.
4	Analyze data	Direct students in analyzing data to obtain correct conclusions.	Analyze data from the results of the investigations conducted.
5	Explain the results of the investigation	Check the results of the students' explanation, whether it is correct or not.	Explain and interpret the results of data analysis
6	Display and present the work	Guide and direct students at the time of presentation.	Display and present the conclusions in front of the class.

The PRBL model syntax in science learning demonstrates the potential to empower analytical thinking skills, as presented by Arends [20] that problem-based learning helps students develop thinking and problem-solving skills. Analytical thinking skills in this study are listed in Table 2.

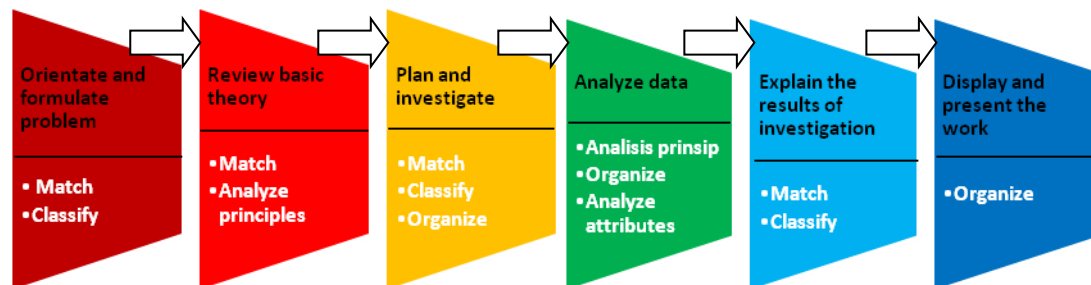
**Table 3.** Analytical thinking skills and indicators

No	The aspect of Analytical Thinking Skills	Indicators
1	Match	Compare, check
2	Classify	Categorize, select
3	Analyze principles	Identify pattern, make up the equation
4	Organize	Identify coherence, integrate, elaborate
5	Analyze attributes	Attribute between variables, construct

Table 2. explains the aspects of analytical thinking skills as a result of the researcher's synthesis, number 1 and 2 of the opinion of Marzano & Kendall [21] which states that aspects of analytical thinking skills consist of: matching, classifying, analyzing errors, generalizing and detailing. Aspects

3, 4 and 5 of the opinion of Montaku, et al., [22] which detail the aspects of analytical thinking skills consisting of: element analysis, relationship analysis, principle analysis, and organizing.

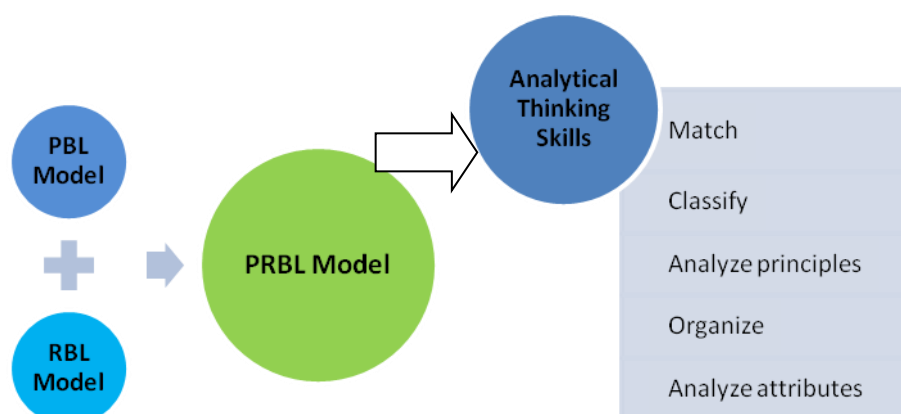
The relationship between the PRBL model syntax and analytical thinking skills, as shown in Figure 3.



**Figure 3.** Potential of the PRBL Model in empowering analytical thinking skills

Figure 3 shows each step of the PRBL model that empowers several aspects of analytical thinking skills. Stage 1) Orientation and formulating problems demonstrate the potential to empower analytical thinking skills in matching and classifying aspects because, at this stage, students compare, check, and classify the problems that are being studied and continue to formulate problems. Stage 2) Assessing the theoretical basis has the potential to empower analytical thinking skills in the aspect of matching and principle analysis because, at this stage, students compare, check, and identify patterns in studying theory as a basis for investigation. Stage 3) Planning and carrying out investigations have the potential to empower analytical thinking skills in the aspects of matching, classifying and organizing because, at this stage, students integrate, find and describe planning and investigation activities. Stage 4) Analyzing data has the potential to empower analytical thinking skills in aspects of principal analysis, organizing, and relationship analysis because, at this stage, students describe, connect between variables and find the results of the investigation. Stage 5) Explaining the research results has the potential to empower analytical thinking skills in matching and classifying aspects because, at this stage, students are required to explain the physical meaning of the results of data analysis. Stage 6) Presenting the work and presenting it has the potential to empower organizational thinking skills because at this stage, students are required to describe the results of their research in the form of reports and present them in front of the class.

The PRBL model is a combination of the PBL and the RBL model, briefly illustrated in Figure 4, accompanied by an instructional impact on critical thinking skills, especially analytical thinking skills.



**Figure 4.** Summary of the PBL model framework and its instructional impact

The PBL model is a learning model based on the mental activities of students in grasping the concepts of situations and problems presented at the beginning of learning which aims to train students to solve problems [23]. Meanwhile, according to Wulandari, et al., [24] [25], the PBL model makes

discussion activities more interesting than general discussions, so that the activities of students are maintained to be active when students have carried out the phases of learning activities.

The PBL model has advantages and disadvantages. The advantages of the PBL model are: 1) the PBL model develops students' critical thinking skills in solving a problem, 2) fosters the creativity of educators, 3) makes students accustomed to facing problems, and 4) grows motivation, courage, self-confidence, and spirit of students [26] [27]. Meanwhile, according to Rerung, et al., [28] the advantages of PBL include: 1) having the ability to develop their own knowledge through learning activities, 2) learning to focus on problems, 3) scientific activity occurring in students through group work, 4) students can assess their own learning progress, and 5) students can carry out scientific communication in group discussion activities. While the weaknesses of the PBL model are: 1) Learning that applies to the PBL model requires high concentration because there are many things must be prepared by educators in presenting learning activities, 2) it requires a lot of money and energy [26]. In addition, the shortcomings of the PBL model according to Rerung et al., [28] include: 1) the PBL model cannot be implemented in all learning materials, and 2) if the class has a high level of student diversity, it will be challenging to divide tasks.

Based on RBL is a learning based on authentic problems, problem-solving, cooperative learning and discovery guided by the philosophy of constructivism. In line with Syafitri [29] [30], RBL is a learning model that uses authentic learning, problem-solving, cooperative learning, and contextual learning. The RBL model can be an alternative learning model applied, because through this model, students can explore, interpret, and synthesize information to obtain various learning outcomes, including: knowledge and skills and scientific attitudes [31] [32]. Whereas the instructor of this model can challenge to rethink the teaching that is routinely used [14].

The RBL model has advantages and disadvantages. The advantages of RBL include: 1) to encourage the role of students in the learning process, 2) students are familiar with the thinking process with a scientific approach, 3) students are independent, logical, critical, and creative [33]. In addition, RBL can improve academic achievement, practice learning on how to acquire and construct new knowledge by yourself [34]. According to Toisuta [35], the RBL Model not merely develops the ability to find and communicate knowledge but can also integrate moral and ethical decisions both personally and collectively that are useful for individuals and the public. Another advantage of the RBL model is explained by Yahya [36] the RBL model provides opportunities for students to understand the content of teaching materials, practice searching, formulating hypotheses, collecting and analyzing data, and formulating conclusions. While the weaknesses of the RBL model are: 1) there will be a failure to find out if students cannot follow and the experimental procedure, 2) Educators act to monitor or monitor the course of the experiment so that if an experiment fails, students have a chance of misconception [37] [38].

The PRBL model is a model constructed based on the synthesis of the PBL and RBL models. An important part of the PRBL model involves students in authentic real-life problems and package them in problem formulations. This model assists students to design, conduct investigations, and analyze data from the results of the investigation. Students can find knowledge and explain their findings in the form of presentations. Based on the theoretical review, the PRBL model has advantages and disadvantages, as in table 4.

**Table 4.** The advantages and disadvantages of PRBL model

Advantages	<ol style="list-style-type: none"> <li>1. Stimulating motivation to think critically</li> <li>2. Stimulating and foster a creative climate</li> <li>3. Constructing his own knowledge and solve problems by himself</li> <li>4. Encourage courage and self-confident in scientific communication</li> <li>5. Encourage to have self-evaluation</li> <li>6. Develop a scientific attitude in learning</li> </ol>
Disadvantages	<ol style="list-style-type: none"> <li>1. Need high concentration in learning</li> <li>2. Unable to be applied in all learning materials</li> </ol>

- 
3. Students are required to be creative
  4. Required a careful preparation before learning
- 

Based on the analysis of advantages and disadvantages, the modified PRBL Model possesses the potential to empower students' analytical thinking skills in the aspects of matching, identifying, principle analysis, organizing, and relationship analysis.

#### 4. Conclusion

Based on the results of data analysis, it can be concluded: a) The conceptual framework of the modified science learning model is called the problem and research-based learning (PRBL) model, b) The modified PRBL model provides a syntax, namely: (1) problem orientation and problem formulation, (2) assessing theoretical basics, (3) planning and carrying out investigations, (4) analyzing data, (5) explaining research results, and (6) displaying and presenting the work. c) The modified PRBL model has the potential to empower students' analytical thinking skills in the aspects of matching, identifying, analyzing principle, organizing, and analyzing the relationship. This study illustrates to lecturers and subsequent researchers that the modified PRBL model demonstrates the potential to empower analytical thinking skills. The researcher suggests the next researchers conduct research on the application of the PRBL model in the field to test the validity and practicality of the model.

#### References

- [1] E. Van Laar, A. J. A. M. Van Deursen, J. A. G. M. Van Dijk, and J. De Haan, "The relation between 21st-century skills and digital skills: A systematic literature review," *Comput. Human Behav.*, vol. 72, pp. 577–588, 2017.
- [2] R. H. Ennis, "Critical thinking dispositions: Their nature and assessability," *Informal Log.*, vol. 18, no. 2, 1996.
- [3] S. Grantham-McGregor *et al.*, "Developmental potential in the first five years for children in developing countries," *Lancet*, vol. 369, no. 9555, pp. 60–70, 2007.
- [4] K. Rasheva-Yordanova, E. Iliev, and B. Nikolova, "Analytical Thinking As A Key Competence For Overcoming The Data Science Divide," in *Proceedings of Edulearn18 Conference*, 2018, pp. 2–4.
- [5] H. Husain, S. S. Mokri, A. Hussain, S. A. Samad, and R. A. Majid, "The level of critical and analytical thinking skills among electrical and electronics engineering students, UKM," *Asian Soc. Sci.*, vol. 8, no. 16, p. 80, 2012.
- [6] I. Ikhwanuddin, "Problem Solving dalam Pembelajaran Fisika untuk Meningkatkan Kemampuan Mahasiswa Berpikir Analitis," *J. Kependidikan Penelit. Inov. Pembelajaran*, vol. 40, no. 2, 2010.
- [7] D. Astriani, H. Susilo, H. Suwono, and B. Lukiat, "Profil Keterampilan Berpikir Analitis Mahasiswa Calon Guru Ipa Dalam Perkuliahan Biologi Umum," *J. Penelit. Pendidik. IPA*, vol. 2, no. 2, pp. 66–70, 2018.
- [8] I. E. Dafrita, "Pengaruh Discovery Learning Terhadap Kemampuan Berpikir Kritis dan Analitis dalam Menemukan Konsep Keanekaragaman Tumbuhan," *J. Pendidik. Inform. dan Sains*, vol. 6, no. 1, pp. 32–46, 2017.
- [9] N. D. Setyani, A. Suparmi, and S. Sarwanto, "Kemampuan berpikir analitis mahasiswa dalam pembelajaran menggunakan model inkuiri bebas," in *Prosiding SNPF (Seminar Nasional Pendidikan Fisika)*, 2017, pp. 54–59.
- [10] R. I. Arends, "Learning to teach." Mc Grow-Hill Companies, New York, 2012.
- [11] E. H. J. Yew and K. Goh, "Problem-based learning: an overview of its process and its impact on learning," *Heal. Prof. Educ.*, vol. 2, no. 2, pp. 75–79, 2016.
- [12] H. G. Schmidt, J. I. Rotgans, and E. H. J. Yew, "The process of problem-based learning: what works and why," *Med. Educ.*, vol. 45, no. 8, pp. 792–806, 2011.
- [13] Y. L. Rahmi, H. Alberida, and M. Y. Astuti, "Enhancing students' critical thinking skills



- through inquiry-based learning model,” in *Journal of Physics: Conference Series*, 2019, vol. 1317, no. 1, p. 12193.
- [14] A. Brew and C. Saunders, “Making sense of research-based learning in teacher education,” *Teach. Teach. Educ.*, vol. 87, p. 102935, 2019.
- [15] D. J. Pratama, S. Ranti, U. Usmeldi, and S. Syafriani, “Preliminary analysis of learners in developing student book-oriented research-based learning models using 3D page flip professionals on science lessons junior high school,” in *Journal of Physics: Conference Series*, 2019, vol. 1185, no. 1, p. 12125.
- [16] Carin & Sund, “Teaching science through discovery.” New York: Merrill Publishing Company, 1990.
- [17] S. Fatimah, “Analisis pemahaman konsep IPA berdasarkan motivasi belajar, keterampilan proses sains, kemampuan multirepresentasi, jenis kelamin, dan latar belakang sekolah mahasiswa calon guru SD,” *J. Inov. Pendidik. Dan Pembelajaran Sekol. Dasar*, vol. 1, no. 1, 2017.
- [18] F. Yahya and S. Fitriyanto, “Pengaruh Model Pembelajaran Berbasis Masalah Berbantuan Simulasi Interaktif Terhadap Keterampilan Generik Sains Siswa SMA Pada Materi Elastisitas,” *J. Pendidik. Fis. dan Teknol.*, vol. 2, no. 3, pp. 136–141, 2018.
- [19] P. Tremp, “Research-based Teaching and Learning, A LERU project,” *Univ. Zurich*, 2010.
- [20] R. I. Arends, *Learning to Teach*. 2012.
- [21] R. J. Marzano and J. S. Kendall, *Designing and assessing educational objectives: Applying the new taxonomy*. Corwin Press, 2008.
- [22] S. Montaku, P. Kaikkomol, and P. Tiranathanakul, “The model of analytical thinking skill training process,” *Res. J. Appl. Sci.*, vol. 7, no. 1, pp. 17–20, 2012.
- [23] S. Susilawati, J. Jamaluddin, and I. Bachtiar, “Pengaruh Model Pembelajaran Berbasis Masalah (Pbm) Berbantuan Multimedia Terhadap Kemampuan Berpikir Kritis Peserta Didik Kelas Vii SMP Negeri 2 Mataram Ditinjau Dari Kemampuan Akademik,” *J. Pijar MIPA*, vol. 12, no. 2, pp. 64–70, 2017.
- [24] N. I. Wulandari, A. Wijayanti, and W. Budhi, “Efektivitas Model Pembelajaran Problem Based Learning Terhadap Hasil Belajar Ipa Ditinjau Dari Kemampuan Berkomunikasi Siswa,” *J. Pijar Mipa*, vol. 13, no. 1, pp. 51–55, 2018.
- [25] R. Maskur, “The Effectiveness of Problem Based Learning and Aptitude Treatment Interaction in Improving Mathematical Creative Thinking Skills on Curriculum 2013,” *Eur. J. Educ. Res.*, vol. 9, no. 1, pp. 375–383, 2020.
- [26] R. Vitasari, “Peningkatan Keaktifan dan Hasil Belajar Matematika Melalui Model Problem Based Learning Siswa Kelas V SD Negeri 5 Kutosari,” *Kalam Cendekia PGSD Kebumen*, vol. 4, no. 3, 2013.
- [27] T. Taher, “Application Of Problem Based Learning Model To Improve Activities And Student Learning Outcomes Of Class Xi Ipa2 Of Sma Negeri 5 Tidore On Colloidal Material,” *Int. J. Educ. Inf. Technol. Others*, vol. 2, no. 2, pp. 24–28, 2019.
- [28] N. Rerung, I. L. S. Sinon, and S. W. Widyansih, “Penerapan model pembelajaran Problem Based Learning (PBL) untuk meningkatkan hasil belajar peserta didik SMA pada materi usaha dan energi,” *J. Ilm. Pendidik. Fis. Al-Biruni*, vol. 6, no. 1, pp. 47–55, 2017.
- [29] A. Syafitri, “Penerapan Model Research Based Learning Dalam Peningkatan Pembelajaran Ipa Kelas V Sekolah Dasar,” *Kalam Cendekia PGSD Kebumen*, vol. 4, no. 1, 2013.
- [30] G. Sukma, “Application of Problem Based Learning (PBL) Learning Model in Improving Student Learning Outcomes in Natural Sciences Subjects of Material Changes in Objects in Class II MI Al-Islah Sidoarjo,” *Indones. J. Sci. Learn.*, vol. 1, no. 1, pp. 26–31, 2020.
- [31] Eka Fitriah, “Model Research Based Learning Etnozologi Untuk Meningkatkan Keterampilan Generik Sains Dan Sikap Ilmiah Mahasiswa Guru Biologi,” *5th Urecol Proceeding UAD*, pp. 1261–1273, 2017.
- [32] M. Hidayatul, I. M. Tirta, Y. Wangguway, and D. M. O. Suni, “The implementation of research

- based learning and the effect to the student metacognition thinking skills in solving H-irregularity problem,” in *Journal of Physics: Conference Series*, 2020, vol. 1538, no. 1, p. 12113.
- [33] Y. Yulhendri, “The Development Of Research-Based Learning Model And Journal As For Graduate Students’scientific Publications Of M. Pd. E On Economic,” 2019.
- [34] S. Srikoon, T. Bunterm, J. Samranjai, and J. Wattanathorn, “ A research synthesis of research-based learning for education in Thailand,” *Procedia-Social Behav. Sci.*, vol. 116, pp. 913–917, 2014.
- [35] W. Toisuta, “Pembelajaran berbasis Penelitian. Jakarta: WTA.” 2012.
- [36] I. Yahya, “Manajemen Empat Langkah dalam Pengembangan Bahan Ajar Berbasis Riset: Sebuah Pengalaman dari Perkuliahan Akustik di Jurusan Fisika FMIPA UNS,” *Diakses dari [http://iwany.staff.uns.ac.id/2010/10/19/files/2010/10/research-enhanced-teaching\\_okt2010.pdf](http://iwany.staff.uns.ac.id/2010/10/19/files/2010/10/research-enhanced-teaching_okt2010.pdf)*, 2010.
- [37] S. Slameto, “Pembelajaran Berbasis Riset Mewujudkan Pembelajaran Yang Inspiratif,” *Satya Widya*, vol. 31, no. 2, pp. 102–112, 2015.
- [38] T. S. Susiani, M. Salimi, and R. Hidayah, “Research Based Learning (RBL): How to Improve Critical Thinking Skills?,” in *SHS Web of Conferences*, 2018, vol. 42, p. 42.