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Project Based Learning Model by Biology Teachers in Creative Thinking and Science Communication Skills in State Senior High School Students in Poso City

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Abstract

The Project Based Learning (PjBL) model has been widely implemented in schools; however, limited evidence is available regarding its impact on students' creative thinking and science communication skills in public senior high schools in Poso City. This study aimed to describe the implementation of the PjBL model by biology teachers in promoting students' creative thinking and science communication skills. The study employed a descriptive qualitative approach involving 60 respondents, consisting of 48 students from SMA Negeri 1 Poso, SMA Negeri 2 Poso, and SMA Negeri 3 Poso, as well as 12 biology teachers. Data were collected through questionnaires and unstructured interviews and analyzed descriptively. The findings revealed differences between students' and teachers' perceptions of PjBL implementation. Students' responses were categorized as moderate (66.6%), whereas teachers' responses were categorized as high (70.8%). Teachers' efforts to encourage students' creative thinking skills were rated moderate by both students (64.5%) and teachers (68.0%). Similarly, efforts to develop science communication skills were also rated moderate, with student responses reaching 55.9% and teacher responses 62.6%. Overall, the findings indicate that the implementation of PjBL has contributed moderately to fostering creative thinking and science communication skills among senior high school students in Poso City.

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Introduction

The learning that needs to be carried out by teachers, especially in biology learning in high schools, is learning that provides students with the ability to think creatively and communicate science. The Project Based Learning model is one of learning that has character for that purpose. This is in accordance with the explanation put forward by Hosnan (2014), that is the main purpose of the Project Based Learning This model aims at the learning process to hone and develop students' creative thinking skills, so that students have problem solving abilities, as well as develop students' abilities actively in building their own knowledge.

Wurdinger (2016) also stated that the Project Based Learning Model is an approach that encourages and inspires students to learn and helps them to become independent learners from time to time. In addition, students are not only directed to learn their content or projects but are trained to hone life skills of problem solving, creativity in thinking, collaboration, communication, time management and responsibility. Based on several theories and statements , it can be concluded that the Project Based Learning The model is a learning model that involves students directly through research activities to work on and complete a particular project. Project Based Learning is learning that emphasizes students to always think creatively and communicate scientifically in the learning process.

Creative thinking will give birth to creativity . Creativity is one thing that has an important role in the success of learning, because creativity is an effort to generate ideas or something unique or new. Greenstein (2012), states that creativity is one thing that has an important role for the success of a learning process. In line with what was conveyed by Feri (2021), that someone who has the ability to think creatively can state and express new relationships, see problems from new perspectives, form new combinations of concepts that have been previously mastered, are practical, and can bring up solution. Furthermore, Surya (2013), explains that creative thinking is a process (action) that becomes a means to stimulate and bring out various potentials and talents hidden from within a person to become talents, ideas and works. Therefore, teachers should be able to develop creative students so that they can move towards better self-actualization according to their abilities.

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During the learning process takes place in In the classroom , the activeness of students, especially in communicating , is one of the most important things that must be understood by the teacher, one of the activities in In the classroom, the learning process that is rarely shown by students is by communicating scientifically. Tina (2017), explains that communication plays an important role, because with communication students can exchange ideas, both among students themselves, students with teachers, and the environment so that communication is the key to success in the learning process where teachers and students are united in the learning environment. From this it can be concluded that the activeness of students in the learning process, especially communicating scientifically is very important. Because with the ability to communicate, teachers can see the abilities of students, and teachers are able to choose and use appropriate learning methods according to the subject to be delivered, also taking into account the level of development of their students.

Project Based Learning model in high schools, especially in Poso City, is carried out in accordance with the demands of learning in the curriculum, but many things are still not understood by teachers in encouraging students to be able to think creatively and communicate scientifically. have not been fully encouraged to think creatively, and communicate science in the learning process. In line with what was stated by Kunandar (2016), the duties and roles of teachers from day to day are getting heavier, along with developments and technology, teachers as the main component in the world of education are required to be able to balance and even exceed the development of science and technology that develops in the world of education. Public. In other words, the task and role of the teacher lies in the teaching fields. According to Wena (2014), the Project Based Learning Model is a learning model that provides opportunities for teachers to manage learning at school class by involving students in project work. In the learning process with the Project Based Learning Model , it is intended to develop independent learning and social skills of students. Therefore, teachers must be able to understand that by being able to solve a problem, indirect learning independence and students' social skills can be formed. Besides that when students can collaborate to find out relevant information, strategies, and learning resources, the student can automatically solve a problem.

The results of initial observations in the form of interviews with several MIPA teachers who taught in the biology study program, which were carried out before the implementation of the research, the researchers found that the learning process that occurred in several public high schools in Poso City which ignores the meaning of real learning . In the learning process, even though the teacher directs students to be able to search, find, and see the main problems so that students can solve the problems they face, the results are not fully felt by the teacher in the process of achieving this. One of them is the absence of creativity in thinking creatively and communicating scientifically, such as students who have not been encouraged to be able to generate new ideas or ideas, have not been able to solve problems using new approaches, and have not been fully able to create goods and develop products. While the ability to communicate science, students also do not fully have the ability to classify observed data and get used to communicating through the presentation of findings. Although the learning model has been directed by teachers to various approaches, one of them is the Project Based Learning Model, but the results are still unsatisfactory . That statement raises problems such as whether this is because in the learning process the teacher has not been maximized in class management, or the concept of approach by the teacher still does not encourage students, or is it the other way around that the professionalism of the teacher as a motivator agent has not been maximally played so that the learning process is with the Project Based Learning Model in each the school, still does not encourage and direct students to think creatively and communicate scientifically.

The results of previous research conducted by Nugroho et al. (2019), The Effect of the Project Based Learning (PJBL) Model on Communication Skills and Creative Thinking. The results show that there is an influence from the use of the Project Based Learning Model on communication skills and creative thinking. Based on this description, it is necessary to have a research to answer these problems. Because of that, a study entitled " Model Project Based Learning by biology teachers in the ability to think creatively and communicate science in SMA Negeri Poso students" will be conducted . This research is expected to be research that reveals information about the impact of learning with the Project Based Learning Model on students' abilities to think creatively and to communicate scientifically in high schools in Poso City . If the research is successfully carried out , it is hoped that it will be able to make a positive contribution to teaching biology and other sciences .

Materials and Method

This research is a descriptive research with a qualitative method approach or better known as descriptive qualitative. This research is intended to describe the actual situation based on facts or events and existing data. In this study, the data obtained were qualitative data in the form of descriptions of the variables being measured. In this study also obtained quantitative data in the form of percentages, so that it is expected to be able to describe more objective research results, (Sugiyono, 2012).

This research activity was carried out in several public high schools in Poso City, Central Sulawesi, namely SMA Negeri 1, SMA Negeri 2, and

SMA Negeri 3 which have several major classes, especially in the Mathematics and Natural Sciences department. The research sample consisted of 60 samples consisting of 25 men and 35 women, 18 students from SMA Negeri 1, 12 students from SMA Negeri 2, 18 students from SMA Negeri 3, and 12 teachers.

Questionnaire data analysis of the Project Based Learning Model given to teachers consisted of 20 questions and students consisted of 15 questions, students' creative thinking abilities for teachers 10 questions and for students 10 questions, and communicating science consisted of 5 questions for teachers and 5 questions for students . Then measured with a Likert scale and analyzed with percentage statistical techniques and the T-test. This percentage is used to obtain data as it is about the object under study. Questionnaire data analysis used a modified formula from Sudijono (2012).

Table 1. Likert scale

Score	Answer
5.	Always
4.	often
3.	Sometimes
2.	Seldom
1.	Never

Riduwan (2023)

Table 2 . Percent Interval Criteria.

No	Percent Interval Criteria	Categories
1.	>85 %	Very Hight
2.	69 – 84 %	Higt
3.	53 – 68 %	Medium
4.	37 – 52 %	Low
5.	< 36 %	Very Low

Akbar (2017).

Analysis of the results of interviews in the form of oral will be converted into writing, and then analyze the results of the interview. In this interview, the researcher did not prepare a detailed interview guide, but the interview guide used by the researcher only contained an outline of the questions to be asked, which could then be added according to the conditions found. In this study, interviews were conducted directly with biology teachers, especially those teaching at state high schools in Poso City in the biology study program and vice principals in the field of curriculum which were the research samples.

Results and Discussion

Based on the research that has been done, the results are as follows.

The results of the descriptive analysis of the respondent's data on aspects of the Project Based Learning Model by students and teachers can be seen in Table. 3 and Table. 4

Table 3. *Project Based Learning* Model by Public High School Students in Poso City

Categories	Intervals	% Intervals	Frequency
Very Hight	64-75	>85%	0
Higt	52-63	69-84%	16
Medium	40-51	53-68%	32
Low	28-39	37-52%	0
Very Low	15-27	< 36%	0
			48
Average	50.0	66.6%	Medium

Table 4. *Project Based Learning* Model by Biology Teachers at Public High Schools in Poso City

No	Teacher Name	Score	Percentage (%)	Categories
1.	A	67	67%	Medium
2.	BR	80	80%	Higt
3.	HL	66	66%	Medium
4.	J	66	66%	Medium
5.	LK	73	73%	Higt
6.	M	78	78%	Higt
7.	MW	74	74%	Higt
8.	SK	67	67%	Medium
9.	SS	67	67%	Medium
Average		70.8	70.8%	Higt

The results of the descriptive analysis of the respondent's data on aspects of the ability to think creatively by students and teachers can be seen in Table 5 and Table. 6

Table 5. Creative Thinking Ability by Public High School Students in Poso City

Category	Intervals	% Intervals	Frequency
Very Hight	42-50	>84%	2
Higt	33-41	66-82%	19
Medium	24-32	48-64%	25
Low	15-23	30-46%	2
Very Low	05—14	< 28%	0
			48
Average	32.2	64.5%	Medium

Table 6. Creative Thinking Skills by Biology Teachers at Public High Schools in Poso City

No	Teacher Name	Score	Percentage (%)	Category
1.	A	34	68%	Medium
2.	BR	35	70%	Higt
3.	HL	34	68%	Medium
4.	J	32	64%	Medium
5.	LK	33	66%	Medium
6.	M	33	66%	Medium
7.	MW	34	68%	Medium
8.	SK	36	72%	Higt
9.	SS	35	70%	Higt
Average		34	68%	Medium

The results of the descriptive analysis of the respondent's data on aspects of students' and teachers' science communication skills can be seen in Table. 7 and Table. 8.

Table 7. Science Communication Skills by Public High School Students in Poso City

Category	Intervals	% Intervals	Frequency
Very Hight	22—25	>88%	0
Higt	18—21	72-84%	4
Medium	14—17	56-68%	19
Low	10—13	40-52%	24
Very Low	05—9	< 36%	1
			48
Average	13.9	55.9%	Medium

Table 8. Science Communication Skills by Biology Teachers at Public High Schools in Poso City

No	Teacher Name	Score	Percentage (%)	Category
1.	A	14	56%	Medium
2.	BR	15	60%	Medium
3.	HL	17	68%	Medium
4.	J	13	52%	Low
5.	LK	14	56%	Medium
6.	M	17	68%	Medium
7.	MW	19	76%	Higt
8.	SK	14	56%	Medium
9.	SS	18	72%	Higt
Average		15.6	62.6%	Medium

Then an independent sample t-test was used to find out whether there was a difference in the average of the two unpaired samples, namely to find out the responses of students and teachers to the Project Based Learning Model, creative thinking abilities and students' scientific communication skills . The results of the independent sample t - test analysis with the help of the SPSS 2.2 application. The results of the independent sample t - test analysis with the help of the SPSS 2.2 application. the results obtained for the Project Based Learning Model on the responses of students and teachers (μ = 50.02; SD = 4.75) means that 0.001 < 0.005 thus there is a significant difference between the answers of teachers and students regarding the Project Based Learning Model, students' abilities in creative thinking based on the independent sample t-test obtained results for teacher and student responses (μ = 32.25; SD = 5.85) meaning that 3.79 > 0.005 so that there is no significant average difference from the results of teacher responses and students on the ability to think creatively, while for the ability to communicate science from the results of the independent sample t-test obtained (μ = 13.97; SD = 2.37) means that 0.52 > 0.005 so that there is no difference in the average significantly from the results of teacher and student responses to the ability to communicate science.

The results of descriptive analysis of respondent data on the three assessment variables in the Project Based Learning Model by biology teachers in the ability to think creatively and communicate science in State High School Students in Poso City. Assessment is carried out through instruments on teachers and students to determine the achievement of the learning process is also presented in the diagram.

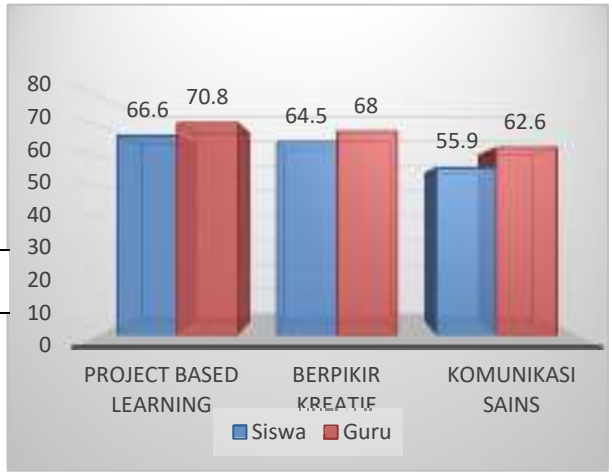


Figure 1. Results of Responses to the Project Based Learning Model by Students and Teachers in the Ability to Think Creatively and Communicate Science in Public High School Students in Poso City

The diagram above shows the results of the values (%) of the 3 variables that were used as assessments in the study where based on the results of the independent sample t-test which can be seen in the picture above, it was found that the responses of students and teachers to the Project Based Learning Model, the results obtained were 0.001 <0.005 so that the average is stated to be significantly different, as seen from the responses of students (66.6%) in the medium category and teachers (70.8%) in the high category. The responses of students and teachers in the ability to think creatively on the results of the t-test obtained results of 3.79 > 0.005 so that there was no significant average difference in the results of student responses, namely (64.5%) in the moderate category and teacher responses (68%) in the category currently. Whereas for the responses of students and teachers in the ability to communicate science from the results of the t-test also obtained results that were 0.52> 0.005 so that from these results for the responses of students and teachers there was no significant average difference, it can be seen that students got (55.9 %) is in the moderate category, while teachers (62.6%) are in the moderate category.

Responses of Teachers and Deputy Principals in the Curriculum Field to the Project Based Learning Model

In this study, unstructured interviews were also conducted with the vice principal of the curriculum field and several teachers who teach in the biology study program. From the results of the unstructured interviews, the researchers obtained a lot of supporting and complementary data related to the Project Based Learning Model by Biology Teachers in Creative Thinking and Communicating Science Skills in State High School Students in Poso City.

Interviews were conducted with several teachers and curriculum deputy heads, three public high schools in Poso City regarding the Project Based Learning Model, consists of a number of questions including: application of the Project Based Learning Model that has been taught to students, implementation of lesson plans and syllabus, how to encourage students to be able to think creatively, such as generating ideas and ideas in the learning process, and how to encourage students to able to communicate scientifically such as being able to present the results of products that have been worked on in the Project Based Learning Model. From the results of the interview, it was found that almost all teachers and vice principals of the curriculum who were asked a number of questions had the same answers.

Description of the Process of the Project Based Learning Model Implemented in Poso City Senior High Schools

Process description of the Project Based Learning Model in SMA Negeri Poso City, the teachers have been carried out in accordance with the learning syntax in the Project Based Learning Model, the learning approach used has the characteristics that students are encouraged by the teacher to seek and make decisions about a framework, problem or challenges are posed to students, students are also taught to design the process of determining solutions to the problems posed, besides that the teacher has directed students to be collaboratively responsible for accessing and managing information in solving problems, the evaluation process is carried out on the final product created by students , students periodically reflect on the activities that have been carried out by communicating through presentations to others.

An overview of the Project Based Learning Model carried out by teachers at SMA Negeri Poso City, shows activities during the learning process where the teacher opens the lesson with a challenging question starting with a question that can assign students to carry out an activity. The teacher plans the planning project to be carried out collaboratively between the teacher and the students, so that students are expected to feel ownership of the project. Planning the Project Based Learning Model contains the rules of the game, selection of activities that can support in answering essential questions by integrating various supporting subjects, as well as informing the tools and materials that can be used by students in completing projects. In addition, the teacher arranges an activity schedule with students collaboratively in completing the project. The project completion time must be clear, and students are given directions to manage the time available. Na'imah et al. (2015), states that Project Based Learning or project-based learning is an alternative learning that can be used not only to assess cognitive aspects, but also student performance, this method is quite effective and challenging as a tool for actively teaching students because the students are encouraged to be more independent, by not fully relying on the teacher, but directed to be able to learn independently. In addition, this learning is the development of an effective contextual learning, because the project-based learning model has the potential to make learning experiences more interesting where students are required to think creatively and be able to work in teams or groups to shape student creativity and student learning experiences with real projects.

The teacher encourages students to try to explore something new, but the teacher must also keep reminding them that if student activities deviate from the project objectives, the teacher asks students to complete their projects in groups outside of school hours. The teacher oversees the course of the project and is responsible for monitoring student activities while completing the project. Monitoring is carried out by facilitating students in each process, in other words educators act as mentors for student activities, educators teach students how to work in a group. At the end of this learning model the teacher evaluates the products produced. The assessment is carried out to assist educators in measuring achievement of competency standards, and also at the end of the product assessment is carried out when each group presents its product in front of other groups in turn. At this stage, students are asked to express their feelings and experiences while completing the project.

According to Chasanah et al. (2016), one learning model that emphasizes science process skills and students' creative thinking abilities is the Project Based Learning Model or project-based learning model. This learning model allows students to develop their creativity in designing and creating a project that can be used to solve problems. In addition, this learning model also takes place systematically and can create new learning that

reflects the environment in which students live and learn.

In line with the statement of Luthvitasari et al. (2012), that the selection of learning models should be able to overcome various problems that students experience when the learning process takes place. Learning at public high schools in Poso City is certainly not free from obstacles in terms of the limited abilities of students who are less developed, as well as the low skills of creative thinking and communicating science. Student abilities are basic skills possessed by each student, and can grow and develop through project-based learning because the Project Based Learning Model is learning that involves students in transferring knowledge and skills through a discovery process with a series of questions arranged in assignments or project. In addition, there were also many problems that occurred in several schools such as the influence of online learning which lasted for about two years due to the Covid-19 pandemic, so that the Project Based Learning learning model that will be implemented in schools encounters many obstacles such as: the large number of students who cannot access online learning due to the condition of the availability of electronic facilities such as mobile phones (HP), internet networks that are still not good in several areas, online learning time is still very limited and does not provide flexibility to teachers, so that controlling the learning process does not go well.

Carrilo & Flores (2020), argues that online learning will be effective if it is supported by appropriate tools and technology such as utilizing chat rooms in the learning process and other applications, because in the online learning process it is very difficult to identify the characteristics of each student. According to the teacher, it will be easier to see the characteristics of students when face to face. As expressed by Mu'minah (2021), states that teacher creativity is the key to successful online learning, because a teacher must be able to innovate in designing and concocting material, learning methods, learning media and applications that are appropriate to learning material.

Teacher Efforts in Encouraging Creative Thinking Skills in Learning with Project Based Learning Models

The teacher's efforts in encouraging the creative thinking skills of State Senior High School students in Poso City have shown that they have been carried out in encouraging students' abilities to be able to think creatively, seen in the learning process the teacher encourages students to be able to think smoothly, by directing students to be able to come up with ideas, answers , or finding problems from learning material in accordance with reality, the teacher encourages students' abilities to be able to try, find solutions to problems with more than one varied answer, besides that in the learning process in class the teacher has also instructed students to be able to think flexibly, it can be seen from the results of teacher interviews on, in this case the teacher encourages students to be able to see a problem from different perspectives, tries as much as possible to change the way students think in a more creative direction, students are expected to be able to produce something new and unique, hone and M encourage students' abilities to be able to express themselves by creating, producing, and developing a product from the Project Based Learning Model so that students have the ability to think elaboratively.

According to Noviyana (2017), that the ability to think creatively it is only natural that attention is paid to the implementation of learning because with students who can think creatively, of course it will greatly facilitate students to be creative in other subjects, creatively students can solve problems and be able to face global competition. Furthermore, Dinawati & Siswono (2020), explains that the ability to think creatively is a mental activity that is used by a person to compile and produce new ideas or ideas from a thought process to reveal new relationships, see things from a new perspective and form new combinations of the two. concept or more that has been mastered before.

The teacher's efforts to encourage creative thinking skills in learning with the Project Based Learning Model is the teacher encouraging students by giving practical assignments according to the material being taught, utilizing school facilities and infrastructure in learning, this can be seen in the results of interviews with teachers and vice principals in the field of curriculum, where learning is with the Project Based Learning Model *at* Public High Schools in Poso City the teacher seeks to encourage students' ability to think creatively, aiming to familiarize students in honing their abilities to carry out learning tasks, so that the teacher can reward these students.

According to Qulub & Manoy (2020), creative thinking or creativity is one of the abilities that needs attention in learning. He argued that creativity is something that is rarely paid attention to in learning because it usually places logic as a top priority in learning and considers creativity to be less important. . In line with this, Jeffri et al. (2018), also stated that creative thinking is a way of thinking that is filled with ideas or ideas in developing imagination, creative thinking is the ability to utilize one's potential that arises from various circumstances. This is an obstacle in the learning process at Public High Schools in Poso City, where various efforts have been made by teachers to encourage students' ability to think creatively, but the results have not been effective because there are still many students who have not been encouraged by their ability to think creatively. in the learning process.

Teachers' Efforts in Encouraging Students' Science Communication Skills in the Project Based Learning Model

The teacher's efforts to encourage science communication skills of State High School students in Poso City, in the Model Project Based Learning certainly cannot be separated from the ability of the teacher, in terms of encouraging students to learn, these efforts can be seen from the activities of the teacher according to the information that the researcher obtained during interviews with the teacher in the field of study concerned as well as the vice principal in the field of curriculum, where efforts that have been made by the teacher in the learning process by directing students to have the ability to classify observational data themselves in the form of tables or graphs, this aims to encourage students in the ability to describe experimental results.

The teacher encourages students to have problem-solving skills, makes students more active and successful in solving complex problems, increases collaboration with colleagues in group work, and encourages students to develop and practice communication skills such as the ability to be able to present product results. has been made to other people, from this the teacher hopes to encourage students' skills in managing communication skills, and the teacher tries to make the learning atmosphere in the classroom fun, so that students and educators enjoy the learning process.

According to Ma'rifah et al. (2020), communication is the process of conveying information, ideas, emotions, and skills through the use of symbols such as words, pictures, numbers, and others and states that communication helps in building meaning when students carry out the process of thinking and reason, then communicate their ideas orally and in writing so that conceptual understanding can develop. Thus it can be said that communication plays an important role in the process of learning interaction because science communication helps students reflect, clarify, and develop ideas and understanding.

Based on the results of previous research conducted by Maudi (2016), regarding the Implementation of the Project Based Learning Model *to* improve students' mathematical communication skills, the results of the study found that there was an increase in students' mathematical communication abilities both orally and in writing, students felt more active learning in Project Based Learning . Student activity in class as a whole is getting better, so this model can be used as an alternative in learning. However, this is inversely proportional to what was found in this study, it turns out that with the Project Based Learning Model applied by teachers at Public High Schools in Poso City, especially in biology subjects, even though the implementation of learning is said to be good but has not encouraged students as a whole in scientific communication skills. It is considered important for the teacher to know that in the learning process not all students have the ability to be able to quickly understand the intent and purpose of the learning model taught by the teacher. Ernawati (2020), explains that communication skills are a very important part of the learning process because communication is a way of sharing ideas and clarifying understanding, through communication ideas can be reflected, improved, discussed and developed.

Conclusion

The description of the learning process with the Project Based Learning Model implemented in Public High Schools in Poso City, shows differences in responses between students and teachers, student responses are in the medium category, and teacher responses are in the high category. The biology teacher's efforts in encouraging students to think creatively in learning with the Project Based Learning Model at Public High Schools in Poso City, is in the medium category, the biology teacher's efforts to encourage scientific communication skills in the Project Based Learning Model at Public High Schools in Poso City, are in the medium category. In addition, there were also obstacles from within the students.

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References

Akbar, S. (2017). *Instrumen perangkat pembelajaran.* Bandung: PT. Remaja Rosdakarya.

Carrillo, C., & Flores, M. A. (2020). Covid-19 and teacher education: a literature review of online teaching and learning practices. *European Journal of Teacher Education, 43*(4), 466-487.

Chasanah, A. R. U., Khoiri N., & Nuroso H. (2016). Efektivitas model *project based learning* terhadap keterampilan proses sains dan kemampuan berpikir kreatif siswa pada pokok bahasan kalor kelas x sman 1 wonosegoro tahun pelajaran 2014/2015. *Jurnal Penelitian Pembelajaran Fisika, 7*(1), 19-24.

Dinawati, E. N., & Siswono T. Y. E. (2020). Pengaruh kecemasan matematika terhadap berpikir kreatif siswa smp. *Jurnal Penelitian Pendidikan Matematika dan Sains, 4*(2), 83-92.

Ernawati (2020). Pengaruh pembelajaran *problem based learning* terhadap kemampuan komunikasi dan *self efficacy* matematis siswa. *Jurnal Pembelajaran dan Matematika Sigma (JPMS), 6*(2), 62 – 71.

Feri, I. (2021). Meningkatkan kemampuan berpikir reatif matematis siswa dengan pendekatan problem posing. *Jurnal Pendidikan Matematika dan sains*, *2*(2), 50-60.

Greenstein, L. (2012). *Assessing 21st century skill: a guide to evaluation mastery and authentic learning.* California: Corwin.

Hosnan, M. (2014). *Pendekatan saintifik dan kontekstual dalam pembelajaran abad 21*. Jakarta: Ghalia Indonesia.

Jeffri, R., Anggereini E., & Budiarti R. S. (2018). Analisis kemampuan berpikir kreatif siswa dalam kegiatan praktikum biologi pada siswa kelas xi mia di sma negeri 11 kota jambi. *Pendidikan Biologi FKIP Universitas Jambi.*

Kunandar (2016). *Langkah mudah penelitian tindakan kelas sebagai pengembangan profesi guru*. Jakarta: PT Raja Grafindo Persada.

Luthvitasari, N., P. N. M. D., & Linuwih S. (2012). Implementasi pembelajaran fisika berbasis proyek terhadap keterampilan berpikir kritis, berpikir kreatif dan kemahiran generik sains. *Journal of Innovative Science Education, 1*(2), 92-97.

Ma'rifah, C., Sa'dijah C., Subanji, & Nusantara, T. (2020). Profil kemampuan komunikasi matematis peserta didik dalam pemecahan masalah soal cerita. *Jurnal Pendidikan Sains & Matematika*, *8*(2), 43-56.

Maudi, N. (2016). Implementasi model *project based learning* untuk meningkatkan kemampuan komunikasi matematis siswa. *Jurnal Pendidikan Matematika Indonesia, 1*(1), 39-43.

Mu'minah, L. H. (2021). Pemanfaatan media pembelajaran berbasis video sebagai alternatif dalam pembelajaran daring ipa pada masa pandemi covid19. *Prosiding Penelitian Pendidikan Dan Pengabdian*, *1*(1), 1197-1211.

Na'imah, N. J., Supartono & Wardani, S. (2015). Penerapan pembelajaran berbasis proyek berbantuan e-learning untuk meningkatkan hasil belajar siswa. *Jurnal Inovasi Pendidikan Kimia, 9*(2), 1566-1574.

Noviana, H. (2017). Pengaruh model *project based learning* terhadap kemampuan berpikir kreatif matematika siswa. *Jurnal Edumath*, *3*(2), 110-116.

Nugroho, A. T., Jalmo, T., & Surbakti, A. (2019). Pengaruh model *project based learning* (pjbl) terhadap kemampuan komunikasi dan berpikir kreatif. *Jurnal Bioterdidik*, *7*(3), 50-58.

Qulub, S., & Manoy, J. T. (2020). Proses berpikir kreatif siswa smp bergaya kognitif impulsif dan reflektif dalam mengajukan masalah matematika. *Jurnal Ilmiah Pendidikan Matematika*, *9*(3), 468-477.

Riduwan (2023). *Dasar-dasar statistika.* Bandung: Alfabeta.

Sudijono, A. (2018). *Pengantar statistik pendidikan*. Jakarta: Raja Grafindo Persada.

Sugiyono (2012). *Metode penelitian kuantitatif kualitatif dan r&d*. Bandung: Alfabeta.

Surya, H. (2013). *Cara belajar orang jenius*. Jakarta: Elex Media Komputindo.

Tina, S. S. (2017). Meningkatan kemampuan komunikasi matematis siswa melalui model pembelajaran predict observe explanation. *Jurnal Program Studi Matematika, 3*(2), 5-16.

Wena, M. (2014). *Srategi pembelajaran inovatif kontemporer, suatu tinjauan konseptual operasional.* Jakarta: Bumi Aksara.

Wurdinger, S. D. (2016). *The power of project based learning, helping students develop important life skills.* London: Rowman & Littlefield.