TA'DIB JOURNAL, 27 (1), 2024, (January-June)

ISSN: 1410-8208 (*Print*) 2580-2771 (*Online*)
Available online at https://ejournal.uinmybatusangkar.ac.id/ojs/index.php/takdib/index

Investigating the Impact of STEAM Learning on Higher Order Thinking and Science Achievement

Received: 12-05-2024; Revised: 27-05-2024; Accepted: 04-06-2024

Linda Juliharti *)
Universitas Negeri Padang
E-mail: Lindajuliharti@gmail.com

Abna Hidayati
Universitas Negeri Padang
E-mail:Abnahidayati@gmail.com

Yullys Helsa
Universitas Negeri Padang
E-mail:Yullys@fip.unp.ac.id

Asrizal
Universitas Negeri Padang
E-mail:Asrizal@fmipa.unp.ac.id

*) *Corresponding Author*

Abstract: Development of the industrial era 4.0 emphasizes the need for higher-order thinking skills (HOTS), especially in science and science learning in elementary schools. The low level of high-level thinking skills and science learning outcomes of elementary school students is a current problem. This research aims to determine the effect of implementing the STEAM (Science, Technology, Engineering, Arts, Mathematics) Learning Model on high-level thinking skills and learning outcomes in Natural and Social Sciences (IPAS) of class V students at SDN 18 Kampung Durian. This type of research is quantitative research. The research design used was Nonequivalent Control Group Design. The population in this study were all class V students at SDN 18 Kampung Durian, totaling 52 students consisting of 26 students in class VA (experiment) and 26 student class VB (control). The data were analize using a prerequisite test in the form of a normality test, then homogeneity, and hypothesis testing using the t-test. The research results show that the application of the STEAM Learning Model significantly improves students' high-level thinking skills and science learning outcomes compared to conventional learning. The average score of evaluation of higher-order thinking skills and science learning outcomes in the experimental group was significantly higher than in the control group. The t-test statistical test of critical thinking skills and students' science learning outcomes showed significant differences between the two groups (Sig.0.000>0.05). STEAM learning can be an effective alternative to enrich students' learning experiences, provide real-world science contexts, and stimulate the development of higher-order thinking skills.

Abstrak : *Perkembangan era industry 4.0 menekankan perlunya keterampilan berpikir tingkat tinggi (HOTS) terutama dalam pembelajaran IPAS di sekolah dasar. Rendahnya keterampilan berpikir tingkat tinggi dan hasil belajar IPAS siswa sekolah dasar merupakan masalah yang terjadi saat ini. Penelitian ini bertujuan untuk mengetahui pengaruh penerapan Model Pembelajaran STEAM (Science, Technology, Engineering, Arts, Mathematics) terhadap keterampilan berpikir tingkat tinggi dan hasil belajar Ilmu Pengetahuan Alam dan Sosial (IPAS) siswa kelas V di SDN 18 Kampung Durian. Jenis penelitian ini adalah penelitian kuantitatif. Desain penelitian yang digunakan adalah Nonequivalent Control Group Design yang melibatkan dua kelompok yaitu kelas eksperimen dan kelas kontrol. Populasi*

dalam penelitian ini adalah seluruh siswa kelas V SDN 18 Kampung Durian yang berjumlah 52 siswa yang terdiri dari 26 siswa kelas VA (eksperimen) dan 26 siswa kelas VB (kontrol). Teknik analisis data yang digunakan ialah menggunakan uji prasyarat berupa uji normalitasnya kemudian uji homogenitasnya serta uji hipotesisnya menggunakan uji t. Hasil penelitian menunjukkan bahwa penerapan Model Pembelajaran STEAM secara signifikan meningkatkan keterampilan berpikir tingkat tinggi siswa serta hasil belajar IPAS dibandingkan dengan pembelajaran konvensional. Skor rata-rata evaluasi keterampilan berpikir tingkat tinggi dan hasil belajar IPAS pada kelompok eksperimen secara signifikan lebih tinggi dari pada kelompok kontrol. Uji statistik t-test keterampilan berpikir kritis dan hasil belajar IPAS siswa menunjukkan perbedaan yang signifikan antara kedua kelompok tersebut (Sig.0,000>0,05). Pembelajaran STEAM dapat menjadi alternatif efektif untuk memperkaya pengalaman belajar siswa, memberikan konteks IPAS dalam dunia nyata, dan merangsang perkembangan keterampilan berpikir tingkat tinggi/

Keywords: ***Higher Level Thinking Abilities, Natural and Social Sciences, STEAM Learning Model***

INTRODUCTION

The changing times marked by the Industrial 4.0 revolution require people to have high-level thinking skills. In the industrial era 4.0, students must be able to think critically, creatively, communicate and collaborate in everyday life. Learning should be able to develop students' literacy skills in the era of industrial revolution 4.0 (Asrizal et al., 2023) These four abilities require high-level thinking processes (HOTS). This is a 21st century skill that requires a regular practice process with contextual material Higher order thinking skills will not appear by themselves, but must be trained and honed. One way is through the learning process at school. One of them is IPAS (Natural and Social Sciences) education. The science learning process is very determined by teacher factors. Teachers must able to manage the class well and create learning activities in accordance with self-development (Fitria & Idriyeni, 2017).

When the problem is not resolved then it will negative impact on participant competency educate (Lufri et al., 2019). It is hoped that the learning carried out can prepare students to face future developments. Learning that enables students to have and be able to hone students' high-level thinking skills, where learning does not only reach the limit of remembering or understanding but also reaches the stage of analyzing, developing, evaluating, or finding solutions and until learning reaches the stage of creating. This strategy can be realized by applying the STEAM (Science, Technology, Engineering, Art and Mathematics) approach. Researchers chose to use the STEAM approach because it can improve high-level thinking skills and prepare students to work in their desired field in the future. Then the STEAM approach is suitable for use in the current era of globalization, because the STEAM approach covers the fields of science, technology, engineering, arts and mathematics.

Basically, the STEAM approach can facilitate the implementation of active learning, namely learning where students are actively involved. The STEAM approach is an approach that combines science, technology, arts and mathematics subjects as an effort to develop student inquiry, critical thinking and communication during learning (S. Efwinda, 2021). The aim of the research to be conducted is to see students' thinking skills in solving

problems after being taught using the STEAM approach so that they can see the results of learning before and after using the STEAM approach. A research conducted in a journal entitled Application of the Flipped Classroom with the STEAM approach to electrolyte and non-electrolyte solution material to improve high-level thinking skills states that the STEAM approach can improve students' high-level thinking abilities

Students' thinking abilities play an important role in successful learning, especially in Natural and Social Sciences (IPAS) lessons. Students' Higher Level Thinking Ability is one of the important abilities that students themselves can master (Simanjuntak et al., 2021) tudents' Higher Level Thinking Abilities are closely related to everyday life, especially to solving problems that occur in life (Rosdiana et al., 2022).

Based on the background of the problem above, researchers are interested in conducting research with the title "The Influence of the STEAM Approach on Higher Level Thinking Abilities and Science Learning Outcomes" Based on the problem studied, the aim of this research is to examine, compare and describe:

1. To investigate the effect of the STEAM approach on students' higher order thinking abilities in fifth grade elementary school.

2. To investigate the influence of the STEAM approach model on students' science and science learning outcomes in grade V elementary school.

METHOD

The type of research used in this research is quasi experiment. According to Sugiyono (2013) experimental research can be interpreted as a research method used to find the effect of certain treatments on others under controlled conditions. The research design used is Randomized Control Group Only Design, because this research wants to know the effect of a treatment on a variable. In this research, the treatment given to the experimental class was the application of STEAM learning to students' high-level thinking skills, while the control class used conventional learning. The author's research design consists of two groups, namely the experimental group and the control group. The eki sperimenii group and the control group will be given prei-theist fish (O1, O3). The results of the theoretical predictions are used as a basis for determining change. Thus, the eikspeirimein group is characterized by treatment using the STEAM approach in learning as (X), while the control group uses the conventional learning model (-). Next, the experimental group and control group are given a post-test (O2, O4) and the results will be compared to determine the effect or extent of the influence of the treatment given to the experimental group.

The population in this study were fifth grade elementary school students at several schools in cluster IV, East Padang District who were registered in the 2023/2024 academic year. There are 5 schools in cluster IV, East Padang District, Padang City. The number of study groups at SDN 10, 12 and 17 has 1 class group, while SDN 18 Kampung Durian has 2 groups and SDN 23 has 3 groups and has used the independent curriculum. All fifth grades in these five schools have used the independent learning curriculum. To measure whether students' abilities in each school are the same or different, this is done by carrying out a normality test and homogeneity test of the mid-semester exam results data in each school. . Sampling was taken using "Simple random sampling". Simple Random Sampling is a technique for taking sample members randomly without paying attention to the strata in the population. . Random sampling was carried out by drawing lots using paper rolls. From the results of the drawing, it was obtained that it was class V at SDN 18 Kampung Durian. Where the experimental class was in class VA SDN 18 Kampung Durian, totaling 25 students and the control

class was in class VB SDN 18 Kampung Durian, totaling 25 students.

This research is experimental research to determine the effect of the STEAM Approach on students' higher-order thinking abilities and science learning outcomes. The instrument used is a test. A test is a series of exercises or other tools used to measure skills, knowledge, intelligence or talents possessed by individuals or groups. A test is a tool or procedure used to find out or measure something in a predetermined atmosphere, method and rules (Anggito & Setiawan, 2018). This test is carried out or carried out with the aim of being able to differentiate the level of a student. In a test, the potential that exists in the test taker will be reflected in the results of the test. . In this research, researchers used tests to collect data. The information in this research was collected through the use of instruments to see how the STEAM learning model affects students' high-level thinking skills and science and science learning outcomes for grade V elementary schools. The following actions were taken during the research to collect data namely:

1). Providing HOTS test questions in the experimental class and control class to determine students' high-level thinking skills in learning science and technology using the STEAM learning model and as an answer to the first hypothesis.

2). Providing a test of learning outcomes abilities in the experimental class and control class to determine the level of student learning outcomes in learning using the STEAM learning model and as an answer to the second hypothesis.

3). Calculate the magnitude of the relationship or influence of the STEAM Approach with higher level thinking abilities and student learning outcomes using regression tests until the coefficient of determination is obtained to answer the third hypothesis.

This research was conducted in the even semester, namely January - June in the Science and Technology subject in class V of SDN 18 Kampung Durian, East Padang District. This research was carried out in two different classes, namely the experimental class, the VA class and the control class, the VB class at SDN 18 Kampung Durian. The experimental class uses the STEAM approach and the control class uses conventional development.

RESULTS AND DISCUSSION

Results

Higher Level Critical Thinking Skills

The research data consist of assessment scores obtained from both the experimental and control groups. These scores were derived from a study investigating the impact of the STEAM learning model on the high-level thinking skills of students in class V at SDN 18 Kampung Durian. The details of the data are presented in the subsequent table:

Table 1. Critical Thinking Skills Evaluation Test Results

Group	N	Mean	Std. Deviation	Maximum	Minimum
Experiment	26	81.50	7.64	94	69
Control	26	60.46	6.58	71	50

The provided data indicates that the mean score for high-level thinking skills in the experimental class is 81.50 ± 7.64, while in the control class it is 60.46 ± 6.58. The highest score in the experimental class was 94, compared to 71 in the control class, while the lowest score in the experimental class was 69, as opposed to 50 in the control class. Subsequently, both sets of data underwent normality testing using the Shapiro-Wilk test.

The outcomes of the normality test analysis are presented in the subsequent table:

Table 2. Normality Calculation Results

Class	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistics	Df	Sig.	Statistics	df	Sig.
Experiment	0.072	26	0.200	0.958	26	0.359
Control	0.126	26	0.200	0.938	26	0.120

The normality test applied in this analysis is the Shapiro-Wilk test. This type of test was chosen based on the sample size of less than 50 sample data for each VA and VB class. Based on the table above, it can be seen that the significance value of normality for the control class is 0.359 and the experimental class is 0.120. The significance value in both classes meets the Sig value. > 0.05, therefore it can be accepted that the data on the results of high-level thinking skills for students in the control class and experimental class for class V at SDN 18 Kampung Durian is normally distributed. Next, a homogeneity test was carried out. The data that has been analyzed produces the results as below:

Table 3. Homogeneity Test Calculation Results

Test of Homogeneity of Variances				
	Levene Statistics	df1	df2	Sig.
Based on mean	0.651	1	50	0.424
Based on median	0.743	1	50	0.393
Based on median adjusted df	0.743	1	49,795	0.393
Based on trimmed mean	0.651	1	50	0.423

After conducting the homogeneity test, it was determined that the Sig values for both the control and experimental classes were greater than 0.05. Therefore, it can be inferred that the evaluation data for high-level thinking skills in both the experimental and control classes are homogeneous, as are the post-test score data. Subsequently, the hypothesis test was performed. Below are the results of the independent sample t-test calculations :

Table 4. Hypothesis Test Calculation Results

	F	Sig.	T	df	Sig. (2-tailed)
Equal variances assumed	0.651	0.424	10,628	50	0,000
Equal variances not assumed			10,628	48,922	0,000

The table displaying the t-test calculation indicates that the significance value (Sig.) is 0.000, which is less than 0.05. Consequently, the null hypothesis (H0) is rejected, and the alternative hypothesis (H1) is accepted. This signifies that there is a significant influence of the STEAM learning model on the high-level thinking skills of fifth-grade students at SDN 18 Kampung Durian.

Science Learning Results

The data used in this research are the evaluation scores of the experimental group and the control group. Data from research on the influence of the STEAM learning model on science and science learning outcomes for class V students at SDN 18 Kampung Durian can be seen in the following table:

Table 5. Science Learning Results

Group	N	Mean	Std. Deviation	Maximum	Minimum
Experiment	26	84.62	5.22	94	76
Control	26	67.54	4.73	75	59

The data above shows that the average score for science learning outcomes in the experimental class is 84.62 ± 5.22 and the control class is 67.54 ± 4.73. The maximum in the experimental class was 94 and in the control class 75. The minimum in the experimental class was 76, while the control class was 59. Data from the two classes were then tested for normality using the Shapiro-Wilk test. The results of the normality test data analysis can be seen in the following table:

Table 6. Normality Calculation Results

Class	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistics	df	Sig.	Statistics	df	Sig.
Experiment	0.119	26	0.200	0.958	26	0.327
Control	0.096	26	0.200	0.938	26	0.450

The normality test applied in this analysis is the Shapiro-Wilk test. This type of test was chosen based on the sample size of less than 50 sample data for each VA and VB class. Based on the table above, it can be seen that the significance value of normality for the control class is 0.327 and the experimental class is 0.450. The significance value in both classes meets the Sig value. > 0.05, therefore it can be accepted that the science and science learning outcomes data for students in the control class and experimental class for class V at SDN 18 Kampung Durian are normally distributed. Next, a homogeneity test was carried out. The data that has been analyzed produces the results as below:

Table 7. Homogeneity Test Calculation Results

	Test of Homogeneity of Variances			
	Levene Statistics	df1	df2	Sig.
Based on mean	0.582	1	50	0.449
Based on median	0.560	1	50	0.458
Based on median adjusted df	0.560	1	50,000	0.458
Based on trimmed mean	0.582	1	50	0.449

Based on the homogeneity test results, it is known that the Sig results for the control and experimental classes show that the Sig. > 0.05. So it can be concluded that the science and science learning outcomes data for the experimental class and control class are homogeneous and the posttest score data for the experimental class and control class are also homogeneous. After carrying out the two tests above, the hypothesis test is then carried out. The following are the results of the calculation of the independent sample t-test as a hypothesis test:

Table 8. Hypothesis Test Calculation Results

	F	Sig.	t	Df	Sig. (2-tailed)
Equal variances assumed	0.582	0.449	12,351	50	0,000
Equal variances not assumed			12,351	49,525	0,000

The t-test calculation can be seen in the table above shows that Sig. is 0.000 < 0.05, then H0 is rejected and H1 is accepted, meaning that the hypothesis states that there is an influence of the STEAM learning model on the science and science learning outcomes of class V students at SDN 18 Kampung Durian.

Discussion

This research is an experimental research that tests the application of the STEAM approach to the learning process to find out whether or not there is an influence of the application of the STEAM approach on students' high-level thinking abilities in learning in class V at SDN 18 Kampung Durian. The analysis of students' high-level thinking skills based on the final evaluation results revealed notable distinctions between the experimental and control groups. In the experimental class, where the STEAM approach was implemented, students achieved scores ranging from 69 to 94, with an average score of 81.50. Conversely, in the control class, where conventional learning methods were employed, scores ranged from 50 to 71, with an average of 60.46. Hypothesis testing using the Independent Sample T-Test at a 5% significance level yielded a p-value of 0.000, indicating statistical significance. Consequently, the null hypothesis (H0) was rejected, and the alternative hypothesis (H1) was accepted, indicating that the STEAM approach significantly influences the high-level thinking abilities of fifth-grade students at SDN 18 Kampung Durian. These result are in line with previous research (Susanti et al., 2018) which states that there are quite significant differences in competency achievement results (cognitive, affective, and psychomotor) between students who take part in STEAM learning and students who take part in learning using conventional methods. Other research conducted by (Rahman et al., 2020) shows that there is an increase in student learning outcomes after using the PjBL STEAM model in learning. Next, research (Widodo et al., 2021) the results found that there was an increase in the learning outcomes of Class IV students after using STEAM PBL, and from this research, it was also known that STEAM PBL had a significant influence on the learning process.In accordance with the instruments of high-level thinking skills, namely analyzing, evaluating and creating (Ahmad et al., 2017).

Learning using the STEAM approach has obstacles and challenges in terms of subject matter(Nuragnia et al., 2021). Based on the analysis of students' science learning outcomes, the final evaluation results from

the experimental class, where the STEAM approach was implemented, ranged from 76 to 94, with an average score of 84.62. Conversely, in the control class, employing conventional learning methods, scores ranged from 59 to 75, with an average of 67.54. Utilizing the Independent Sample T-Test at a 5% significance level, a p-value of 0.000 was obtained, indicating statistical significance. Consequently, the null hypothesis (H0) was rejected, and the alternative hypothesis (H1) was accepted, signifying that the application of the STEAM approach significantly influences the science learning outcomes of fifth-grade students at SDN 18 Kampung Durian. These findings corroborate previous research hich stated that interactive teaching materials based on the STEAM approach were proven to be significantly effective in improving thematic learning outcomes for social studies subjects in fifth-grade elementary school students. The same results were also shown by research (Astuti et al., 2023), the integration of the STEAM approach with problem-based learning (PBL) has been found to significantly impact the cognitive science learning outcomes of sixth-grade students. Implementing the STEAM model in education fosters a holistic learning environment that effectively amalgamates natural science, technology, engineering, art, and mathematics. This holistic approach consequently enhances students' comprehension of scientific concepts and materials. STEAM is very supportive of scientific literacy (Wandraini et al., 2022)

The application of the STEAM model helps elementary school students to be able to think at a higher level because the STEAM model can be applied in various conditions to increase students' potential and help improve students' thinking abilities. Apart from that, this model also helps achieve student learning achievements, achieve students' understanding of concepts, increase students' critical thinking and problem-solving skills, actively involve students during the learning process, and increase students' motivation and interest in learning (Iaskyana et al., 2022). Through STEAM, students in elementary schools can develop their competencies to compete in the era of globalization and be able to solve problems faced in everyday life through the correct and appropriate use of technology. The STEAM model can guide students to have several skills, namely problem-solving skills, critical thinking skills, and collaboration skills (Amelia & Marini, 2022).

This STEAM approach uses constructivism theory which emphasizes student-centered learning by containing several activities such as practice, projects, problem-based, inquiry, authentic, and contextual learning (Rahma & Isralidin, 2022)

Learning with a steam approach is very helpful for teachers in learning science (Efwinda et al., 2021). The implementation of a scientific approach in science learning is also in line with the STEAM approach (Elvianasti et al., 2021).

Students will build their knowledge and understanding through assigned projects (Mu'minah & Suryaningsih, 2020). Students will also be involved in multiple disciplines simultaneously, they learn to view problems from a variety of different perspectives (Zubaidah, 2019) implementing the STEAM approach in education motivates students to engage in designing, developing, and utilizing technology. It also facilitates the refinement of cognitive, manipulative, and affective skills while promoting the application of knowledge to address challenges. Furthermore, it inspires students

to innovate and create novel solutions (Amir, 2019). The STEAM approach fosters the emergence of unique and unforeseen creations from individuals or groups. Additionally, collaboration, cooperation, and communication naturally evolve throughout the learning journey as STEAM is implemented in group settings. Grouping students in STEAM necessitates both personal and interpersonal accountability for the learning process, which in turn enhances students' comprehension of the subject matter. Through this approach, students proactively devise strategies independently for their learning, thereby honing problem-solving, critical thinking, and collaboration abilities (Mu'minah & Suryaningsih, 2020). Critical thinking skills greatly influence learning outcomes (Wanelly & Fitria, 2019). Moreover, students' higher level thinking abilities are also really needed in mathematics lessons (Arifin & Retnawati, 2017).

The STEAM approach aims to cultivate students' comprehension of the learning process by blending multiple disciplines within real-world contexts. It encourages students to explore their capabilities by incorporating relevant technologies, which they may select based on personal preferences or interests, and communicate ideas through engaging mediums like art. Furthermore, students can develop their understanding of STEAM learning through collaborative group work that emphasizes inquiry-based approaches. In this case, students are encouraged to autonomously seek and comprehend the concepts under study, both individually and collaboratively within groups (Mu'minah & Suryaningsih, 2020) in terms of curriculum enhancement, adopting the STEAM approach offers a promising avenue to enhance students' educational journeys, offering authentic contexts and fostering the cultivation of advanced cognitive abilities. The practical implication of this study underscores the importance of integrating the STEAM learning model across different educational levels to enhance learning quality and student outcomes. Nonetheless, it's crucial to acknowledge that various factors such as student motivation, the efficacy of learning implementation, and other variables may also affect outcomes. Conducting further research with stricter control over these variables could yield deeper insights into the efficacy of the STEAM learning model

CONCLUSION

In this research, the application of the STEAM learning model in class V of SDN 18 Kampung Durian was proven to have a positive impact on students' higher-order thinking skills and science learning outcomes. The significantly higher scores in the experimental group indicate that the STEAM learning model can be an effective alternative to enrich student's learning experiences, provide real-world context, and stimulate the development of higher-order thinking skills. The implications of this research support the need to integrate the STEAM learning model in the basic education curriculum to improve the quality of learning in the era of globalization

REFERENCES

Ahmad, N. Q., & Yustinaningrum, B. (2022). The Development of Project-Based E-Learning Tool to Improve Students' Creative Thinking Skill. *Ta'dib*, *25*(1), 95-104.

Ahmad, S., Prahmana, R. C. I., Kenedi, A. K., Helsa, Y., Arianil, Y., & Zainil, M. (2017, December). The instruments of higher order thinking skills. In Journal of Physics: Conference Series (Vol. 943, No. 1, p. 012053). IOP Publishing.

Asrizal, A., Annisa, N., Festiyed, F., Ashel, H., & Amnah, R. (2023). STEM-integrated physics digital teaching material to develop conceptual understanding and new literacy of students. Eurasia Journal of Mathematics, Science and Technology Education, 19(7), em2289.

Ahmad, S., Prahmana, R. C. I., Kenedi, A. K., Helsa, Y., Arianil, Y., & Zainil, M. (2017). *Instrumen keterampilan berpikir tingkat tinggi*.

Amelia, W., & Marini, A. (2022). Urgensi Model Pembelajaran Science, Technology, Engineering, Arts, And Math (STEAM) Untuk Siswa Sekolah Dasar. *Jurnal Cakrawala Pendas*, *8*(1), 291–298.

Amir, R. H. (2019). *Efektivitas Model Pembelajaran STEAM (Science, Technology, Engineering, Art, and Mathematics) dalam Pembelajaran IPA Konsep Sumber Energi pada Siswa Kelas IV SD Pertiwi Makassar*. Universitas Muhammadiyah Makassar.

Anggito, A., & Setiawan, J. (2018). Metodologi Penelitian Kualitatif. *Sukabumi: CV Jejak*.

Arifin, Z., & Retnawati, H. (2017). Pengembangan instrumen pengukur higher order thinking skills matematika siswa SMA kelas X. *PYTHAGORAS: Jurnal Pendidikan Matematika*, *12*(1), 98. https://doi.org/10.21831/pg.v12i1.14058

Asrizal, A., Annisa, N., & Amnah, R. (2023). *Bahan ajar digital fisika terintegrasi STEM untuk mengembangkan pemahaman konseptual dan literasi baru siswa*. *19*(7).

Astuti, L., Mayasari, D., & Setyowati, R. (2023). *Pengaruh Pendekatan Steam dengan Model Problem Based Learning (PBL) terhadap Hasil Belajar Kognitif Siswa Pembelajaran IPA SDN 15 Singkawang*. *4*, 2063–2070.

Efwinda, S., Qadar, R., Rananda, N., Mabrurah, F. F., & Setiyawan, R. (2021). Pelatihan Pembelajaran STEAM bagi Guru IPA SMP di Kalimantan Timur. *Bubungan Tinggi: Jurnal Pengabdian Masyarakat*, *3*(4), 447. https://doi.org/10.20527/btjpm.v3i4.4074

Elvianasti, M., Lufri, L., Asrizal, A., & Rikizaputra, R. (2021). Implementasi Pendekatan Saintifik dalam Pembelajaran IPA di Indonesia : Suatu Meta-Analisis. *Edukatif : Jurnal Ilmu Pendidikan*, *4*(1), 390–398. https://doi.org/10.31004/edukatif.v4i1.1819

Fitria, Y., & Idriyeni, I. (2017). Development of Problem-Based Teaching Materials for the Fifth Graders of Primary School. *Ta'dib*, *20*(2), 99. https://doi.org/10.31958/jt.v20i2.747

Iaskyana, B., Triatna, C., & Nurdin, N. (2022). Kajian Pedagogik dalam Implementasi STEAM pada Pembelajaran Jarak Jauh di Era Pandemi. *SAP (Susunan Artikel Pendidikan)*, *7*(1), 50–58.

Lufri, L., Amrianto, A., & Anhar, A. (2019). Pengaruh Metode Example Non Example Terhadap Kompetensi Ipa Peserta Didik Pada Materi Interaksi Makhluk Hidup. *Ta'dib*, *22*(2), 99. https://doi.org/10.31958/jt.v22i2.1506

Mu'minah, I. H., & Suryaningsih, Y. (2020). Implementasi STEAM (Science, Technology, Engineering, Arts and Mathematics) dalam Pembelajaran Abad 21. *Jurnal Bio Education*, *5*(1), 65–73.

Nuragnia, B., Nadiroh, & Usman, H. (2021). Pembelajaran Steam Di Sekolah Dasar : Implementasi Dan Tantangan. *Jurnal Pendidikan Dan Kebudayaan*, *6*(2), 187–197. https://doi.org/10.24832/jpnk.v6i2.2388

Rahma, & Isralidin. (2022). Implementasi Steam Meningkatkan Kemampuan Berpikir Kritis Siswa SD Negeri 1 Bireuen. *Jurnal Edukasi Matematika Dan Sains*, *3*(1), 33–37.

Rahman, M. K., Suharto, B., & Iriani, R. (2020). Meningkatkan Berpikir Kreatif dan Hasil Belajar Menggunakan Model PjBL Berbasis STEAM pada Materi Larutan Elektrolit dan Nonelektrolit. *JCAE (Journal of Chemistry And Education)*, *3*(1), 10–22.

Rosdiana, Marnita, & Safarati, N. (2022). Model Pembelajaran STEAM untuk Meningkatkan Keterampilan Berpikir Tingkat Tinggi Siswa Kelas X SMA Negeri 2 Peusangan. *Jurnal Edukasi Matematika Dan Sains*, *3*(2), 47–52.

Simanjuntak, M. P., Hutahaean, J., Marpaung, N., & Ramadhani, D. (2021). Effectiveness of problem-based learning combined with computer simulation on students' problem-solving and creative thinking skills. *International Journal of Instruction*, *14*(3), 519–534. https://doi.org/10.29333/iji.2021.14330a

Sugiyono. (2013). Metode Penelitian Kuantitatif Kualitatif dan R&D. *Bandung: CV. Alfabeta*.

Susanti, L. Y., Rafiatul, H., & Khirzin, M. H. (2018). Penerapan Media Pembelajaran Kimia Berbasis Science, Technology, Engineering, and Mathematics (STEM) untuk Meningkatkan Hasil Belajar Siswa SMA/ SMK pada Materi Reaksi Redoks. *Jurnal Pendidikan Sains*, *6*(2), 32.

Wandraini, A., Wau, A., Putri, E. I., & Fitri, R. (2022). Implementasi STEAM (Science , Technology , Engineering , Arts , and Mathematics) pada Pembelajaran Biologi. *BioEdu Prosiding SEMNAS BIO 2022 UIN Syarif Hidayatullah Jakarta*, 938–946.

Wanelly, W., & Fitria, Y. (2019). Pengaruh Model Pembelajaran Integrated Dan Keterampilan Berpikir Kritis Terhadap Hasil Belajar Ipa. In *Jurnal Basicedu* (Vol. 3, Issue 1, pp. 180–186). https://doi.org/10.31004/basicedu.v3i1.99

Widodo, T. H., Rokhmaniyah, & Arifin, M. H. (2021). Pengaruh Pembelajaran STEAM melalui Problem Based Learning terhadap Hasil Belajar Siswa Kelas IV pada Mata Pelajaran PKn di SDN 1 Kuwayuhan Kecamatan Pejagoan Kabupaten Kebumen. *Jurnal Pendidikan Tambusai*, *5*(5), 483–3489.

Zubaidah, S. (2019). STEAM (Science, Technology, Engineering, Arts, and Mathematics): Pembelajaran untuk Memberdayakan Keterampilan Abad ke-21. *Seminar Nasional Matematika Dan Seni*.