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Literature Study: Application of PBL-STEM on Simple Machine Topic to Improve Critical Thinking Skills

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Abstract: This study aims to know and describe the application of problem-based learning integrated science, technology, engineering, and mathematics or commonly known as PBL-STEM on Simple Machine Topic to Improve Critical Thinking Skills. The method used in this research is qualitative research with data collection techniques, namely literature studies. The process of collecting data in this study is by looking for theoretical references that are relevant to the problems found. The data obtained is then analyzed with descriptive analysis methods. Based on the analysis of the data used, the result showed an increase in critical thinking skills owned by students, which can be seen from the N-gain score obtained. These results are also supported by other relevant studies. Based on a literature review, it can be concluded that the application of PBL-STEM on simple machine subjects can improve critical thinking skills.

Keywords: Problem-based learning; STEM; Simple machine; Critical thinking

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Introduction

The advancement of science and technology that develops in the 21st century affects aspects of life, one of which is the aspect of Education (Pratiwi et al., 2019). This has an impact on the expected learning objectives, to train and equip students with 21st-century skills (Astuti, 2019). 21st-century skills include critical thinking, creativity, communication, and collaboration known as 4C (Erdoğan, 2019). These skills are very important for every individual because it is a provision of life to be able to compete in the era of globalization (Ratnawati et al., 2018). The concept of learning to train these 21st-century skills has been adapted in the Kurikulum 2013 or commonly known as K13 through a scientific approach and authentic assessment.

One of the implementations of the K13 applied in elementary to secondary school level education is a natural science. In natural science learning, critical thinking skills are one of the important components, so they must be trained in students (Santos, 2017). According to Ennis (1993), critical thinking is the feasibility of reflective thinking focused on deciding what to believe or do. According to Kristanto & Susilo (2015) critical thinking in learning is used to understand the arguments and beliefs of others, critically evaluate arguments and beliefs, and develop and defend their arguments.

The critical thinking skills possessed by students in Indonesia are still low. This can be seen from some findings in previous studies, such as the findings of research results from Pamungkas et al. (2018), Susilowati et al. (2017), and Fernanda et al. (2019) three found that the critical thinking skills of students in Indonesia are still low. Based on these facts, there must be synergy between the strategy and the learning model to achieve the goal. Innovation is needed in the process of learning IPA that must be done, one of which is applying problem-based learning.

Problem-Based Learning or can be abbreviated as PBL is one of the learning models that can meet the educational goals of the 21st century and is also one of the learning models that are by the references in the K13 that apply scientific approaches (Afriana et al.,

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2016). PBL is a learning model that uses problems as a starting point for starting learning (Talib et al., 2019). Based on the findings of Lubis et al. (2019) PBL strategies are very effective for increasing critical thinking skills. Another finding from Hussin et al. (2019) states that PBL can improve students' critical thinking skills.

Learning today also needs to keep up with the times in the era of globalization, one way is to integrate Science, Technology, Engineering, and Mathematics, which can be shortened to STEM (Afriana et al., 2016). STEM applications can make students find innovative solutions to problems faced in real terms and can convey them well (Lestari et al., 2018). The use of STEM in learning activities applied in the form of models, teaching materials and student worksheets can have a good impact, such as improving learners' reasoning skills (Fitriani et al., 2017).

In natural science learning, there is a simple machine topic. A simple machine is one of the topics accommodated in natural science learning at the junior high level (Subagia & Priyanka, 2020). This topic is closely related to aspects of STEM because in this material all aspects of STEM are involved. Judging from its basic competencies, this simple machine topic is suitable for the PBL model, because in basic competence there is a presentation of the results of problem-solving.

Based on the description, the effectiveness of natural science learning can be an alternative to improving students' critical thinking skills. Therefore, this article will be discussed the Application of PBL-STEM on a Simple machine topic to Improve Students' Critical Thinking Skills. With the study of the literature on research results on PBL-STEM, it is expected to be a reference for educators in conducting learning innovations.

Method

This study is a literature study using secondary data from research results that have been published in journals and proceedings both nationally and internationally. According to Zed (2014), a literature study is an activity related to the method of collecting library data. In line with Nazir (2014) literature studies are a technique of collecting data by conducting a study of books and literature that have to do with solved problems.

This study seeks to find out and describe the Application of PBL-STEM to Simple machine topics to Improve students' Critical Thinking Skills. The process of collecting data in this study is done by looking for theoretical references that are relevant to the problems found. The data obtained is then analyzed with descriptive analysis methods. Descriptive analysis methods are done by describing a problem or facts obtained by explanation and decomposition and then analyzed by researchers. The data used in this research literature study can be seen in Table 1.

Table 1. Research Data from Relevant Journals

Name	Conclusion
Parno et al. (2020)	Students' critical thinking skills are not affected by the initial circumstances but are only influenced by the different treatment of each class based on the model or learning base applied.
Putri et al. (2020)	There was a significant difference in the average improvement in students' critical thinking skills in the PBL-STEM group and the PBL group.
Febrianto et al. (2021)	Problem-based virtual learning with PBL-STEM assisted Schoology is effective at improving critical thinking skills.

Result and Discussion

This analysis is used to determine the improvement of critical thinking skills through PBL-STEM learning. Based on an analysis of the results of research conducted by Parno et al. (2020), this study aims to develop critical thinking skills with virtual simulation media on the topic of optical tools. The study used three groups: the 1st experimental group that applied PBL-STEM based learning, the 2nd experimental group that applied PBL-based learning, and the control group that applied conventional learning. The data obtained is N-gain data from the three class groups. Data on the N-gain of all three class groups can be seen in Table 2.

Table 2. N-gain Data

Group	N-gain	Category
Experimental Group 1	0.75	High
Experimental Group 2	0.49	Medium
Control	0.32	Medium

Based on Table 2. The experimental group 1 got an N-gain score of 0.75 in a high category, the experimental group 2 got an N-gain score of 0.49 in a moderate category, and the control group got an N-gain score of 0.32 in a moderate category. The results of increasing students' critical thinking skills in experimental group 1, experimental group 2, and the control group can be seen in the following figure.

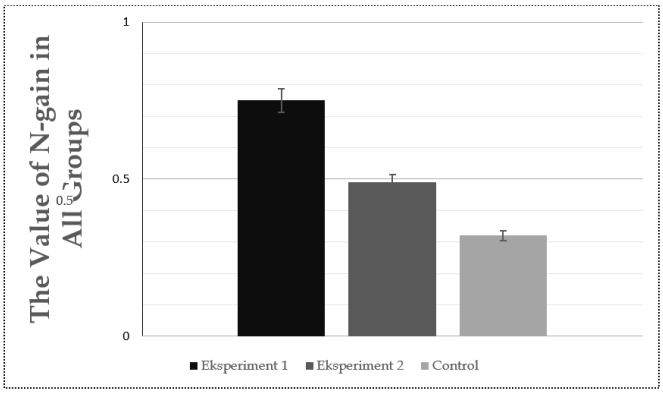

Figure 1. The Value of N-gain in All Groups

The picture above shows that the N-gain score of the experimental group 1 is one level higher than that of experimental group 2 and the control group, and the N-gain score of the experimental group 2 is higher than the control group. Based on the results of this analysis it can be stated that there is a difference in the improvement of critical thinking skills after being given treatment to each group. From the above research, it can be concluded that PBL-STEM can improve the critical thinking skills that students have. The results of this study are in line with what was revealed by Oktaviani et al. (2019) which states that the treatment given during learning can affect the results obtained by students. This is also supported by research conducted by Ulger (2018) which also states that the treatment given during learning can improve expected learning outcomes.

Another study conducted by Putri et al. (2020) aims to improve students' critical thinking skills through learning problem-based learning integrated science, technology, engineering, and mathematics (PBL-STEM) online. In this study, two groups were used, namely the experimental group and the control group. The experimental group applied the PBL-STEM model, while the control group applied the PBL model. The data obtained from this study were N-gain and data on the significance of the difference in average improvement in students' critical thinking skills from pretest and posttest results in experimental groups and control groups. Data on pretest, posttest, and n-gain can be seen in Table 3.

Table 3. Pretest, Posttest, and N-gain Data

Parameters	PBL-STEM		PBL	
	Pretest	Posttest	Pretest	Posttest
Lowest score	37.00	75.00	40.00	65.00
Highest score	57.00	92.00	66.00	83.00
Average score	47.40	85.10	54.80	74.20
N-gain		0.72		0.43

In Table 3. There are data regarding the results of the pretest and posttest in the experimental class that applies the PBL-STEM model and the control class that applies the PBL model. The data includes the lowest score, highest score, average score, and N-gain. Based on these data, there was an increase in the scores obtained by students after being given treatment. The results of increasing scores on pretest and posttest obtained by students can be seen in the following picture.

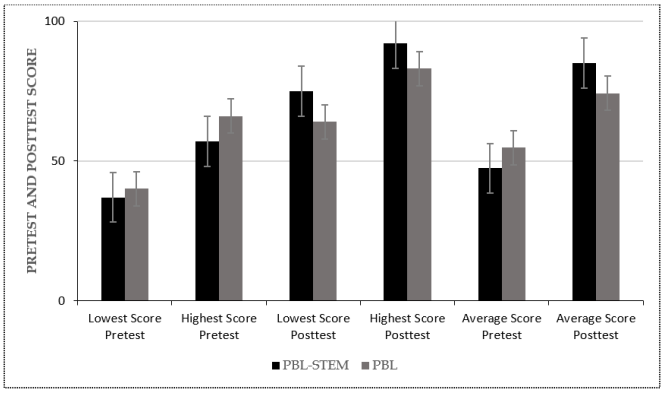

Figure 2. Pretest and Posttest Data

From the picture above, it can be seen that the pretest and posttest scores were obtained by students for the PBL-STEM group and the PBL group. Judging from the average score obtained during the pretest and posttest both groups experienced an increase in score. Based on this analysis, it can be seen that the scores obtained related to critical thinking skills in the group that applied PBL-STEM and the group that applied PBL both experienced an increase. It can be concluded that the two learning models namely PBL-STEM and PBL can improve critical thinking skills.

The results of the N-gain of critical thinking skills in the PBL-STEM group and the PBL group can be seen in the following figure.

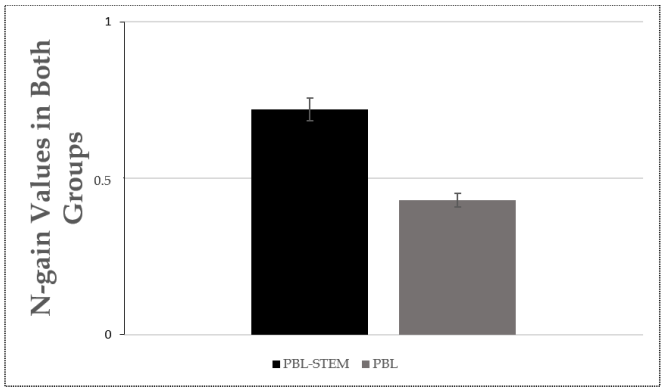

Figure 3. N-gain Values in Both Groups

The picture above shows that the experimental group that applied the PBL-STEM model got an N-gain

score of 0.72, while the control group that applied the PBL model got an N-gain of 0.43. Based on the results of the analysis, it can be stated that the increase in critical thinking skills in the experimental group that applied the PBL-STEM model was greater than that of the control group that applied the PBL model.

The results of the analysis on the significance of the difference in average improvement in students' critical thinking skills in the PBL-STEM and PBL groups can be seen in Table 4.

Table 4. Average Difference Significance Data

Group		Normality Test	Homogeneity Test	t-Test
PBL-STEM	Pretest	0.200	0.346	0.000
	Posttest	0.143		
PBL	Pretest	0.200		
	Posttest	0.200		

Based on Table 4. it can be stated that there is a significant difference in the average improvement in the critical thinking skills of students in the PBL-STEM group and the PBL group. From the results of the above research, it can be concluded that the PBL-STEM model is effective for improving the critical thinking skills of students. The results of this study are in line with the results of research conducted by Mulyani (2019) which states that STEM-based learning can facilitate students' use of multidisciplinary science in problem-solving and can train 21st-century skills, one of which is critical thinking skills. Learning by applying PBL-STEM can encourage students to always be critical in finding concepts and linking the experiences students have with the material studied (Putri et al., 2020).

Another study was also conducted by Febrianto et al. (2021) which aimed to analyze the effectiveness of Schoology-assisted PBL-STEM on environmental pollution materials to improve critical thinking skills, as a result of student learning. The study used four groups that were experimental groups. The data obtained from this study is N-gain from the results of the pretest and posttest. N-gain data from pretest and posttest results can be seen in Table 5.

Table 5. N-gain Pretest and Posttest Results

Group	Pretest	Posttest	N-gain
Experiment 1	46.60	70.70	0.43
Experiment 2	42.50	71.17	0.48
Experiment 3	45.89	73.20	0.47
Experiment 4	44.00	70.20	0.47
Mean	44.70	71.30	0.46

Based on Table 5. It can be stated that the average N-gain of all experimental groups is 0.46, which falls into the moderate category. This means that there is an increase from before getting treatment and after getting treatment by applying PBL-STEM. Based on the results of the above research it can be concluded that learning with PBL-STEM is effective for improving critical thinking skills. These results are in line with the opinions expressed by Ariyatun & Octavianelis (2020) which state that PBL-STEM has a positive impact on improving students' critical thinking skills.

Based on the analysis of some of the above studies it can be concluded that PBL-STEM is applied ineffective learning to be able to improve the critical thinking skills of students. This can be seen from the N-gain gained after being given treatment during learning in the form of PBL-STEM in each study. PBL-STEM can also be applied to various materials in IPA learning, one of which is a simple machine topic.

PBL-STEM is suitable for application in simple machine topic learning because it is by the basic competencies used. The basic competencies used in simple aircraft materials are found in KD 3.3 and KD 3.4. In this basic competency, it is expected that learners can present the results of investigation or problem solving about the benefits of using a simple machine in everyday life (Kemendikbud, 2017). That's because simple machine topics are very closely related to everyday life.

Based on this, because students are expected to solve a problem related to daily life, then one of the suitable learning models is PBL. PBL is one of the innovative learning models that can be applied in the learning process (Rerung et al., 2017). Parno et al. (2018) define PBL as one of the learning models centered on learners that starts by using a real problem and learners must solve the problem.

The real problems that occur in everyday life are closely related to STEM, which is currently one of the main trends in the modernization of education by involving the integration between natural sciences, technology, engineering, and mathematics in the learning process (Soroko et al., 2019). The integration of various disciplines can make students not only skilled in one discipline but across disciplines (Bahrum et al., 2017). According to Mayasari et al. (2014) STEM can produce students who can develop the competencies they have to be applied in various situations and problems that will be faced in everyday life.

Sayary et al. (2015) state that the strategies present in PBL match STEM-related activities, as PBL can shape students' cognitive processes using their own experiences in the learning process, and STEM is closely related to real life. Another opinion is from Casteldine & Chalmers (2012) who state that PBL has an important role in integrated learning such as STEM because it can develop skills that students have such as critical thinking skills, collaboration, creativity, communication, and motivation. It is also in line with Tawfik & Trueman's (2015) opinion that instructional strategies in PBL are suitable for being integrated with

STEM because it emphasizes problem-solving, interdisciplinary understanding, and creativity, and can enhance critical thinking skills.

Conclusion

Based on the literature review, it can be concluded that the application of PBL-STEM on simple plane materials is suitable for improving students' critical thinking skills. The results of the research analysis show that learning that applies the PBL-STEM model is better able to improve students' critical thinking skills. It can be seen from the comparison of N-gain obtained when applying the PBL-STEM model is always higher.

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References

Afriana, J., Permanasari, A., & Fitriani, A. (2016). Penerapan Project Based Learning Terintegrasi STEM untuk Meningkatkan Literasi Sains Siswa Ditinjau dari Gender. *Jurnal Inovasi Pendidikan IPA*, *2*(2). doi: https://doi.org/http://dx.doi.org/10.21831/jipi.v2i2.8561

Ariyatun, A. & Octavinelis, D. F. (2020). Pengaruh Model Problem Based Learning Terintegrasi STEM Terhadap Kemampuan Berpikir Kritis Siswa. *Journal of Educational Chemistry*, *2*(1), 33–39. doi: https://doi.org/10.21580/jec.2020.2.1.5434

Astuti, T. P. (2019). Model Problem Based Learning dengan Mind Mapping dalam Pembelajaran IPA Abad 21. *Proceeding of Biology Education*, 64–73. doi: https://doi.org/10.21009/pbe.3-1.9

Bahrum, S., Wahid, N., & Ibrahim, N. (2017). Integration of STEM Education in Malaysia and Why to STEAM. *International Journal of Academic Research in Business and Social Sciences*, *7*(6), 645–654. doi: https://doi.org/http://dx.doi.org/10.6007/IJARBSS/v7-i6/3027

Casteldine, A-R., & Chalmers, C. (2011). LEGO robotics: An authentic problem solving tool? *Design and Technology Education. An International Journal*, *16*(3), 19–27. Retrieved from https://files.eric.ed.gov/fulltext/EJ960118.pdf

Ennis, R. H. (1993). Critical Thinking Assessment. *Theory Into Practice*, *32*(3), 180–186. doi: https://doi.org/http://dx.doi.org/10.1080/00405849309543594

Erdoğan, V. (2019). Integrating 4C Skills of 21st Century into 4 Language Skills in EFL Classes. *International Journal of Education and Research*, *7*(11), 113–124. Retrieved from https://www.ijern.com/journal/2019/November-2019/09.pdf

Febrianto, T., Ngabekti, S., & Saptono, S. (2021). The Effectiveness of Schoology-Assisted PBL-STEM to Improve Critical Thinking Ability of Junior High School Students. *Journal of Innovative Science Education*, *10*(2), 222–229. Retrieved from http://journal.unnes.ac.id/sju/index.php/jise

Fernanda, A., Haryani, S., Prasetya, A. T., & Hilmi, M. (2019). Analisis Kemampuan Berpikir Kritis Siswa Kelas XI pada Materi Larutan Penyangga dengan Model Pembelajaran Predict Observe Explain. *Jurnal Inovasi Pendidikan Kimia*, *13*(1), 2326–2336. Retrieved from https://journal.unnes.ac.id/nju/index.php/JIPK/article/view/16183

Fitriani, D., Kaniawati, I., & Suwarma, I. R. (2017). Pengaruh Pembelajaran Berbasis Stem (Science, Technology, Engineering, and Mathematics) Pada Konsep Tekanan Hidrostatis Terhadap Causal Reasoning Siswa Smp. In *Prosiding Seminar Nasional Fisika*. doi: https://doi.org/10.21009/03.snf2017.01.eer.08

Hussin, W. N. T. W., Harun, J., & Shukor, N. A. (2019). Problem Based Learning to Enhance Students Critical Thinking Skill via Online Tools. *Asian Social Science*, *15*(1), 14–23. Retrieved from https://pdfs.semanticscholar.org/eb08/7e43fdf58fe64b921a2c5e58d46cdc3358db.pdf

Kemendikbud. (2017). *Ilmu Pengetahuan Alam*. Jakarta, Indonesia: Kementerian Pendidikan dan Kebudayaan.

Kristanto, Y. E. & Susilo, H. (2015). Pengaruh Model Pembelajaran Inkuiri Terbimbing terhadap Kemampuan Berpikir Kritis dan Hasil Belajar IPA Siswa Kelas VII SMP. *Jurnal Pendidikan Dan Pembelajaran*, *22*(2), 197–208. Retrieved from https://www.neliti.com/publications/120977/

Lestari, D. A., Astuti, B., & Darsono, T. (2018). Implementasi LKS dengan Pendekatan STEM (Science, Technology, Engineering, and Mathematics) untuk Meningkatkan Kemampuan Berpikir Kritis Siswa. *Jurnal Pendidikan Fisika Dan Teknologi*, *4*(2), 202–207. Retrieved from https://jurnalfkip.unram.ac.id/index.php/JPFT/article/view/809

Lubis, R. R., Irwanto, I., & Harahap, M. Y. (2019). Increasing Learning Outcomes and Ability Critical Thinking of Students Through

Application Problem Based Learning Strategies. *International Journal for Educational and Vocational Studies*, *1*(6), 524–527. doi: https://doi.org/0.29103/ijevs.v1i6.1679

Mayasari, T., Kadarohman, A., & Rusdiana, D. (2014). Pengaruh Pembelajaran Terintegrasi Science, Technology, Engineering, and Mathematics (STEM) pada Hasil Belajar Siswa; Studi Meta Analisis. *Prosiding Semnas Pensa VI "Peran Literasi Sains."* Retrieved from https://adoc.pub/pengaruh-pembelajaran-terintegrasi-science-technology-engine.html

Mulyani, T. (2019). Pendekatan Pembelajaran STEM untuk menghadapi Revolusi Industry 4.0. *Seminar Nasional Pascasarjana 2019*, 453–460. Retrieved fromhttps://proceeding.unnes.ac.id/index.php/snpasca/article/download/325/351

Nazir, M. (2014). *Metode Penelitian*. Bogor, Indonesia: Ghalia Indonesia.

Oktaviani, T., Dewi, E. R. S., & Kiswoyo, K. (2019). Penerapan Pembelajaran Aktif dengan Metode Permainan Bingo untuk Meningkatkan Hasil Belajar Matematika. *Jurnal Mimbar Ilmu*, *24*(1), 47–52. Retrieved from https://ejournal.undiksha.ac.id/index.php/MI/article/view/17409

Pamungkas, Z. S., Aminah, S. N., & Nurosyid, F. (2018). Analisis Kemampuan Berpikir Kritis Siswa dalam Menyelesaikan Soal Literasi Sains berdasarkan Tingkat Kemampuan Metakognisi. *EDUSAINS*, *10*(2), 256–264. doi: http://dx.doi.org/10.15408/es.v10i2.7932

Parno, P., Fauziyah, S., Pramono, N. A., Anggraini, R. T., Hidayat, A., Supriana, E., Ali, M. (2020). The Increase of Students' Critical Thinking Abilities on Optical Instrument Topic Through PBL-STEM with Virtual Simulation Media. *Journal of Physics: Conference Series*, *1918*, 1–8. doi: 10.1088/1742-6596/1918/5/052067

Parno, P., Yulianti, L., & Ni'mah, B. Q. A. (2018). The influence of PBL-STEM on students' problem-solving skills in the topic of optical instruments. *Journal of Physics*, *1171*, 1–8. doi: https://doi.org/10.1088/1742 6596/1171/1/012013

Pratiwi, S. N., Cari, C., & Aminah, N. S. (2019). Pembelajaran IPA Abad 21 dengan Literasi Sains Siswa. *Jurnal Materi Dan Pembelajaran Fisika*, *9*(1), 34–42. Retrieved from https://jurnal.uns.ac.id/jmpf/article/view/3162

Putri, C. D., Pursitasari, I. D., & Rubini, B. (2020). Problem Based Learning terintegrasi STEM di Era Pandemi Covid-19 untuk Meningkatkan Keterampilan Berpikir Kritis Siswa. *Jurnal IPA Dan Pembelajaran IPA*, *4*(2), 193–204. Retrieved from http://jurnal.unsyiah.ac.id/jipi

Ratnawati , R., Faridah, D., Anam, S., & Retnaningdyah, P. (2018). Investigating Experience on Blended Learning Classroom Practices in Tertiary EFL Students. *International Symposium on Social Sciences, Education, and Humanities (ISSEH)*, *306*, 212–217. doi: https://doi.org/10.2991/isseh-18.2019.50

Rerung, N., Sinon, I. L. S., & Widyaningsih, S. W. (2017). Penerapan Model Pembelajaran Problem Based Learning (PBL) untuk Meningkatkan Hasil Belajar Peserta Didik SMA pada Materi Usaha dan Energi. *Jurnal Ilmiah Pendidikan Fisika Al-BiRuNi*, *6*(1), 47–55. doi: 10.24042/jipf%20al-biruni.v6i1.597

Santos, L. F. (2017). The Role of Critical Thinking in Science Education. *Journal of Education and Practice*, *8*(20), 159–173. Retrieved from https://eric.ed.gov/?id=ED575667

Sayary, A. M. A.E., Forawi, S. A., & Mansour, N. (2015). STEM Education and Problem-Based Learning. In J. C. Wegerif, R., Li, L., & Kaufman (Ed.), *The Routledge International Handbook of Research on Teaching Thinking* (pp. 357–365). Routledge. Retrieved from https://www.routledgehandbooks.com/doi/10.4324/9781315797021.ch29

Soroko, N. V., Mykhailenko, L. A., Rokoman, O. G., & Zaselskiy, V. I. (2019). Educational Electronic Platforms for STEAM-Oriented Learning Environment at General Education School. *7th Workshop on Cloud Technologies in Education (CTE)*, *1*(7), 462–473. Retrieved from http://elibrary.kdpu.edu.ua/handle/123456789/3884

Subagia, I. W. & Priyanka, L. M. (2020). Pengembangan Unit Kegiatan Belajar IPA Berbasis Riset untuk Memfasilitasi Keterampilan Berpikir Kritis, Kreatif, Kolaboratif, dan Komunikatif Perserta Didik. *Seminar Nasional Riset Inovatif*. Retrieved fromhttps://eproceeding.undiksha.ac.id/index.php/senari/article/download/2121/1402

Susilowati, S., Sajidan, S., & Ramli, M. (2017). Analisis Keterampilan Berpikir Kritis Siswa Madrasah Aliyah Negeri di Kabupaten Magetan. *Prosiding Seminar Nasional Pendidikan Sains (SNPS)*, 223–231. Retrieved from https://jurnal.fkip.uns.ac.id/index.php/snps/article/view/11417

Talib, C. A., Rafi, I. B. M., Rajan, S. T., Hakim, N. W. A., Ali, M., & Thoe, N. K. (2019). Steam Teaching Strategies in Related Subject. Education, Sustainability, and Society. *Education, Sustainability and Society (ESS)*, *2*(4), 14–18. Retrieved from https://ideas.repec.org/

Tawfik, A. & Trueman, R. (2015). Effects of Case Libraries in Supporting a Problem-Based Learning

STEM Course. *Journal of Educational Technology Systems*, *44*(1), 5–21. doi: https://doi.org/10.1177/0047239515596724

Ulger, K. (2018). The Effect of Problem-Based Learning on the Creative Thinking and Critical Thinking Disposition of Students in Visual Arts Education. *Interdisciplinary Journal of Problem-Based Learning*, *12*(1). doi: https://doi.org/10.7771/1541-5015.1649

Zed, M. (2014). *Metode Penelitian Kepustakaan*. Jakarta, Indonesia: Yayasan Pustaka Obor Indonesia.