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STEM-PjBL learning incorporates local knowledge to improve science literacy

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ABSTRACT

Integrating local knowledge into the STEM (science, technology, engineering, and mathematics) learning process through PjBL (project-based learning) can help learners develop themselves as a whole that is oriented toward adequate science literacy skills. The study aims to examine the effectiveness of STEM-PjBL learning using BAJARDI (digital IPA teaching materials) to improve the science literacy of learners. This is a quasi-experimental study with two groups of control experiments. Experimental classes use BAJARDI in the STEM-PjBL learning process, while control classes use conventional learning models. The research sample consisted of 120 students from a Class IV elementary school. The sample technique used is a random sampling. Scientific literacy test instruments are used to collect data. The validity of an instrument is determined by the Aiken index, while the reliability of the instrument is measured by the alpha Cronbach coefficient. Independent-Samples T The information is analyzed using test and quantitative descriptive statistics. This research identified a substantial difference in the average value of science literacy between the experimental and control groups (sig =. 00). The results of this research indicate that STEM-PjBL learning with BAJARDI is extremely effective in improving student science literacy.

Keywords: STEM, Project based learning, local knowledge, scientific literacy.

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1. INTRODUCTION

1.1 Conceptual and Theoretical Framework

The digital age necessitates the use of digital devices in the learning process due to the advancement of science and technology in the delivery of education (Parno et al., 2020). This is referred to as 21st century learning. This educational transformation necessitates adequate literacy among students (NCREL & Metiri, 2013). Science literacy is the foundation for following this development (McGregor & Kreaton, 2010; Roth & Barton, 2004; Silva & Lorenzetti, 2020).. The nature sciences basic context is science literacy, which consists of scientific processes, products, and attitudes (Jarman & McClune, 2007; Trefill & Hazen, 2010). Every student is expected to think, act, and make decisions using scientific methods. It begins with observing and communicating the outcomes.

This scientific method is closely related to educational projects that encourage students to experiment, improve products, and come up with solutions to issues they encounter (Barak & Yuan, 2021; Krajcik & Czerniak, 2014). In the world of education, learning projects are a highly recommended model of learning (Latifah et al., 2020). It is also critical to integrate a variety of other disciplines in order to construct the best knowledge possible. By incorporating science, technology, engineering, and mathematics into the most popular subjects in education, students can learn using a STEM approach. It has been implemented across the board in a number of developed nations. The constructivism theory developed by Kilpatrick is supported by this method (Kilpatrick, 1918). The project-based application of STEM provides more opportunities for students to acquire adequate science literacy (Wilhelm & Wilhelm, 2019; Wood et al., 2020).

According to PISA and PUSMENJAR results, Indonesian students have the lowest levels of scientific literacy. 73.61% of students overall fall into the lower category for science literacy (Schleicher, 2019). According to the data, in order to increase students' science literacy, better learning must be accompanied by adequate teaching materials (Ardiansyah, 2018; Dewi et al., 2018; Sabtaningrum et al., 2020). Primary education, particularly primary school, has the lowest level of science literacy that really needs to be set up. There are a number of reasons for this low science literacy, one of which is the method of instruction (Oliver & Adkins, 2020). The knowledge and comprehension of scientific ideas and procedures required for independent judgment, participation in public life, and economic productivity is referred to as science literacy. (1) science as a way of thinking, (2) science as a way of investigating, (3) science as a body of knowledge, and (4) science and its interactions with technology and society are all themes of scientific literacy, according to Chiappetta & Koballa (2010). The STEM-PjBL model can increase students' science proficiency, motivation, material comprehension, capacity for original thought, efficiency, meaningful learning, and future employment prospects (Jauhariyyah, Suwono, 2017; Prabawati & Agustika, 2020). This STEM-PjBL model should be backed up by pertinent instructional materials that have been specially created in line with STEM PjBL education and can be adapted to the local learning environment.

The nature science subject matter investigates the cosmos and its state. This makes it possible for students to fully and uninterruptedly learn. (Holistic). Instead of disregarding native culture or intelligence in the learning process, integral understanding should be supported by meaningful, enjoyable, and relevant learning that is relevant to the student's life. To help learners study and comprehend the facts, concepts, theories, and even the law that are embedded in the subject in a thorough manner, it is imperative that the right teaching materials be used. The teaching resources play a significant part in assisting teachers and students and equating the findings of observations with the perceptions of students (Yuanita & Kurnia, 2019)..When teaching materials are used effectively, students will be able to comprehend the subject matter thoroughly and in a way that incorporates local knowledge. According to Tiarani (2010) To

internalize the integration of religious values, science, and other factors, a future-proof model must be used. The development of digital science teaching resources based on STEM-PjBL integrated local intelligence is required as part of an effort to integrate character education within the context of multicultural education.

1.2 Related research's

According to the findings of several studies, IPA learning materials like textbooks, worksheets, media, and so forth can enhance science literacy when STEM approaches are combined with project models and local intelligence (Ardianti et al., 2020; Kusumastuti et al., 2019; Ruhimat, 2021; Sari et al., 2018). STEM-PjBL education can be used to teach students using digital resources in line with modern advancements during the 4.0 revolution. The foundation of STEM education is the integration of IPA learning with other disciplines, which needs to be developed. Furthermore, as part of the IPA learning process using the STEM-PjBL model, ethnosaints with local wisdom must be empowered (Woro Sumarni, 2018; Kholifatu et al., 2020; Azalia et al., 2020; Safitri et al., 2020).

This integration can be applied through textbooks (Azalia et al., 2020), modules (Putra & Aslan, 2020), media (Ahmad Habib, I Made Astra, 2020), and other teaching tools (Muskania & Wilujeng, 2017; Rogosic et al., 2021) ensuring that students are ready for a future life that will require skills but still have local cultural insights that will form a scientific generation that masters the skills of the 21 This study supports Texley's assertion that children should have access to STEM books (Texley & Ruud, 2018). This is done to help the student become a complete scientist with a literary soul and character as well as a nationalist.

1.3 Research questions about the study

The central question in this study is how effective STEM-PjBL learning is in improving students' scientific literacy in Grade IV elementary schools.

2. Method and Materials

2.1 Research design

The purpose of this study is to determine how well STEM-PjBL learning based on BAJARDI's local expertise can be implemented to improve students' scientific literacy. Using a quasi-experimental, non-equivalent control group design, this study compares the improvement in original thought and problem-solving abilities between the experimental and control classes. The control group was treated using the traditional learning model, while the experimental group was treated using STEM-PjBL learning based on local culture. Between October and December 2022, a three-month period, this study was carried out. The syntax is shown in Table 1 below. BAJARDI is used in STEM-PjBL learning at various stages of teaching and learning (Wilhelm & Wilhelm, 2019).

Table 1

***Table 1**. Syntax of STEM-PjBL learning from BAJARDI based on Local Knowledge*

Teaching and Learning Stages	Activities	Interaction
Questions of accompanying	The teacher selects the question of the student's accompaniment on the project issue.	- Direct communication
Choose part of the question.	The teacher invites the student to choose the part of the question given by the teacher.	- Direct communication

Developing knowledge	Students develop early knowledge.	-	Direct communication
Collaborate	Participants collaborate with experts.	-	Direct communication
Analysis of data	Use BAJARDI to collect and analyze data.	-	Online
Reflection	Participants are given feedback and time for revision.	-	Direct communication
Making a product	Students create a product that is a solution to the problem given to the accompanying question.	-	Online
Communication	Students share their experiences and findings with classmates.	-	Direct communication

2.2 Participants

All elementary school students in West Borneo, Indonesia, made up the study's population. 120 fourth-grade students from public elementary schools in West Borneo, Indonesia, served as the research subjects. A random sampling method was used for the sampling. The experimental group was made up of two classes with 30 students each in elementary school 1's X1 and X2 classes, and the control group was made up of two classes with 30 students each in elementary school 2's X3 and X4 classes.

2.3 Data collection instruments

To collect data for this study, scientific literacy tests were administered.The exams are objective in nature. The indicators for each component are used to arrange the questions in the scientific literacy tests, which use a rating scale of 0 to 20. Students will take these two tests both before and after learning (pretest and posttest). The test grid that will be used to gather information about the student's scientific literacy skills is shown in Table 2 below.

Table 2.

Table 2 Scientific literacy Test Grids

Aspects	Indicators	Cognitive Domain
To be able to participate in society in the digital age, one must possess the scientific knowledge and comprehension required to do so.	Analysis of forces.	C1
	Explain the properties of magnets	C4
Capable of asking, seeking, or determining answers to questions about everyday experiences that arise from curiosity.	Identify the energy transformation of everyday life.	C2
	Identifying changes in things.	C4
Capable of reading and comprehending popular press articles on science and engaging in social conversations about the validity of conclusions.	Analyze the relationship between force, movement and energy	C5
	Identify the type of force that occurs in an event.	C2
Capable of assessing the quality of scientific information based on its source and production	Identify the tools used to change energy.	C3

Aspects	Indicators	Cognitive Domain
methods.		
Possess the capacity to express and assess judgments based on data to draw conclusions.	Conclude the relationship of force, movement and energy of an event.	C3
	Predicting the force that happens in an event.	C5

Since these research tools were approved by three academic authorities, they have been reliable. The validity analysis is used to determine whether or not the instrument items are valid. The researchers evaluate the expert agreement index based on the Aiken index to demonstrate the validity of the instrument (V). The following Table 3 lists the findings of this evaluation.

Table 3.

Table 3. The results of the Aiken Index Coefficient of Instrument Validity

Instruments	V	Validity
Scientific literacy	.91	Valid

The dependability of an instrument is evaluated using Cronbach's alpha. The reliability score of the test device for problem-solving was 0.91. Thus, the instrument received a high rating for reliability (Taber, 2018).

2.4. Data analysis

In order to increase scientific literacy, the efficiency of the STEM-PjBL based on local knowledge from BAJARDI was evaluated utilizing a quantitative descriptive analysis of the research findings. The independent t test was used, and the significance level was set at.05. The use of STEM-PjBL based on local knowledge from BAJARDI will have an impact on enhancing scientific literacy if the probability reaches the specified level of significance. Independent-Samples T Test testing has a number of prerequisites, including homogeneity and normality tests.

3. RESULTS AND DISCUSSION

3.1 . The success of the STEM-PjBL implementation based on BAJARDI's local knowledge

Based on the effect of using the BAJARDI on boosting scientific literacy, the success of the implementation of STEM-PjBL based on local knowledge is assessed. The following Table 4 provides a description of students' scientific literacy, both before and after treatment. The experimental class's average scientific literacy is 58.13, while its average controller class is 59.00, Table 6 shows that there is no difference in average results between experimental and control courses. Both are greater than the average value for the control group.

Table 4

Table 4. The Average Value of Sceintific Literacy

	Group	Mean	STD. Deviation	N
Scientific literacy	Control	59.00	14.18	60
	Experimental	58.13	9.84	60

The STEM-PjBL curriculum is deemed effective if it increases students' scientific literacy. This is accomplished by performing a statistical T test on independent samples. Normality and homogeneity tests are the initial analysis step, which is a prerequisite for this analysis. If sig > 0.05, data on scientific literacy abilities have a normal distribution. The results of the normalcy test are shown in Table 5. Table 6 shows the results of the homogeneity test, which can be performed using the SPSS program and the Levene statistic of equality.

Table 5

Table 5. Normality Test Results

	Class	KS[a]			SW		
		Statistic	df	Sig.	Statistic	df	Sig.
Gain score	Control	0.14	60	0.15	0.96	60	0.45
	Experiment	0.12	60	0.20	0.97	60	0.65

a. Lilliefors Significance Correction

Table 5 shows that the variables gain score control and experiment class had significant values greater than 0.05. It indicates that the data on students' scientific literacy are distributed normally.

Table 6.

Table 6. Levene test results

	Levene Statistic	df1	Sig.
Based on Mean	1.22	1	0.27
Based on Median	1.30	1	0.26
Based on Median and with adjusted df	1.30	1	0.26
Based on trimmed mean	1.24	1	0.27

The Lavene test results in Table 6 reveal that the significant value of science literacy abilities is greater than 0.05. This means that the variance of each pair of groups is homogeneous. This stage of the analysis test utilizes the Independent-Samples T test which can be viewed from analysis parametric.

Table 7.

Table 7. Output of Independent-Samples T Test

	Criteria	Levene's Test for Equality of Variances		T-test for Equality of Means						
		F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
gain_score	Equal variances assumed	1.22	0.27	-4.96	56	0.00	-14.39	2.90	-20.20	-8.58
	Equal variances not assumed	0.00	0.00	-4.91	49.08	0.00	-14.39	2.93	-20.28	-8.50

According to the findings of this study, implementing STEM-PjBL learning with BAJARDI in the experimental class is more beneficial for developing scientific literacy than the conventional model in the control class. According to the research data, Sig 0.000.05 suggests that there are substantial differences in the learning outcomes of students who get STEM-PjBL learning with BAJARDI based on their local knowledge and level of scientific literacy. The research results demonstrate that STEM-PjBL learning with BAJARDI is effective. This is because teachers are able to apply STEM-PjBL learning principles using BAJARDI as a scientific method (Hinojo-Lucena et al., 2020; Wilhelm & Wilhelm, 2019). According to Texley & Ruud (2018), the STEM-PjBL focuses on scientific literacy and is designed to assist students acquire problem-solving skills that are transferable to everyday life.

Implementing STEM-PjBL learning with BAJARDI as a method for enhancing students' cognitive abilities may involve scientific literacy (Afriana et al., 2016; Parno et al., 2020; Sari et al., 2018; Spellman & Price-bayer, 2011). This is the essence of scientific literacy, According to the American Association for the Advancement of Science (1993), the scientific approach of arranging creative ideas can be applied to problem solving. The learning method may focus improving the learning process, developing problem-solving abilities, and reinforcing student creativity, all of which are directed toward the development of students' HOTS (Wahono et al., 2020). The implementation of STEM-PjBL learning with BAJARDI, which utilizes Google sites and WhatsApp groups (WAG), also influences the effectiveness of learning. Although communication is simple, it cannot be conducted face-to-face. Additionally, online learning discussion forums can be facilitated to enhance teachers' and students' communication and learning (Astini, 2020).

The use of technology in learning activities can enhance learning efficiency (Donnelly-Hermosillo et al., 2020). Enables access to information at any time and provides flexibility. Students and adolescents enjoy using WAG (Astini, 2020), and Afriana et al. (2016) consider it capable of fostering scientific literacy (Muskania & Wilujeng, 2017). This is further supported by research conducted by Ramasundrum & Sathasivam (2022), which indicates that the use of Google sites can improve student performance. In addition, research conducted by Nabilah & Dewina (2023) indicates that Google sites can be utilized to support classroom learning activities and interactive. When teachers are unable to attend class, they can still deliver materials and discuss assignments without compromising the quality of the learning outcomes.

The implementation of STEM-PjBL learning with BAJARDI can improve students' scientific literacy, according to research results. Teachers and students conduct their activities in accordance with the procedures for implementing the learning objectives learning (M. M. Capraro et al., 2016; R. M. Capraro et al., 2013; W. Sumarni & Kadarwati, 2020). Local culture is incorporated into lesson planning and

implemented throughout the learning process and evaluation of learning. As a learning model, the STEM-fundamental PjBL's concept is reflected in the referenced learning approaches and strategies. STEM project-based learning refers to Wilhelm & Wilhelm (2019) view that a learning model consists of eight main components for implementation.

According to the study's findings, STEM project-based learning in the experimental class is more effective than traditional learning in the control class at increasing scientific literacy. This is due to the fact that STEM-PjBL learning with BAJARDI has contextual features and creates authentic learning experiences for students to acquire knowledge, technology, procedures, and mathematical ideas that are supported by the arts of languages, social sciences, and arts. (M. M. Capraro et al., 2016). STEM-PjBL requires collaboration, team communication, problem solving, and self-directed learning, and trains all students in rigor. The foundation of this learning is engineering design, in which students apply their knowledge of science, technology, and mathematics to solve real-world problems.

4. CONCLUSION

The findings of the study indicate that STEM-PjBL learning with BAJARDI is an effective and efficient learning tool, with a significant difference in the average value of science literacy ability between the two learning materials usedIn terms of improving scientific literacy, STEM-PjBL learning with BAJARDI in the experimental class outperforms the traditional model in the controller class. Higher-order cognitive abilities are used in STEM-PjBL problem-solving with BAJARDI pupils.. It can also enhance knowledge of science, technology, engineering, mathematics, and local integration. Teachers can use the research findings as a guide for developing contextual science learning based on local knowledge, thereby enhancing their professional abilities. In addition, the findings may reveal aspects of nature science education in elementary schools that need improvement in terms of the targeted competencies.

5. RECOMENDATION

This study recommends that elementary school teachers implement STEM-PjBL learning with BAJARDI to enhance scientific literacy. In addition, by integrating multiple disciplines, it can improve STEM comprehension and local knowledge. The findings of this study can be used to help primary school instructors build contextual nature science learning based on local culture, boosting their professional abilities.

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), 202–212. http://dx.doi.org/10.21831/jipi.v2i2.8561

Ahmad Habib, I Made Astra, E. U. (2020). Pemanfaatan Multimedia Interaktif : Pengembangan Media Pembelajaran Berbasis PJBL(Project Based Learning). *Jurnal Pendidikan Dasar*, 1–13.

Ardiansyah, S. (2018). *ePUB Sebuah Solusi Jitu Bahan Ajar Interaktif Simulasi Digital*. Kun Fayakun.

Ardianti, S., Sulisworo, D., Pramudya, Y., & Raharjo, W. (2020). The impact of the use of STEM education approach on the blended learning to improve student's critical thinking skills. *Universal Journal of Educational Research*, *8*(3 B), 24–32. https://doi.org/10.13189/ujer.2020.081503

Astini, N. K. S. (2020). Pemanfaatan teknologi informasi dalam pembelajaran tingkat sekolah dasar pada masa pandemi covid-19. *Jurnal Lembaga Penjaminan Mutu STKIP Agama Hindu Amlapura*, *11*(2), 13–25.

Azalia, I., Sudarmin, & Wisnuadi, A. (2020). The Effects of Ethnoscience Integrated STEM E-Book Application

on Student's Science Generic Skills in Chemical Equilibrium Topic. *International Journal of Active Learning*, *5*(1), 19–25. https://journal.unnes.ac.id/nju/index.php/ijal/article/view/24017

Barak, M., & Yuan, S. (2021). A cultural perspective to project-based learning and the cultivation of innovative thinking. *Thinking Skills and Creativity*, *39*(November 2020), 100766. https://doi.org/10.1016/j.tsc.2020.100766

Capraro, M. M., Whitfield, J. G., Matthew, & Capraro, R. M. (2016). *A COMPANION TO INTERDISCIPLINARY STEM PROJECT-BASED LEARNING*. Sense Publishers.

Capraro, R. M., Capraro, M. M., & Morgan, J. R. (2013). *STEM project-based learning*. Sense Publishers.

Chiappetta, E. L., & Koballa, T. R. J. (2010). *(2010). Science Intruction in the Middle and Secondary Schools (7th ed.)*. Pearson Education, Inc.

Dewi, D. K., Astra, I. M., & Susanti, D. (2018). Buku Suplemen Berbasis Android Sebagai Media Pembelajaran Pada Materi Gelombang Elektromagnetik Untuk Peserta Didik Sma. *Prosiding Seminar Nasional Fisika*, *VII*, SNF2018-PE-1-SNF2018-PE-8. https://doi.org/10.21009/03.snf2018.01.pe.01

Donnelly-Hermosillo, D. F., Gerard, L. F., & Linn, M. C. (2020). Impact of graph technologies in K-12 science and mathematics education. *Computers and Education*, *146*(October 2019), 103748. https://doi.org/10.1016/j.compedu.2019.103748

Hinojo-Lucena, F. J., Dúo-Terrón, P., Navas-Parejo, M. R., Rodríguez-Jiménez, C., & Moreno-Guerrero, A. J. (2020). Scientific performance and mapping of the term STEM in education on the web of science. *Sustainability (Switzerland)*, *12*(6), 1–20. https://doi.org/10.3390/su12062279

Jarman, R., & McClune, B. (2007). Developing Scientific Literacy. In *Open University Press*. Open University Press. https://doi.org/10.1177/074193250002100205

Jauhariyyah, Suwono, I. (2017). Science, Technology, Engineering and Mathematics Project Based Learning (STEM-PjBL) pada Pembelajaran Sains. *Pros. Seminar Pend. IPA Pascasarjana UM*, 432–436. https://pasca.um.ac.id/conferences/index.php/ipa2017/article/view/1099

Kholifatu, N., Habibillah, N., & Wicaksono, A. G. (2020). THE PRANATA MANGSA IN THE PERSPECTIVE OF AN ETHNOSCIENCE APPROACH AS NATURAL SCIENCE TEACHING. *The 3nd International Conference on Technology, Education, and Social Science 2020*, *2020*, 459–467. https://ejurnal.unisri.ac.id/index.php/proictss/article/view/5057/3777

Kilpatrick, W. H. (1918). The "Project Method'': Child-Centeredness in Progressive Education." *Teacher's College Record*, *19*(September), 319–334. https://historymatters.gmu.edu/d/4954/

Krajcik, J. S., & Czerniak, C. M. (2014). Teaching Science in Elementary and Middle School: A Project-Based Approach. In *Interdisciplinary Journal of Problem-Based Learning* (4 ed, Vol. 8, Issue 1). Routledge Taylor & Francis Group. https://doi.org/10.7771/1541-5015.1489

Kusumastuti, F. A., Rombot, O., & Ariesta, F. W. (2019). The Effect Of STEM Integration On Primary School Students ' Scientific Literacy. *INTERNATIONAL JOURNAL OF SCIENTIFIC & TECHNOLOGY RESEARCH*, *8*(12), 1551–1553.

Latifah, N., Fauzia, U., & Kelana, J. B. (2020). Natural Science Problem Solving in Elementary School Students Using the Project Based Learning (PjBL) Model. *Jurnal Ilmiah Sekolah Dasar*, *4*(4), 596–603. https://doi.org/10.23887/jisd.v4i4.28377

McGregor, D., & Kreaton, G. (2010). (2010). What do Researchers Say about Scientific Literacy in Schools?

ASE.

Muskania, R. T., & Wilujeng, I. (2017). Pengembangan Perangkat Pembelajaran Project-Based Learning Untuk Membekali Foundational Knowledge Dan Meningkatkanscientificliteracy. *Jurnal Cakrawala Pendidikan*, *36*(1), 34–43. https://doi.org/10.21831/cp.v36i1.8830

Nabilah, N. J., & Dewina, Z. (2023). *THE EFFECT OF USING GOOGLE SITES MEDIA ON THE LEARNING OUTCOMES OF SCIENCE AND TECHNOLOGY STUDENTS IN*. *9*(1), 61–69. https://ejournal.unma.ac.id/index.php/cp/article/download/3713/2521

NCREL, & Metiri, G. (2013). *EnGauge 2st Century Skills:Literacy in The Digital Age*. North Central Regional Educational Laboratory and The Metiri Group.

Oliver, M. C., & Adkins, M. J. (2020). "Hot-headed" students? Scientific literacy, perceptions and awareness of climate change in 15-year olds across 54 countries. *Energy Research and Social Science*, *70*(January), 101641. https://doi.org/10.1016/j.erss.2020.101641

Parno, Yuliati, L., Hermanto, F. M., & Ali, M. (2020). A case study on comparison of high school students' scientific literacy competencies domain in physics with different methods: PBL-stem education, PBL, and conventional learning. *Jurnal Pendidikan IPA Indonesia*, *9*(2), 159–168. https://doi.org/10.15294/jpii.v9i2.23894

Prabawati, P. L. S., & Agustika, G. N. S. (2020). Project-Based Learning Based On Stem (Science , Technology , Engineering , And Mathematics) Enhancing Students Science Knowledge Competence. *Jurnal Ilmiah Sekolah Dasar*, *4*(4), 621–629. https://doi.org/10.23887/jisd.v4i4.26670

Putra, P., & Aslan. (2020). Pengembangan Bahan Ajar Berbasis IMTAQ dan IPTEK Di Era Revolusi Industri 4.0 Pada Mata Pelajaran Sains Di Madrasah Ibtidaiyah. *TA'LIMUNA*, *9*(01), 1–15. https://e-journal.staima-alhikam.ac.id/talimuna/article/view/345/254

Ramasundrum, S., & Sathasivam, renuka V. (2022). Effect of Google Sites on Scienece Achievement Among Year Five Students. *Malaysian Online Journal of Educational Sciences*, *10*(April), 24–34. https://eric.ed.gov/?id=EJ1343865

Rogosic, R., Heidt, B., Passariello-Jansen, J., Björnör, S., Bonni, S., Dimech, D., Arreguin-Campos, R., Lowdon, J., Jiménez Monroy, K. L., Caldara, M., Eersels, K., Van Grinsven, B., Cleij, T. J., & Diliën, H. (2021). Modular Science Kit as a support platform for STEM learning in primary and secondary school. *Journal of Chemical Education*. https://doi.org/10.1021/acs.jchemed.0c01115

Roth, W.-M., & Barton, A. C. (2004). *Rethinking Scientific Literacy*. Routledge Falmer.

Ruhimat, T. (2021). *Pembelajaran STEM (Konsep dan Implementasi)*. UPI Press.

Sabtaningrum, F. E., Wiyokusumo, I., & Leksono, I. P. (2020). E-book Tematik Terpadu Berbasis Multikultural Dalam Kegiatan SFH (School from Home). *Jurnal Ilmiah Sekolah Dasar*, *4*(2), 153. https://doi.org/10.23887/jisd.v4i2.24796

Safitri, D., Iskandar, R., Maksum, A., & Marini, A. (2020). Batik Nusantara Exploration Through The Application Of Multicultural Education Based On Local Wisdom In Elementary School. *Multicultural Education*, *6*(4), 219–225. https://doi.org/10.5281/zenodo.4279541

Sari, N., Syarif Sumantri, M., & G Bachtiar, I. (2018). The Development of Science Teaching Materials Based on STEM to Increase Science Literacy Ability of Elementary School Students. *International Journal of Advances in Scientific Research and Engineering*, *4*(7), 161–168.

https://doi.org/10.31695/ijasre.2018.32808

Schleicher, A. (2019). PISA 2018: Insights and Interpretations. In *OECD*.

Silva, V. R. da, & Lorenzetti, L. (2020). Scientific literacy in the early years : indicators evidenced by a didactic sequence. *Educ. Pesqui., São Paulo, 46*, 0–1. https://www.scielo.br/j/ep/a/swHL9FCwBrVv8nsVJq76zRH/?format=pdf&lang=en

Spellman, F. R., & Price-bayer, J. (2011). In defense of science: why scientific literacy matters. In *Government Institutes* (Vol. 48, Issue 12). The Scarecrow Press, Inc. https://doi.org/10.5860/choice.48-6864

Sumarni, W., & Kadarwati, S. (2020). Ethno-stem project-based learning: Its impact to critical and creative thinking skills. *Jurnal Pendidikan IPA Indonesia*, *9*(1), 11–21. https://doi.org/10.15294/jpii.v9i1.21754

Sumarni, Woro. (2018). The Influence Of Ethnoscience-Based Learning On Chemistry To The Chemistry's Literacy Rate Of The Prospective Teachers. *Unnes Science Education Journal*, *7*(2), 198–205. https://doi.org/10.15294/usej.v7i2.23722

Texley, J., & Ruud, R. M. (2018). *Teaching STEM Literacy A Constructivist Approach for Ages 3 to 8*. RedleafPress.

Trefill, J., & Hazen, R. M. (2010). *The Science an Integrated Approach (6th ed.)*. John & Sons Inc.

Wahono, B., Lin, P. L., & Chang, C. Y. (2020). Evidence of STEM enactment effectiveness in Asian student learning outcomes. *International Journal of STEM Education*, *7*(1), 1–18. https://doi.org/10.1186/s40594-020-00236-1

Wilhelm, J., & Wilhelm, R. (2019). *Creating Project- Based STEM Environments*. Springer.

Wood, S., Henning, J. A., Chen, L., Taylor McKibben, Smith, M. L., Weber, M., Zemenick, A., & Ballen, C. J. (2020). A scientist like me: Demographic analysis of biology textbooks reveals both progress and long-term lags. *Proceedings of the Royal Society B: Biological Sciences*, *287*(1929). https://doi.org/10.1098/rspb.2020.0877

Yuanita, & Kurnia, F. (2019). Pengembangan Bahan Ajar Berbasis Stem (Science, Technology, Engineering, And Mathematics) Materi Kelistrikan Untuk Sekolah Dasar. *Profesi Pendidikan Dasar*, *6*(2), 199–210. https://doi.org/10.23917/ppd.v1i2.9046