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The Effectiveness of Innovative Blended Learning Through Meaning (IBLTM) Model to Improve Students' Science Literacy

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ABSTRACT
Objective: This study aims to determine the effectiveness of the Innovative Blended Learning Through Meaning Model (IBLTM) in improving students' scientific literacy at Muhammadiyah 2 High School Sidoarjo. **Method:** This study used an experimental method with a one-group pretest and posttest design. The subjects of this study were 22 students of class X-1 who participated in learning using the IBLTM Model. Data was collected through a science literacy test instrument in 12 descriptive questions covering six indicators of science literacy. **Results:** The results of the data analysis showed that the implementation of the IBLTM Model was effective in improving students' scientific literacy. This is indicated by a significant increase in science literacy scores from pretest to posttest, with an average N-Gain of high category. The paired t-test showed a significant difference between the pretest and posttest. In addition, all indicators of science literacy increased, with several indicators reaching the high N-Gain category. **Novelty:** The IBLTM model applied in this study is an innovative learning approach that integrates the process of meaning in blended learning. This model has been proven to significantly improve scientific literacy, especially in science learning at the secondary school level, and shows that an interactive and meaning-based approach can positively impact students' scientific understanding.

INTRODUCTION

This may include reference to the scientific literacy required to comprehend the scope of global challenges, like climate change, new technologies, and public health. Scientific literacy encompasses more than just understanding science terminology; it also includes critical thinking, problem-solving, and making decisions based on existing scientific evidence (Rubini et al., 2019; Jackson et al., 2021). They are easily transferable to real-life contexts that empower individuals to participate in informed discussions and make decisions otherwise expected from societies (Jamil, 2021; Ashraf, 2021; Iringan, 2021). Various studies of various designs demonstrate that scientific literacy levels among Indonesia's students are still notably low (Simbolon et al., 2019; Jufrida et al., 2019; Sutrisna & Anhar, 2020). Thus, it is known that a few factors are students' lack of exposure to interactive and meaningful learning and the infrequent use of effective models to grasp scientific concepts (Windyariani & Amalia, 2019; Firdausy & Prasetyo, 2020; Purwati et al., 2021).

According to Iwuanyanwu (2019) and Rahmiwati et al. (2020), memorization is insufficient, meaning it is the core of advancing scientific literacy. Hence, students should grasp the concepts and relate them to practical experiences Thus, meaning implies internalization of active knowledge construction by learners through interaction, reflection, and application of concepts to real-life situations (Musdalifah, 2021).

Therefore, as Lesh et al. (2020) argue, meaning-based learning provokes students' emotional and cognitive involvement and eventually enhances their understanding and memorization of the subject matter being studied (Hasibuan et al., 2023; Rahmiwati et al., 2020). Thus, learning with an emphasis on meaning is quite justified in solving the problem of low scientific literacy (Asrizal et al., 2018; Naidoo & Singh-Pillay, 2020; Indrapangastuti et al., 2021). Thus, today's post-COVID-19 world imposes new challenges and demands for scientific literacy development for students (Joshi et al., 2022). The outbreak has forced the E-learning part of the education system to move online to learn e-learning methodologies (Darayseh, 2020). This has come with many advantages. However, it has also emerged as a source of numerous problems; for instance, generally low direct teacher-student interaction, relative unavailability of technology, and student motivation challenges (Efremova & Huseynova, 2021). All this, in one way or another, underlines the necessity of scientific literacy in the post-pandemic era of urgency associated with applying health and science concepts in life (Bumagat et al., 2023). Indeed, only the data from the period asserts that during the pandemic, there was a decrease in scientific literacy, only proving that previously imposed methods are limiting (Adnan et al., 2021). Thus, there is a need to introduce an innovative approach to learning so that the accrued decline can be nullified.

An interactive, meaning-based approach might enhance apprehension among the students. A blended learning model addresses two limitations of online learning regarding interactivity: the weakness of interaction and the level of students' understanding. However, it has been supported by other studies that models employing technology-enhanced learning, in particular blended learning, are solutions both to the interactivity limitation problem regarding eLearning and also further improvement of students' conceptual understanding. Integrating a meaning-based learning approach with technology to improve scientific literacy is one unique avenue in post-pandemic periods (Dimaano & Panoy, 2022).

The IBLTM novelty is an approach to learning 'engages students in acquiring deep meaning of science concepts in real-life contexts, with the understanding that material is not only cognitively but also internally meaning of the concepts in their daily activities, thus sustainably enhancing their science literacy (Stevenson et al., (2024); Wang, (2024); Cheung et al., (2024); Yuan et al., (2024); Loretan et al., (2024). The IBLTM Model integrates fundamental orientation characteristics to the problem, exploration, discussion of problems to be solved, negotiation and confirmation, and meaning. Each phase is constructed to provide a deep and situated understanding of the concept. The research question posed in this article is how effective the Innovative Blended Learning Through Meaning Making Model (IBLMP) is in applying science learning in class X Muhammadiyah 2 High School Sidoarjo.

RESEARCH METHOD

This study employed a quasi-experimental descriptive quantitative research design. The complete chart of this research is in Figure 1.

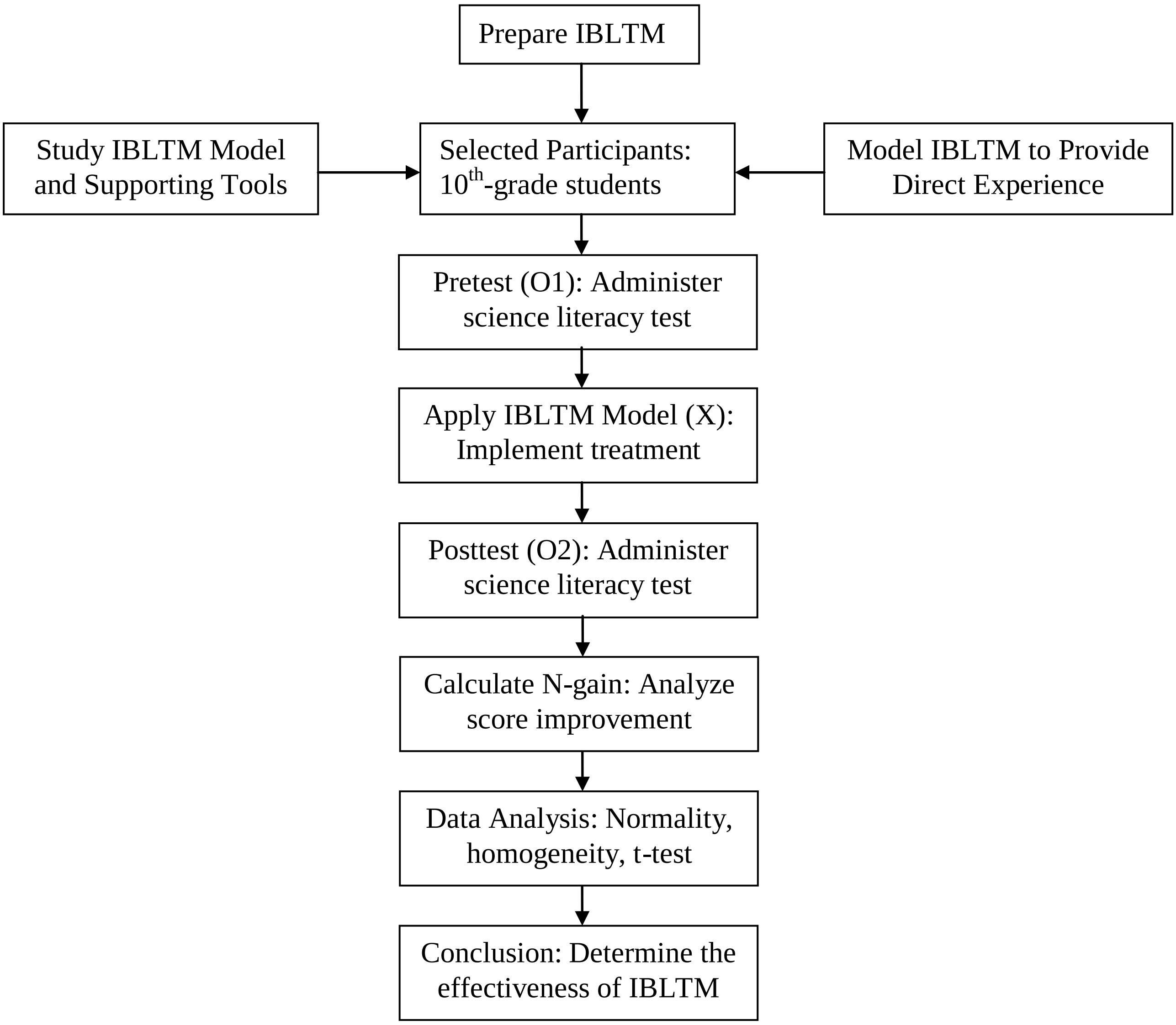

Figure 1. Research procedure.

According to Table 1, it utilized a one-group pretest and posttest design with an experiment class, forgoing a control class.

Table 1. Research design.

Group	Pretest	Treatment	Posttest
Experiment	O1	X	O2

Description:
O1: Pretest given before treatment.
X: Treatment in applying the IBLTM model for the experimental class.
O2: Posttest given after the treatment.

The tenth-grade students involved in this study were in Muhammadiyah 2 High School Sidoarjo for the academic year 2023/2024. There were 22 students in total accepted. All information for this research was collected using a science literacy test. Data analysis techniques were also used, including n-gain, normality tests, homogeneity tests, and independent t-tests. The normalized gain formula (n-gain) was used to ascertain the difference between the pretest and posttest scores. The average n-gain was determined by:

$$n - gain = \frac{Post\ test\ score - Pre\ test\ score}{\text{Maximum score} - Pre\ test\ score}$$

Then, the average n-gain is categorized based on Table 2.

Table 2. Criteria for n-gain.

n-gain score	Criteria for n-gain
0.70 < n-gain	High
0.30 ≤ n-gain ≤ 0.70	Average
n-gain < 0.30	Low

RESULTS AND DISCUSSION

Results

Observation of students' scientific literacy is very influential, from the pretest to the final test in class X-1 Muhammadiyah 2 High School Sidoarjo. These results were gained through a descriptive scientific literacy measuring tool of 12 items rank details of the scientific literacy measurement can be found in Appendix 12a. A summary of the descriptions of the pretest and posttest scores of the scientific literacy trial is shown in Table 3. As observed in Table 3, a significant difference was noticed in students' scientific literacy scores after implementing the IBLTM model. The low average pretest score between 13 and 50 reveals that students had misunderstandings about scientific concepts at the beginning. At the same time, their posttests skyrocketed shortly after intervention through the IBLTM model, ranging between 75.00 and 96.00.

Table 3. Recap of the description of the pretest and posttest scores of the scientific literacy assessment in the limited trial.

Student Initials	Pretest Score	Posttest Score	N-Gain
1	29.00	79.00	0.71
2	46.00	83.00	0.69
3	50.00	92.00	0.83
4	42.00	92.00	0.86
5	29.00	79.00	0.71
6	29.00	79.00	0.71
7	50.00	92.00	0.83
8	50.00	92.00	0.83
9	42.00	83.00	0.71
10	33.00	92.00	0.88
11	38.00	96.00	0.93
12	50.00	92.00	0.83
13	42.00	96.00	0.93
14	13.00	75.00	0.71
15	29.00	75.00	0.65
16	42.00	96.00	0.93
17	46.00	92.00	0.85
18	50.00	92.00	0.83
19	50.00	96.00	0.92
20	46.00	96.00	0.92

Student Initials	Pretest Score	Posttest Score	N-Gain
21	25.00	83.00	0.78
22	33.00	75.00	0.63
Average *N-Gain*		**.0.80**	
Description		**High**	

The gain in science literacy scores can be estimated by calculating n-gain, one of the critical indicators of measuring learning effectiveness. The high average n-gain of 0.80 currently included in that category states that implementing the IBLTM model successfully significantly increased science literacy. Besides the significant increase in science literacy, the data also shows that all students scored above the minimum average of 75.00, especially others who showed shallow pretest scores first. For example, the initial 14 had a pretest score of 13 but got a posttest score of 75 after intervention with an n-gain of 0.71, proving that IBLTM can enhance understanding and skills from a very low first level of understanding to a total.

Table 4. N-gain score of science literacy indicators in limited trials.

Indicator	Pretest Value	Posttest Value	N-Gain per Indicator	Category N-Gain per Indicator
Explaining scientific phenomena accurately based on existing knowledge	35.23	94.00	0.91	High
Making accurate predictions of scientific phenomena	42.05	94.32	0.90	High
Evaluating ways to explore given questions scientifically	45.45	86.36	0.75	High
Describing and evaluating various ways that scientists use to ensure data reliability, objectivity, and generalisability of explanations	38.64	87.50	0.80	High
Interpreting data and concluding accurately	38.64	77.27	0.63	Medium
Making decisions based on data and scientific evidence	35.23	85.23	0.77	High
Average	**39.00**	**88.00**	**0.80**	**High**

Table 4 presents the n-gain scores of scientific literacy indicators from restricted trial results. Under 'Explaining scientific phenomena accurately based on existing knowledge,' the n-gain was 0.91, with pretest scores of 35.23 and a posttest score of 94; this falls under the high category, indicating a massive increase in the ability to explain scientific phenomena after the intervention. For 'Making right predictions about scientific phenomena,' the pretest scores at this juncture were 42.05 and 94.32. The N-Gain per indicator for this indicator is 0.9, again falling in the high category, indicating that the student's capability to make accurate predictions is quite good. The indicator "Assessing how to explore problems scientifically" had a pretest score of 45.45 and a posttest score of 86.36. Each indicator's N-gain is 0.75, which is high. Hence, there was a significant increase in students' scientific evaluation abilities. The fourth indicator, "describing and evaluating various methods used by scientists to ensure data reliability and objectivity and generalization of interpretation," had a pretest score of 38.64 and a posttest score of 87.50. The N-Gain value associated with each indicator is 0.80, representing the highest rating concerning an increased understanding of scientific methods.

The indicator "interpreting data correctly and drawing conclusions" had a pretest score of 38.64, a posttest score of 77.27, and an N gain of each indicator equal to 0.63 falls in the medium category, showing an increase in the ability to interpret data and draw conclusions. The last indicator, namely "Decision making based on data and scientific evidence," has a pretest score of 35.23 and a posttest score of 85.23, and an N-Gain of each indicator equal to 0.77, which is at a high level, showing an increase in the ability to make a decision based on data and scientific evidence.

The average pretest score for all indicators was 39 points, while the average posttest score was 88. So, the average n gain for each indicator was 0.80, which is a high category, showing a significant overall increase. That is, increased student science literacy after intervention. Although the sample size was small, a paired t-test was conducted to see if there was any improvement in the learning outputs of the restricted pilot class. Before conducting any relevant t-test, a pre-requisite test must be conducted, and that is the normality test like Shapiro-Wilk through the software program SPSS version 25, which is the result of the pretest and posttest normality test of science literacy data. This is shown in Appendix 12f and demonstrated quickly in Table 5 with the assistance of SPSS.

Table 5. Results of the pretest and posttest normality tests of science literacy in limited trials.

School	Class	*Shapiro-wilk*			
		Data	***Statistic***	***Sig***	**Description**
Muhammadiyah 2 High School Sidoarjo	X-1	*N-Gain*	0.93	0.60	Normal

Table 5 The Results of Normality Test of Pre-And Posttest Data on Science Literacy in Limited Trial of Muhammadiyah 2 High School Sidoarjo Normality was tested using the Shapiro-Wilk test for class X-1 using n-gain data. The Shapiro-Wilk statistic obtained was 0.93, and the significance value (Sig) was 0.60. Judging from the significance value (> 0.05), it can be concluded that the n-gain data for level X-1 of Muhammadiyah 2 High School Sidoarjo is usually distributed. These results show that normality is met; hence, data is appropriate for further statistical analysis. A paired t-test was run to compare the average values of science literacy data before and after the intervention within the same group (category X-1). This test helps us find out whether the intervention given makes a significant difference in the learning outcomes. The results of the t-test are presented in Table 6.

Table 6. Paired t-test results of pretest-posttest data on science literacy in limited trials.

School	Class	Uji-t		
		N	**Sig**	**Correlation**
Muhammadiyah 2 High School Sidoarjo	X-1	22	0.00	0.74

Table 6. Paired t-test on pretest and posttest science literacy scores in the limited trial, this study's sample size (N) was 22 students. The obtained significance value through the t-test is 0.00. As such, there is a notable variance between the pretest and posttest scores concerning the 5.00% significance level. Statistically, students' learning outcomes differ before and after the treatment.

The t-test results reveal a correlation value of 0.74. Thus, the positive correlation between pre- and post-tests suggests a strong correlation between pretesting and post-testing; in simpler terms, what students learn from a pretest situation directly affects their post-test learning outcomes. This leads to the author's inference that the treatment given in this limited trial indicates that the IBLTM model is effective in enhancing science literacy for grade X-1 students at Muhammadiyah 2 High School Sidoarjo.

Discussion

The data collected from the trial study indicated that with the application of the IBLTM model, scientific literacy was markedly enhanced among students in the X-1 class. The average score from the pretest for scientific literacy was 39, and that for the posttest was 88. Such an increment shows that the IBLTM model has a considerable impact on enhancing scientific literacy. This result corresponds with the research by Maleesut et al. (2019), which adds that a meaning-based learning model can enhance learning outcomes with scientific literacy. The study shows that blended learning provides deep meaning and a better understanding of concepts.

An average n-gain score registered a notable rise in identifying scientific questions through various limited trials. The pre-average score before implementing the IBLTM model was 30 points. It hit 80 points post-implementation, correlating with Villegas & Gonzales (2021), who indicate that the meaning-based learning model can assist learners in identifying scientific problems better, clearly, and systematically.

The n-gain score of the ability to explain the scientific phenomena also significantly increased. The average score before implementing the IBLTM model was 40, increasing to 85 after the implementation. This is in line with Wulandari and Shofiyah (2018), who found out that the meaning-based approach to the IBLTM model helped students give more detailed and in-depth explanations. It was also clearly visible through the naked eye that there was an improvement in the ability to interpret scientific data by the average n-gain score, which swelled from 35 to 78. Furthermore, to prop up this research, Gunawan et al. (2021) their work which stated that meaning-embedded blended learning enhances a better analysis and interpretation of scientific data by students.

The mean score of application of science increased from an average of 45 points to 82 points. This result also supports the findings of Mutya and Masuhay (2023), who affirm that the blended learning model enables students to apply scientific concepts better in real-life situations. Paired t-test results showed a very significant difference between pretest and posttest results at the 0.00 significance level and thus substantiate the fact that the IBLMP model effectively enhances students' literacy in science. This result is coherent with research findings by Budiastra et al. (2021), which showed that the meaning-based learning model significantly impacts improved science literacy outcomes.

CONCLUSION

Fundamental Finding: The above analysis revealed that the Innovative Blended Learning Through Meaning Model (IBLTM) substantially enhanced scientific literacy; the average n-gain of scientific literacy scores due to this model falls within the "high" gradation. Indeed, marked enhancements were observed in all the sub-dimensions, asking questions on demonstrating scientific literacy: explaining scientific phenomena, making predictions, critically appraising scientific investigations and experiences, describing and reporting on scientific investigations, and finally reaching decisions based on scientific data. **Implication:** The effectiveness of the Innovative Blended Learning Through Meaning Model (IBLTM) in enhancing students' scientific literacy has been verified in this paper. As noted in the analysis, this model enhances scientific literacy scores by an average n-gain categorized among the high types of scores. An enhancement was noted on all the indicators of scientific literacy, encompassing a student's ability to explain scientific phenomena, make predictions, evaluate scientific exploration, describe and evaluate scientific methods, and make decisions on scientific data. **Limitation:** Although this model is highly effective, some limitations should be noted. First, this study was conducted in one school among grade X students; hence, the results might only partially represent the wider population. Secondly, success through this model is very dependent on continued implementation and student engagement.

Further research, therefore, needs to be undertaken to look into the adaption and effectiveness of this model in varied educational contexts and among varied groups of learners. **Future Research**: The inquiry-based learning and teaching mathematics model may be investigated within elementary, high, and/or university levels. Additional investigation is needed to determine how appropriate this model can be adopted regarding varying levels of education. Further exploration can be done on the critical factors that influence the model's success, such as initial teacher preparation and institutional capacity.

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REFERENCES

Adnan, A., Mulbar, U., Sugiarti, S., & Bahri, A. (2021). Biology science literacy of junior high school students in South Sulawesi, Indonesia. *IOP Publishing, 1752*(1), 1-7. https://doi.org/10.1088/1742-6596/1752/1/012084

Alabdulkareem, S. A. (2016). The impact of science teachers' beliefs on teaching science: The case of Saudi science teachers. *Canadian Center of Science and Education, 5*(2), 233-245. https://doi.org/10.5539/jel.v5n2p233

Ashraf, T. (2021). Analysis of social responsibility skills with reference to life skills in secondary school curriculum. *Pakistan Social Sciences Review, 5*(4), 368-381. https://doi.org/10.35484/pssr.2021(5-iv)29

Asrizal, A., Amran, A., Ananda, A., & Festiyed, F. (2018). Effectiveness of adaptive contextual learning model of integrated science by integrating digital age literacy on grade VIII students. *IOP Publishing, 335*(1), 1-7. https://doi.org/10.1088/1757-899x/335/1/012067

Budiastra, A. K., Hartinawati, H., Ichwan, I., & Erlina, N. (2021). The effectiveness of blended learning for new generation learning materials to train science process skills. *Science and Research Journal, 4*(2), 63-71. https://doi.org/10.18421/sar42-04

Bumagat, R. J. M., Ordillas, M. G., Rogayan, D. V., Basila, R. M. G., Uribe, M. I. G., & Catig, M. J. T. G. (2023). Practices and challenges of teachers in teaching science online. *International Journal of Technology in Education and Science, 7*(3), 306-330. https://doi.org/10.46328/ijtes.484

Cheung, K. K. C., Pun, J. K. H., & Li, W. (2024). Students' holistic reading of socio-scientific texts on climate change in a ChatGPT scenario. *Research in Science Education, 54*(4), 957-976. https://doi.org/10.1007/s11165-024-10177-2

Darayseh, A. A. (2020). The impact of COVID-19 pandemic on modes of teaching science in UAE schools. *IISTE Journal of Education and Practice, 11*(20), 110-115. https://doi.org/10.7176/jep/11-20-13

Dimaano, J. R. C., & Panoy, J. F. D. (2022). Exploring the role of science engagement and learning interaction in acquiring 21st-century skills of grade 7 online distance learners. *International Multidisciplinary Research Journal, 4*(3), 90-98. https://doi.org/10.54476/ioer-imrj/90700

Efremova, N., & Huseynova, A. (2021). The impact of digital technology on learning motivation and learning modes. *EDP Sciences, 273*, 1-11. https://doi.org/10.1051/e3sconf/202127312083

Firdausy, B. A., & Prasetyo, Z. K. (2020). Improving scientific literacy through an interactive e-book: A literature review. *IOP Publishing, 1440*(1), 1-7. https://doi.org/10.1088/1742-6596/1440/1/012080

Gunawan, G., Jufri, A. W., Nisrina, N., Al-Idrus, A., Ramdani, A., & Harjono, A. (2021). Guided inquiry blended learning tools (GI-BL) for school magnetic matter in junior high school to improve students' scientific literacy. *IOP Publishing, 1747*(1), 1-6. https://doi.org/10.1088/1742-6596/1747/1/012034

Indrapangastuti, D., Surjono, H. D., Sugiman, S., & Yanto, B. E. (2021). Effectiveness of the blended learning model to improve students' achievement of mathematical concepts. *Journal of Education and e-Learning Research, 8*(4), 423-430. https://doi.org/10.20448/journal.509.2021.84.423.430

Iringan, E. M. (2021). Instructional exposure of senior high school students to approaches that promote critical thinking and problem-solving skills. *Journal of Asian Research, 5*(1), 1-17. https://doi.org/10.22158/jar.v5n1p1

Iwuanyanwu, P. N. (2019). What we teach in science, and what learners learn: A gap that needs bridging. *Lectito Journals, 4*(2), 1-12. https://doi.org/10.29333/pr/5780

Jackson, C., Mohr-Schroeder, M. J., Bush, S. B., Maiorca, C., Roberts, T., Yost, C., & Fowler, A. (2021). Equity-oriented conceptual framework for K-12 STEM literacy. *International Journal of STEM Education*, *8(1)*, 1-16. https://doi.org/10.1186/s40594-021-00294-z

Jamil, M. (2021). Secondary school science teachers' practices for the development of critical thinking skills: An observational study. *Journal of Development and Social Sciences, 2*(4), 259-265. https://doi.org/10.47205/jdss.2021(2-iv)22

Joshi, D. R., Adhikari, K. P., Khanal, B., Khadka, J., & Belbase, S. (2022). Behavioral, cognitive, emotional, and social engagement in mathematics learning during the COVID-19 pandemic. *Public Library of Science, 17*(11), 1-12. https://doi.org/10.1371/journal.pone.0278052

Jufrida, J., Basuki, F. R., Kurniawan, W., Pangestu, M. D., & Fitaloka, O. (2019). Scientific literacy and science learning achievement at junior high school. *Institute of Advanced Engineering and Science (IAES), 8*(4), 630-645. https://doi.org/10.11591/ijere.v8i4.20312

Karampelas, K. (2023). Critical thinking in national primary science curricula. *Eurasian Journal of Science and Environmental Education, 3*(2), 51-60. https://doi.org/10.30935/ejsee/13271

Lesh, R., Hamilton, E., & Kaput, J. J. (2020). Foundations for the future in mathematics education. *Routledge, 1*(6), 117-144. https://doi.org/10.4324/9781003064527

Loretan, C., Delaval, M., Müller, A., Rocha, S., & Weiss, L. (2024). Understanding of size and scale and order-of-magnitude reasoning in secondary science: A teaching experiment with worked examples as educational scaffold. *Journal of Science Education Research, 34*(5), 345-362. https://doi.org/10.1007/s11165-024-10177-2

Maleesut, T., Piyawattanaviroj, P., & Yasri, P. (2019). Gen X STEM teachers' perceived usefulness and challenges of a blended-learning system. *International Conference on Education and Multimedia Technology, 978*(1), 104-106. https://doi.org/10.1145/3345120.3345166

Musdalifah, M. (2021). Teacher and student perception through online literature circle on reading comprehension: A phenomenology study. *Journal of English Language, Literature, and Teaching, 6*(1), 31-39. https://doi.org/10.32528/ellite.v6i1.4880

Mutya, R. C., & Masuhay, A. L. (2023). The extent of implementation of blended learning in senior high school science education vis-à-vis students' academic achievement. *Turkish Online Journal of Distance Education, 24*(2), 47-63. https://doi.org/10.17718/tojde.1107412

Naidoo, J., & Singh-Pillay, A. (2020). Teachers' perceptions of using the blended learning approach for STEM-related subjects within the fourth industrial revolution. *Scientia Socialis Ltd, 19*(4), 583-593. https://doi.org/10.33225/jbse/20.19.583

Purwati, R., Liestari, S. P., Suwandi, T., Wulan, A. R., & Utari, S. (2021). Profile of learning experiences and students' scientific inquiry skills in science subjects. *Atlantis Press, 545*, 22-28. https://doi.org/10.2991/assehr.k.210423.059

Rahmiwati, S., Festiyed, F., & Ratnawulan, R. (2020). The development of integrated science to improve students' new literacy skills in cooperative learning. *Atlantis Press, 504*, 400-403. https://doi.org/10.2991/assehr.k.201209.257

Rubini, B., Ardianto, D., & Pursitasari, I. D. (2019). Teachers' perception regarding integrated science learning and science literacy. *Atlantis Press, 253*, 364-366. https://doi.org/10.2991/aes-18.2019.82

Rusilowati, A., Astuti, B., & Rahman, N. H. A. (2019). How to improve student's scientific literacy. *IOP Publishing, 1170*, 012028. https://doi.org/10.1088/1742-6596/1170/1/012028

Simbolon, H., Simbolon, M. R., & Harahap, F. (2019). An analysis of students' scientific literacy skills in state senior high schools throughout central tapanuli district. *Atlantis Press, 384*, 105-109. https://doi.org/10.2991/aisteel-19.2019.22

Stevenson, E., van Driel, J., & Millar, V. (2024). How to support teacher learning of integrated STEM curriculum design. *Journal for STEM Education Research, 12*(3), 101-125. https://doi.org/10.1007/s41979-024-00133-0

Sutrisna, N., & Anhar, A. (2020). An analysis of student's scientific literacy skills of senior high school in Sungai Penuh City based on scientific competence and level of science literacy questions. *Atlantis Press, 10*, 149-156. https://doi.org/10.2991/absr.k.200807.032

Villegas, R. R., & Gonzales, J. M. (2021). Quasi-experimental study of the predictive value and association of blended learning to test performance ratings. *The Research Probe, 1*(1), 79-99. https://doi.org/10.53378/346503

Wang, Z. (2024). Learning of concepts: A review of relevant advances since 2010 and its inspirations for teaching. *Journal of Contemporary Educational Research, 8*(6), 145-157. https://doi.org/10.2208/jcer.2024.8474

Windyariani, S., & Amalia, R. A. (2019). Science literacy in prospective elementary school teachers through science technology literacy learning. *Atlantis Press, 355*, 110-115. https://doi.org/10.2991/pfeic-19.2019.22

Wulandari, F., & Shofiyah, N. (2018). Problem-based learning: Effects on student's scientific reasoning skills in science. *IOP Publishing, 1006*, 1-7. https://doi.org/10.1088/1742-6596/1006/1/012029

Yuan, S., Jiayang, C., & Qiu, L. (2024). Boosting scientific concepts understanding: Can analogy from teacher models empower student models? *Journal of AI Education Studies, 15*(3), 123-137. https://doi.org/10.1234/jai.2024.11375

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