JPPIPA 10(12) (2024)

Jurnal Penelitian Pendidikan IPA

Journal of Research in Science Education

http://jppipa.unram.ac.id/index.php/jppipa/index

Development of Scientific-Based Learning Devices Implemented in the Inquiry-Flipped Classroom Learning Model to Improve Science Literacy in Acid-Base Material

Epinur[1], Fuldiaratman[1], Isra Miharti[1], Minarni[1*]

[1] Chemistry Education FKIP, Universitas Jambi, Jambi, Indonesia.

Received: August 29, 2024
Revised: October 24, 2024
Accepted: December 25, 2024
Published: December 31, 2024

Corresponding Author:
Minarni
minarni@unja.ac.id

DOI: 10.29303/jppipa.v10i12.9517

Abstract: The trend in science education policy in the 21st century emphasizes the importance of scientific literacy in science education as a transferable outcome. This research is a type of Research and Development (R&D) development research. Development research in the field of education aims to produce products for the benefit of education. This research produces a new product in the form of e-LKPD with a scientific approach to acid-base material. The purpose of this research and development is to find out how the procedure for developing teaching materials based on a scientific approach is implemented in the inquiry-flipped classroom learning model to improve Science Literacy skills and to find out the practicality of teaching materials based on a scientific approach implemented in the inquiry-flipped classroom learning model. Based on the results of the validation carried out on material and media experts in two rounds, the results of the first material validation were 89.30%, the second material validation was 98.70%. Design validation was conducted in two rounds where the first round obtained results of 87.50% and the second round of design validation 97.50%. Based on the results obtained from chemistry teachers, the first practitioner validation obtained 87% and the second practitioner validation obtained 91%, student responses to teaching materials with a percentage of 85.50%. Based on the criteria for the interpretation of the percentage of practicality, the group evaluation (student responses) was obtained with practical criteria or feasible for revision

Keywords: Development; Learning tools; Scientific literacy

Introduction

In Indonesia, it is generally known that the level of scientific literacy of Indonesian students as measured by PISA to date shows a concerning condition (Amir et al., 2023). The trend in science education policy in the 21st century emphasizes the importance of scientific literacy in science education as a transferable outcome. A survey conducted by PISA (Program for International Student Assessment), that the average score of scientific literacy skills in Indonesia in 2018 was 396, placing Indonesia in 74th place out of 79 participating countries. Indonesia is only above Morocco, Lebanon, Kosovo, the Dominican Republic and the Philippines. This means that in 2018 there was a decrease in score of 7 from 2015. Based on the data obtained, around 40% of students in Indonesia reached Level 2 or Indonesian students were only able to recognize the correct explanation for known scientific phenomena and were able to use that knowledge to identify, in simple cases (Ekawati et al., 2020). This is supported by research conducted by Mellyzar et al. (2022). The average scientific literacy of students in colloidal systems is only in the content ability to recognize several basic phenomena and students are still unable to communicate and connect these abilities with various things related to science, let alone apply abstract

How to Cite:
Epinur, Fuldiaratman, Miharti, I., & Minarni. (2024). Development of Scientific-Based Learning Devices Implemented in the Inquiry-Flipped Classroom Learning Model to Improve Science Literacy in Acid-Base Material. *Jurnal Penelitian Pendidikan IPA*, *10*(12), 10509–10517. https://doi.org/10.29303/jppipa.v10i12.9517

and complex chemical concepts. Given the importance of scientific literacy, educating students to have scientific literacy is the main goal of every science education reform (Broderick, 2023; Rudolph, 2024).

Scientific literacy focuses on building students' knowledge to use scientific concepts meaningfully, think critically and make balanced and adequate decisions on problems that are relevant to students' lives (Fortus et al., 2022). The chemistry learning process requires students to be able to construct concepts, laws or principles. In chemistry there are three forms of representation to explain a phenomenon, namely macroscopic, microscopic, and symbolic (Fauzi et al., 2019; Santoso et al., 2024). Acid-base material is conceptually dense material besides acid-base material is also abstract material (Ningrum et al., 2022). This fairly high abstraction and conceptual interconnectedness is what makes it difficult for students to understand acid-base solution learning, thereby reducing students' interest in learning. A learning approach is needed to support independent learning (Limbong et al., 2023). The scientific approach is a learning approach that is carried out through the process of observing, asking, trying, reasoning, and communicating (Marwiyati & Istiningsih, 2020).

According to Bramastia et al. (2023), Learning with a scientific approach can provide a positive contribution to improving critical thinking skills and solving simple problems. According to Ellizar et al. (2018), The scientific approach is an approach that provides opportunities for students to actively construct concepts, laws or principles through activities such as observing, asking, reasoning, associating and communicating which aim to develop scientific thinking skills and students' curiosity, so that students are motivated to observe the phenomena around them (Jirout, 2020). The learning process that requires students to be independent is in line with the independent learning curriculum that combines the learning process both asynchronously and synchronously using the blended learning model. Learning with blended learning is an alternative that teachers can do in learning and allows students to learn more freely according to their abilities and potential so that students have the freedom to innovate and learn independently (Voskamp et al., 2022). The inquiry-flipped classroom learning model is a blended learning model that combines the learning syntax of the inquiry model and the flipped classroom learning model (Delfianza et al., 2023).

The flipped classroom inquiry learning model has steps, namely: introduction before class; formulating problems; review; formulating hypotheses; collecting data; testing hypotheses; formulating conclusions; post-test. In the process, students are able to learn independently and teachers can provide teaching materials that support learning both online and offline (Sharma et al., 2022). This is also supported by Epinur et al. (2023), that investigations using flipped classrooms can be developed and the results are valid, effective and practical in the teaching materials used. Teaching materials are one of the means of supporting the learning process. According to Gusmaweti et al. (2023), that during the online learning process, students do not have books as a reference in learning. Chemistry material only comes from the teacher because it is not yet available. This is in line with the observations made by researchers at SMA N 1 Batanghari during the learning process during the Covid-19 pandemic, learning takes place online.

During the learning process, teachers still rely on printed books, due to various reasons that make teachers prefer to carry out learning with limited teaching materials and existing facilities and infrastructure without introducing new, more innovative learning approaches. This has not been able to support students to be able to learn independently in blended learning. So teachers need innovative teaching materials that support learning both synchronously and asynchronously. Research conducted by Suradi et al. (2024), developed e-LKPD with a scientific approach to improve critical thinking skills of elementary school students in science learning obtained a score of between 86% and 100% which is categorized as very practical. The research conducted (Refmidawati et al., 2023), developed e-LKPD with a scientific approach to electrolytes and non-electrolytes. Small group trials obtained a score percentage of 81.70%. Large group trials obtained a score percentage of 82.30% which identified the product developed as being in the very good category.

Method

The type of research conducted is research and development (Research and Development or R&D). Research and development in the field of education aims to produce products for educational purposes. This research produces a new product in the form of e-LKPD with a scientific approach to acid-base material. The development model used in this study is the ADDIE model which consists of the stages of analysis, design, development, implementation and evaluation (ADDIE). ADDIE is a coherent and systematic framework in organizing a series of research design and development activities.

The illustration of the image related to the stages contained in the ADDIE model according to Spatioti et al. (2022). The instruments used to collect data in this study were interview sheets, material expert validation questionnaires, media expert validation questionnaires, teacher assessment questionnaires, and student response questionnaires. There are qualitative and quantitative data, qualitative data in the form of responses, suggestions and input from experts from material experts and design experts will then be used for product revisions and improvements. Data obtained from other assessment questionnaires will be processed using a quantitative approach. The scores obtained based on the results of the answer choice gradation are then converted into a five-point Likert scale with an interval range.

Result and Discussion

The results obtained from the research and development that have been carried out are: Stages of the scientific approach-based inquiry-flipped classroom learning device to improve students' scientific literacy skills in acid-base material at SMA S Zulhijah Muara Bulian; validity of the scientific approach-based inquiry-flipped classroom learning device to improve students' scientific literacy skills in acid-base material at SMA S Zulhijah Muara Bulian, and Teacher assessment and student responses related to the practicality of the scientific approach-based inquiry-flipped classroom learning device to improve students' scientific literacy skills in acid-base material at SMA S Zulhijah Muara Bulian. The steps in developing the scientific approach-based inquiry-flipped classroom learning device to improve argumentation skills in addictive substances and additives at SMPN 2 Sarolangun were carried out by following the ADDIE (Analysis-Design-Develop-Implement-Evaluate) development model. In this study, the researcher only carried out the small group evaluation stage. The ADDIE stages can be seen as follows.

Analysis Stage

Based on the results of the researcher's interview with the Chemistry teacher at SMA S Zulhijah Muara Bulian, it can be analyzed that students' literacy skills in learning Chemistry are still low, where the factors causing this low student interest have many factors ranging from school environmental factors, family environment, community environment, and factors from the students themselves. One solution to improve students' scientific literacy skills in learning chemistry is to use learning tools designed to improve scientific literacy. The learning model used by teachers is still focused on teacher center, teachers still have difficulty managing time when conducting simple experiments so that practical methods are often not carried out. To use various learning tools in the chemistry learning process, the facilities and infrastructure at SMP S Zulhijah Muara Buliah are quite adequate in conducting simple experiments. However, students are still not allowed to use cellphones in the school area because the school is a semi-Islamic boarding school, but students can be allowed if confirmed in advance.

Therefore, in the process of learning chemistry, learning tools and learning models are needed that can support the learning process when the practicum method is implemented and can improve scientific literacy skills by being assisted through a scientific approach. Based on the results of the student characteristics questionnaire in table 1, student responses were obtained regarding chemistry learning in class, namely 43.40% answered that it was normal, 30% answered that it was fun and 26.60% answered that it was difficult. Based on this, half of the students already think that learning chemistry is fun, but there are still half of the students who think that learning chemistry is ordinary and difficult. For this reason, teachers need to use learning tools and practicum methods in the learning process so that students can be more interested in learning chemistry. This is in line with the results of the student questionnaire where 83.40% of students agreed that the use of teaching materials in learning would make learning more fun (not boring).

Furthermore, the students' responses related to the acid-base material are quite interesting to understand, namely 56.70% answered yes and 43.42% answered no. This means that 56.70% of students think that acid-base material is quite interesting to understand. However, there are still 63.40% of students who have difficulty understanding acid-base material. Based on this, it is necessary to provide additional teaching materials to overcome students' difficulties in understanding acid-base material by applying the flipped classroom inquiry model and developing scientific approach learning tools to improve students' scientific literacy skills in acid-base material. This is in line with the results of the student questionnaire in the application of flipped classroom inquiry and developing scientific approach tools to improve students' scientific literacy skills in acid-base material where 73.40% of students agree.

Students' scientific literacy skills are made based on PISA scientific literacy level indicators from level 1 to level 5. Each level of scientific literacy is integrated with one or more IPKD. Science Literacy Ability Level 5 with indicators Identifying scientific components in complex situations, comparing, selecting, or evaluating appropriate scientific evidence to respond to life situations, and building explanations based on evidence and arguments based on critical analysis. Science Literacy Ability Level 4 with indicators Making conclusions about the role of science and technology, integrating explanations from science and technology in aspects of life, and reflecting on actions from decisions taken using the knowledge and evidence they have. Science Literacy Ability Level 3 with indicators identifying scientific problems in various life contexts, selecting facts and knowledge to explain phenomena. Science Literacy Ability Level 2 with indicators providing possible explanations in the context of general knowledge, making interpretations of the results of investigations or problem-solving technologies.

Science Literacy Ability Level 1 with indicators having limited knowledge that can only be applied to several frequently encountered situations and presenting scientific explanations by following the information provided. The students' literacy skills based on the opinions of class teachers with a total of 3 students at SMA S Zulhijah showed results at level 1 23.40%, level 2 as much as 50%, level 3 26.60%, level 4 and level 5 are still missing with the following figure 1.

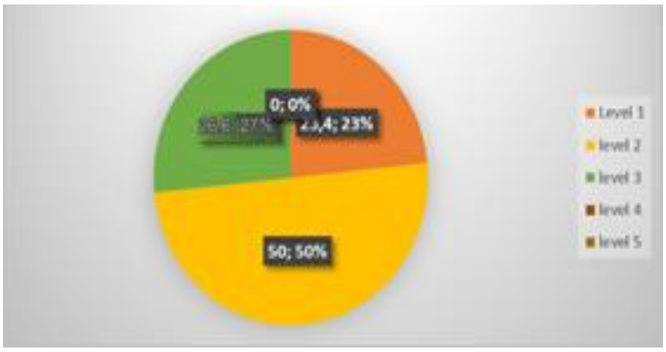

Figure 1. Students' literacy skills

Design Stage

The product developed in accordance with the needs analysis, availability of sources, product development orientation and the purpose of the product is developed. The product to be developed is a scientific-based learning device implemented in the inquiry learning model - flipped classroom to improve scientific literacy in acid-base material applied at SMA S Zulhija Muara Bulian.

Development Stage

The development stage is carried out with the aim of validating the developed learning device. The validation consists of validation by a team of experts, namely material experts and design experts. The expert validation carried out is material validation by material expert Mrs. Siti Raihan, S.Pd., M.Pd. After the material expert sees and reads the scientific-based learning device implemented in the inquiry learning model - flipped classroom to improve scientific literacy in the acid-base material applied, the material expert then assesses the material contained in the learning device by providing an assessment on the questionnaire and providing comments and suggestions related to the Acid-Base material. After the learning device is revised according to the comments and suggestions, the learning device is shown back to the material expert to see the revised results. Validation of the material by the material expert was carried out 2 times. The following are comments and suggestions given in the first stage of material validation related to the learning devices implemented in the inquiry-flipped classroom learning model on the material of addictive substances and additives, namely: The material in the E-LKPD needs to be packaged more attractively and can include more contextual examples; The material can be added with more interactive learning videos by entering links or barcodes so that students can access them; Writing symbols can be given more attention so that students do not misconstrue reading reactions.

The results of the material validation in the first stage, namely E-LKPD 89.30% with the criteria of being quite valid or can be used with minor revisions. Furthermore, after the Acid-base material was corrected in the first stage of validation according to the comments and suggestions, the second stage of material validation was carried out. For the results of the material validation by the material expert in the second stage of validation related to the learning devices, the following results were obtained. The second expert validation carried out was design validation by the design expert, namely Prof. Dr.rer.nat. H. Rayandra Asyhar, M. Si After the design expert sees and reads the developed learning device, the design expert then provides an assessment related to the design of the learning device by providing an assessment on the questionnaire and providing comments and suggestions on the scientific-based learning device implemented in the inquiry learning model - flipped classroom to improve scientific literacy in the applied acid-base material.

After the learning device is revised according to the comments and suggestions, the learning device is shown again to the design expert to see the revised results. Design validation by the design expert is carried out 2 times. The following are comments and suggestions given in the first stage of design validation of scientific-based learning devices implemented in the inquiry learning model - flipped classroom to improve scientific literacy in the acid-base material applied, namely: Filling in E-LKPD can use liveworksheet so that it can be filled in directly; The appearance of E-LKPD can be made more attractive and efficient; E-LKPD must be designed to be easy to use (user friendly); Can be equipped with barcodes for videos and so on. The results of the design validation in the first stage, namely E-LKPD 87.50% with valid criteria or recommended for revision. So based on this, the design of the learning device must be improved according to the comments and suggestions given by the design expert so that the design of the learning device can be used. Furthermore, after the design is improved in the first stage of validation according to the comments and suggestions, the second stage of design validation is carried out. So based on the data from the expert validation results by material experts and design experts above, it can be obtained that the learning devices implemented in the learning model in the scientific-based learning devices implemented in the inquiry learning model - flipped classroom to improve scientific literacy in acid-base material meet the validity criteria, namely very valid or can be tested at the next stage.

Implementation and Evaluation Stage

This implementation stage contains elements of formative evaluation in the form of one-on-one evaluation and group evaluation. The one-on-one evaluation was carried out to obtain initial input on the products produced from 1 experienced and competent Chemistry subject teacher in his field, namely Yultari ramadani S. Pd,.M.Pd after the chemistry teacher saw and read the scientific-based learning device implemented in the inquiry learning model - flipped classroom to improve scientific literacy in acid-base material, then the teacher was asked to provide an assessment of the learning device by providing an assessment on the questionnaire and providing comments and suggestions in the improvement suggestions column contained in the questionnaire. Based on the calculation results in table 7, the teacher's response results were 91% with the criteria of very valid or feasible needed. After the learning device was revised according to the comments and suggestions, it could be continued with a group evaluation.

The group evaluation was carried out by asking for opinions from respondents, namely 30 Class XI students by showing scientific-based learning devices implemented in the inquiry learning model - flipped classroom to improve scientific literacy in acid-base material. After that, 30 students of class XI SMA S Zulhijah were asked to fill out the questionnaire that had been provided. The results of the student response questionnaire at the group evaluation stage of the Learning Devices are as follows: student response results with a percentage of 85.50%. Based on the criteria for the interpretation of the percentage of practicality, the group evaluation (student response) was obtained with the criteria of practicality or feasible/no need for revision. So, based on the calculation data from the teacher's assessment and the student's response above, it can be obtained that the scientific-based learning device implemented in the inquiry-flipped classroom learning model to improve scientific literacy in acid-base material meets the criteria of practicality, namely practical or can be tested without/no need for revision. Students' Literacy Skills based on the opinions of class teachers with a total of 3 students at SMA S Zulhijah showed results at level 1 6.60%, level 2 as much as 10%, level 3 40%, level 4 as much as 36.7% and level 5 6.60% with the following figure 2.

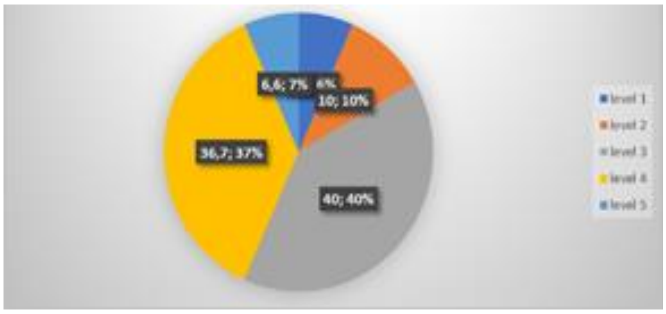

Figure 2. Sanin's literacy skills after implementation

Discussion

A person's scientific literacy will increase continuously. Assessment of students' scientific literacy skills needs to be carried out within a certain period of time (Osborne & Allchin, 2024). One of the surveys to measure students' scientific literacy skills is the PISA test which is carried out every 3 years (Mulyana & Desnita, 2023). Scientific literacy instruments need to be developed to measure students' abilities in applying scientific concepts in everyday life. The importance of scientific literacy instruments is that they can train students' abilities in scientific thinking. Multiple-choice questions can be used to determine the level of students' scientific literacy skills (Bahtiar et al., 2022; Saraswati et al., 2021; Dirman & Mufit, 2022). Students' scientific literacy skills are made based on indicators of PISA scientific literacy levels from level 1 to level 5. Each level of scientific literacy is integrated with one or more IPKD. Level 5 scientific literacy skills with indicators Identifying scientific components in complex situations, comparing, selecting, or evaluating appropriate scientific evidence to respond to life situations, and building explanations based on evidence and arguments based on critical analysis. Science Literacy Ability Level 4 with indicators Making conclusions about the role of science and technology, integrating explanations from science and technology in aspects of life, and reflecting on actions from decisions taken using the knowledge and evidence owned.

Science Literacy Ability Level 3 with indicators identifying scientific problems in various life contexts, selecting facts and knowledge to explain phenomena. Science Literacy Ability Level 2 with indicators providing possible explanations in the context of general knowledge, making interpretations of the results of investigations or problem-solving technology. Science Literacy Ability Level 1 with indicators having limited knowledge that can only be applied to several frequently encountered situations and presenting scientific explanations by following the information provided (McKasy et al., 2020). After the learning device was implemented in the inquiry-flipped classroom learning model, an increase in students' science literacy skills was obtained, which can be seen in the following graphic comparison:

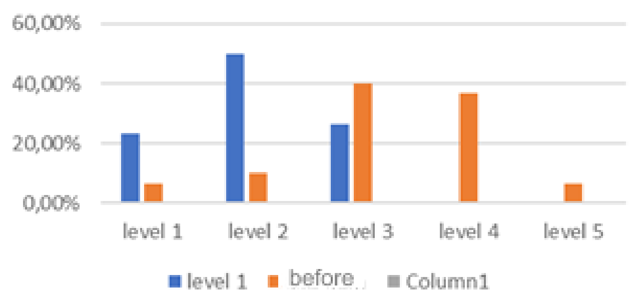

Figure 3. Science literacy skills

After the implementation of scientific-based learning devices in the inquiry-flipped classroom learning model to improve science literacy in acid-base material, it has increased as seen in the graph of students who have science literacy skills at level 1 6.60%, level 2 as much as 10%, level 3 40%, level 4 36.70%, and level 5 6.60% where the previous results were level 1 as much as 23.40%, level 2 50%, Level 3 26.6%, level 4 and level 5 are still missing. This is supported by research conducted by Rohmaya et al. 2023 which aims to test the effectiveness of E-LKPD chemistry in improving students' science literacy skills. Where testing is carried out on one group that is given an initial pretest of the students, the results of this study. Analysis of research data using descriptive analysis that presents a description of the average score (mean), frequency distribution, normalized N-gain score, and standard deviation of students' science literacy tests obtained from the results of the pretest and posttest. E-LKPD chemistry SMA/MA with a problem-based learning model in the context of social science issues is effective in improving students' science literacy.

The results of the normalized N-gain score obtained were 0.54 so that they are included in the moderate category. Students who reach more than 75%. The use of teaching materials that are not suitable and do not support science literacy skills is one of the triggering factors for low levels of science literacy. Teaching materials is a general term used to describe the use of learning resources from teachers to present lesson materials that can support students to carry out learning and provide improvements to learning outcomes (Nurjaya et al., 2023). Thus, teachers should select and use teaching materials that match the characteristics, depth and breadth of the material, and its application in students' lives (Yanti & Rahmadhani, 2023). In addition, the available teaching materials do not emphasize aspects of attitude and context, more on content aspects so that chemistry learning is more focused on textual aspects than on aspects of context and attitude (Amaliyah et al., 2024; Limeri et al., 2020). If chemistry learning is limited to text alone, it will make it difficult for students to connect the knowledge studied with real problems in their lives. This condition proves that the existence of teaching materials is a component that influences students' scientific literacy skills, so that in learning it is necessary to pay attention to the use of good teaching materials.

One of them is in terms of the use of student worksheets (LKPD) (Putriyani et al., 2024). This effectiveness test experienced several obstacles, including; limited research time. This research was conducted after the semester exams took place and was carried out during remedial time (Yolak et al., 2019; Marinelli et al., 2024). However, this did not have a significant impact as evidenced by the results of observations, namely the activeness and enthusiasm for learning of students; Students are not yet accustomed to using problem-based learning models. The second problem is that students involved in the effectiveness test are accustomed to direct learning so that some participants experience difficulties at the beginning of the meeting when learning with PBL syntax (Sutarto et al., 2022;(Harianja et al., 2023; Hidayati & Wagiran, 2020). These difficulties include students having difficulty formulating problems from the social science issues presented (Soebagyo et al., 2022). However, at the third meeting, students began to formulate problems fluently; Unstable internet network and lack of student devices. Initially, students used their own internet to access the internet, but obstacles were found, namely an unstable internet network and some students did not have an internet quota so that at the third meeting all students used the school's wifi network. Furthermore, there were several students who experienced obstacles when accessing E-LKPD such as black screens, long loading times and missing answers (Neumann, 2024). This problem can be overcome by changing the browser used on the smartphone.

Conclusion

P Learning devices are developed using the ADDIE method of ADDIE development (Analysis, Design, Development, Implementation, and Evaluation). Based on the results of validation carried out on material and media experts for two rounds, the results of the first material validation were 89.30%, the second material validation was 98.70%. Design validation was carried out in two rounds where the first round obtained results of 87.5% and the second round of design validation was 97.50%. Based on the results of practitioners obtained from chemistry teachers, the first practitioner validation was 87% and the second practitioner validation was 91%, student responses to teaching materials with a percentage of 85.50%. Based on the criteria for the interpretation of the percentage of practicality, the group evaluation (student responses) was obtained with practical criteria or feasible/no need for revision.

Acknowledgments
Thanks to all parties who have supported the implementation of this research. I hope this research can be useful.

Author Contributions
Conceptualization, E.; methodology, F.; validation, I. M; formal analysis, M.; investigation, E.; resources, I. M.; data curation, M.: writing—original draft preparation, E.; writing—review and editing, F.: visualization, I. M. All authors have read and agreed to the published version of the manuscript.

Funding
Researchers independently funded this research.

Conflicts of Interest
The authors declare no conflict of interest.

References

Amaliyah, N. I., Aznam, N., & Dewi, S. S. (2024). Analysis of Students' Scientific Attitude Through Experience Practicum Activities in Chemistry Learning. *Jurnal Penelitian Pendidikan IPA*, *10*(1), 19–27. https://doi.org/10.29303/jppipa.v10i1.6068

Amir, J., Dalle, A., Dj, S., & Irmawati, I. (2023). PISA Assessment on Reading Literacy Competency: Evidence from Students in Urban, Mountainous and Island Areas. *Jurnal Kependidikan: Jurnal Hasil Penelitian Dan Kajian Kepustakaan Di Bidang Pendidikan, Pengajaran Dan Pembelajaran*, *9*(1), 107. https://doi.org/10.33394/jk.v9i1.7103

Bahtiar, B., Ibrahim, I., & Maimun, M. (2022). Analysis of Students' Scientific Literacy Skill in terms of Gender Using Science Teaching Materials Discovery Model Assisted by PhET Simulation. *Jurnal Pendidikan IPA Indonesia*, *11*(3), 371–386. https://doi.org/10.15294/jpii.v11i3.37279

Bramastia, B., & Rahayu, S. (2023). Study of Science Learning Based on Scientific Literacy in Improving Critical Thinking: A Scoping Review. *Jurnal Penelitian Pendidikan IPA*, *9*(8), 499–510. https://doi.org/10.29303/jppipa.v9i8.5667

Broderick, N. (2023). Exploring different visions of scientific literacy in Irish primary science education: Core issues and future directions. *Irish Educational Studies*, 1–21. https://doi.org/10.1080/03323315.2023.2230191

Delfianza, E., Mawardi, M., & Suryani, O. (2023). Development of Flipped Classroom Based Guided Inquiry Learning System with Digital Literacy Using Discord Application on Thermochemistry. *Jurnal Penelitian Pendidikan IPA*, *9*(7), 5228–5235. https://doi.org/10.29303/jppipa.v9i7.4245

Dirman, H. M., & Mufit, F. (2022). Disain dan Validitas E-Instrument Five Tier-Multiple Choice Test Menggunakan iSpring Quiz Maker Sebagai Asesmen Literasi Sains Siswa Pada Pembelajaran Abad-21. *Jurnal Penelitian Pendidikan IPA*, *8*(6), 3170–7179. https://doi.org/10.29303/jppipa.v8i6.2300

Ekawati, R., Susanti, S., & Chen, J.-C. (2020). Primary Students' Mathematical Literacy: A Case Study. *Infinity Journal*, *9*(1), 49. https://doi.org/10.22460/infinity.v9i1.p49-58

Ellizar, E., Hardeli, H., Beltris, S., & Suharni, R. (2018). Development of Scientific Approach Based on Discovery Learning Module. *IOP Conference Series: Materials Science and Engineering*, *335*, 012101. https://doi.org/10.1088/1757-899X/335/1/012101

Epinur, E., & Minarni, M. (2023). Development of Student Worksheets on the Inquiry-Flipped Classroom Model on Addictive and Addictive Substance Material to Improve Student's Argumentation Abilities. *Jurnal Penelitian Pendidikan IPA*, *9*(8), 6292–6299. https://doi.org/10.29303/jppipa.v9i8.4499

Fauzi, H., Farida, I., Sukmawardani, Y., & Irwansyah, F. S. (2019). The making of e-module based in inquiry on chemical bonding concept with representation ability oriented. *Journal of Physics: Conference Series*, *1402*(5), 055059. https://doi.org/10.1088/1742-6596/1402/5/055059

Fortus, D., Lin, J., Neumann, K., & Sadler, T. D. (2022). The role of affect in science literacy for all. *International Journal of Science Education*, *44*(4), 535–555. https://doi.org/10.1080/09500693.2022.2036384

Gusmaweti, Sari, R. P., & Enjoni. (2023). Application of Problem-Based Learning with Video Assistance to The Learning Outcomes of Science from Students in Class V Elementary. *Journal of Digital Learning And Distance Education*, *1*(12), 387–394. https://doi.org/10.56778/jdlde.v1i12.107

Harianja, R., Tampubolon, T., & Manalu, L. (2023). Analysis of Problem-Based Learning Model on Mathematical Critical Thinking Skills of Elementary School Studentst. *Formatif: Jurnal Ilmiah Pendidikan MIPA*, *13*(1). https://doi.org/10.30998/formatif.v13i1.17251

Hidayati, R. M., & Wagiran, W. (2020). Implementation of problem-based learning to improve problem-solving skills in vocational high school. *Jurnal Pendidikan Vokasi*, *10*(2). https://doi.org/10.21831/jpv.v10i2.31210

Jirout, J. J. (2020). Supporting Early Scientific Thinking Through Curiosity. *Frontiers in Psychology*, *11*, 1717. https://doi.org/10.3389/fpsyg.2020.01717

Limbong, M. M., & Limbong, A. M. (2023). Obstacles and Difficulties in Implementing the Independent Learning Curriculum in High Schools. *Jurnal Pedagogi Dan Pembelajaran*, *6*(3), 374–384. https://doi.org/10.23887/jp2.v6i3.66084

Limeri, L. B., Carter, N. T., Choe, J., Harper, H. G., Martin, H. R., Benton, A., & Dolan, E. L. (2020). Growing a growth mindset: Characterizing how and why undergraduate students' mindsets change. *International Journal of STEM Education*, *7*(1), 35. https://doi.org/10.1186/s40594-020-00227-2

Marinelli, H. A., Berlinski, S., & Busso, M. (2024). Remedial Education: Evidence from a Sequence of Experiments in Colombia. *Journal of Human Resources*, *59*(1), 141–174. https://doi.org/10.3368/jhr.0320-10801R2

Marwiyati, S., & Istiningsih, I. (2020). Pembelajaran Saintifik pada Anak Usia Dini dalam Pengembangan Kreativitas di Taman Kanak-Kanak. *Jurnal Obsesi: Jurnal Pendidikan Anak Usia Dini*, *5*(1), 135. https://doi.org/10.31004/obsesi.v5i1.508

McKasy, M., Cacciatore, M., Su, L. Y.-F., Yeo, S. K., & Oneill, L. (2020). Operationalizing science literacy: An experimental analysis of measurement. *Journal of Science Communication*, *19*(04), A03. https://doi.org/10.22323/2.19040203

Mellyzar, M., Lukman, I. R., Alvina, S., Pasaribu, A. I., & Fadli, Mhd. R. (2022). Chemical Literacy of High School Students: Analysis of Cognitive Abilities on Colloid Material. *Jurnal Penelitian Pendidikan IPA*, *8*(6), 3128–3133. https://doi.org/10.29303/jppipa.v8i6.2377

Mulyana, V., & Desnita, D. (2023). Empirical Validity and Reliability of the Scientific Literacy Assessment Instrument Based on the Tornado Physics Enrichment Book. *Jurnal Penelitian Pendidikan IPA*, *9*(5), 3961–3967. https://doi.org/10.29303/jppipa.v9i5.3290

Neumann, T. (2024). Analysis of Advanced Driver-Assistance Systems for Safe and Comfortable Driving of Motor Vehicles. *Sensors*, *24*(19), 6223. https://doi.org/10.3390/s24196223

Ningrum, L. S., Drastisianti, A., Setiowati, H., & Pratiwi, R. (2022). Effectiveness of Cognitive Conflict-Based Chemistry Learning in Reducing Students' Misconceptions of Acid-Base Materials. *Jurnal Penelitian Pendidikan IPA*, *8*(4), 2425–2429. https://doi.org/10.29303/jppipa.v8i4.2092

Nurjaya, I. G., & Wulandari, I. G. A. A. M. (2023). Lesson Study Oriented Teaching Materials Improve Student Learning Outcomes. *Journal for Lesson and Learning Studies*, *6*(1), 9–17. https://doi.org/10.23887/jlls.v6i1.59595

Osborne, J., & Allchin, D. (2024). Science literacy in the twenty-first century: Informed trust and the competent outsider. *International Journal of Science Education*, 1–22. https://doi.org/10.1080/09500693.2024.2331980

Putriyani, P., Masriani, M., & Lestari, I. (2024). Development of Guided Inquiry-Based Student Worksheets On Element, Compound, And Mixture Materials. *Jurnal Pendidikan Glasser*, *8*(1), 78–86. https://doi.org/10.32529/glasser.v8i1.996

Refmidawati, & Megahati S, R. R. P. (2023). Integration of Sustainability Literacy in Digital Learning in Chemistry Education: A review. *Journal of Digital Learning and Distance Education*, *2*(5), 625–629. https://doi.org/10.56778/jdlde.v2i5.256

Rudolph, J. L. (2024). Scientific literacy: Its real origin story and functional role in American education. *Journal of Research in Science Teaching*, *61*(3), 519–532. https://doi.org/10.1002/tea.21890

Santoso, T., Ahmar, D. S., Tukaedja, S. V., & Haetami, A. (2024). The Effect of the Discovery Learning Model with a Scientific Approach on Student Representation Ability in the Buffer Solution. *Jurnal Penelitian Pendidikan IPA*, *10*(6), 3296–3302. https://doi.org/10.29303/jppipa.v10i6.7389

Saraswati, Y., Sifak Indana, & Elok Sudibyo. (2021). Science Literacy Profile of Junior High School Students Based on Knowledge, Competence, Cognitive, and Context Aspects. *IJORER: International Journal of Recent Educational Research*, *2*(3), 329–341. https://doi.org/10.46245/ijorer.v2i3.118

Sharma, D., Sood, A. K., Darius, P. S. H., Gundabattini, E., Darius Gnanaraj, S., & Joseph Jeyapaul, A. (2022). A Study on the Online-Offline and Blended Learning Methods. *Journal of The Institution of Engineers (India): Series B*, *103*(4), 1373–1382. https://doi.org/10.1007/s40031-022-00766-y

Soebagyo, J., Umam, K., Istikharoh, I., & Suhendri, H. (2022). An Analysis of Students' Mathematical Problem-Solving Ability at Class VII Social Arithmetic Materials Based on Learning Styles. *Formatif: Jurnal Ilmiah Pendidikan MIPA*, *12*(1). https://doi.org/10.30998/formatif.v12i1.10099

Spatioti, A. G., Kazanidis, I., & Pange, J. (2022). A Comparative Study of the ADDIE Instructional Design Model in Distance Education. *Information*, *13*(9), 402. https://doi.org/10.3390/info13090402

Suradi, S., Prastowo, S. B., & Sutomo, Moh. (2024). Development of PBL-Based Interactive LKPD to Improve Elementary Students' Critical Thinking Skills in Science Learning. *Jurnal Paedagogy*, *11*(2), 300. https://doi.org/10.33394/jp.v11i2.10034

Sutarto, Dwi Hastuti, I., Fuster-Guillén, D., Palacios Garay, J. P., Hernández, R. M., & Namaziandost, E. (2022). The Effect of Problem-Based Learning on Metacognitive Ability in the Conjecturing Process of Junior High School Students. *Education Research International*, *2022*, 1–10. https://doi.org/10.1155/2022/2313448

Voskamp, A., Kuiper, E., & Volman, M. (2022). Teaching practices for self-directed and self-regulated learning: Case studies in Dutch innovative secondary schools. *Educational Studies*, *48*(6), 772–789. https://doi.org/10.1080/03055698.2020.1814699

Yanti, M., & Rahmadhani, A. (2023). Analysis of Teacher Interpretation of the Depth and Breadth of Middle School Level Global Warming Material using "Content Representation" (CoRe). *Prisma Sains: Jurnal Pengkajian Ilmu Dan Pembelajaran Matematika Dan IPA IKIP Mataram*, *11*(4), 1066. https://doi.org/10.33394/j-ps.v11i4.8964

Yolak, B. B., Kiziltepe, Z., & Seggie, F. N. (2019). The Contribution of Remedial Courses on the Academic and Social Lives of Secondary School Students. *Journal of Education*, *199*(1), 24–34. https://doi.org/10.1177/0022057419836434