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Development of a Physics Teaching Module Based on Scientific Literacy to Improve Students' Analytical Thinking Skills

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Abstract: This research is a type of R&D research using a 4D model. The 4D stages include define, design, develop, and disseminate. This research and development aims to analyze the validity of the content of the developed science literacy-based physics teaching module design, analyze practitioners' assessments of science literacy-based physics teaching modules, and analyze the effectiveness of using science literacy-based physics teaching modules to improve students' analytical thinking skills. Based on the results of the analysis, it can be concluded that the science literacy-based physics teaching module developed based on expert assessment using the Aiken V index analysis is declared valid and feasible to use with a little revision, the science literacy-based physics teaching module in terms of practitioner (teacher) responses for all aspects obtained an average score percentage of 86% which is on very good criteria, and the effectiveness of using science literacy-based physics teaching modules is obtained from the results of tests of students' analytical thinking skills as many as 77% of students are on an N-gain score of ≥ 56% or with effective criteria where this means there is an increase in students' analytical thinking skills in physics learning.

Keywords: Analytical thinking skills; Physics teaching modules; Science literacy

Introduction

Today, the development of science in the changing order of the 21st century is advancing very rapidly in various fields, including the field of education. Changes in education in the 21st century are very evident in the paradigm shift in learning which refers to changes in objects, namely previously teachers as learning centers became students who played a role as learning centers, In line with this, the Ministry of Education and Culture's R&D also formulates that the 21st century learning paradigm in the realm of learning objectives emphasizes the ability of students to find out from various sources, formulate problems, think analytically and cooperate and collaborate in solving problems. The ability to think analytically is one of the life skills in the 21st century that must be possessed by students as a provision of life to be able to compete in the global era (Hanicza et al., 2021). In this modern era one way of thinking a person in the learning process involves a lot of analytical thinking.

According to Susanti et al. (2021) analytical thinking skills are internal abilities possessed by students where these abilities are part of critical thinking skills. Furthermore, according to Fadly (2021) analytical thinking skills include learners' skills in applying logical thinking to collect and analyze information, design and test solutions to problems, and formulate plans. Analytical thinking is useful for adapting and modifying information and in it includes useful cooperation in everyday life, where if students are able to analyze from a material or problem, students are automatically able to know, understand, and apply the material that the teacher delivers. Therefore, if students' analytical thinking skills are honed, then students can improve all cognitive aspects of learning. This is in line with the opinion of Almulla (2023) which states that analytical skills also affect student learning achievement. Learning physics is a science that really requires a more complex learning process.

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Physics cannot be learned only by reading and memorizing content, so analytical skills are needed in learning physics. A similar opinion was also presented by Wang et al. (2015) and Rosenberg et al. (2019), that in the process of learning physics, the ability to analyze a science content is needed to support the development of students in the investigations carried out in learning. The ability to think analytically is very important for high school students because it can increase students' understanding in solving problems (Prastiwi et al., 2018). One of the important variables that can increase understanding of learning is analytical skills because it is one of the basic skills in solving problems.

The development of students' analytical thinking skills needs to be designed through good planning by the teacher (Blegur et al., 2023). In the independent curriculum, analytical thinking skills play a very important role, especially in science process skills because these abilities can develop critical thinking skills, make evidence-based decisions, and apply knowledge in real situations so that learning must be directed as well as possible to achieve these abilities. For this reason, it can be said that analytical skills are one of the basic abilities that must be possessed by students, so it is very necessary to pay attention to physics learning, especially in class X. So that these abilities can be realized and possessed by students as demands of 21st century learning goals and science process skills as a key element in the independent curriculum, so there needs to be a role for teachers and learning resources that contain these abilities.

One of the learning resources that greatly influences the achievement of students expected analytical thinking skills is the use of teaching modules. The use of this teaching module in addition to helping students understand learning material can also increase student interest and motivation which will certainly greatly affect achievement, especially students' analytical thinking skills. According to Margot et al. (2019), teaching modules emphasize more on student activities than teachers. Teaching modules are usually independent, meaning that students can learn independently because they are systematic and complete. According to Asri et al. (2022) a teaching module is something used by teachers and students to facilitate the learning process which is seen as increasing students' knowledge and experience according to the demands of the curriculum as an implementation of learning. However, ironically the content of the teaching modules that exist now is dominated by theory in general. Even though students need to understand and accept objectively, concretely and rationally for learning, especially in learning Physics.

In line with the statement above, this condition also occurs at SMA Negeri 1 Sendana. Researchers have made initial observations, namely the first teaching module used is still in the form of teaching modules such as supporting textbooks assessment of aspects of competence, theory, sample questions, independent tasks, and evaluation where the results of the assessment are still considered to have many shortcomings based on the assessment of these aspects. This book is also only distributed when class hours are not a student handbook, but a teacher handbook so that its use by students is not optimal, and cannot be used by students outside of class hours. Second, researchers also observed the characteristics of students at SMA Negeri 1 Sendana, which is when KBM most students feel bored so that physics learning is less desirable. Third, in solving C4 questions most students have difficulties. In line with research according to Lodge et al. (2018) students in working on analyzing category questions still have difficulties.

Fourth, classroom learning uses lecture and discussion methods. In the learning process in the classroom, the teacher plays an active role as the center of learning, while students play a passive role. The material is presented in the form of a general concept without the implementation of the material in real life. Even though the demands of physics subjects should associate the concept of physics with giving physical meaning and its implementation in everyday life. Furthermore, in providing material evaluation in the form of practice questions in the form of questions C_3 and C4, not all students are able to answer question C_4 correctly and most students have not been able to separate the important parts of the question to be used as the key to solving the problem. In accordance with (Tuela et al., 2022) in his research on the analysis of students' abilities in the cognitive realm in Physics learning that the cognitive dimensions mastered by students are still in the range of C1-C3 and are still very lacking in mastering the C4 level.

In fact, the cognitive dimension of C4 is very beneficial for the development of all cognitive dimensions of students, especially their knowledge and understanding (Assegaff et al., 2016) from a number of statements above, this is an indication that the analytical thinking skills of grade X students of SMAN 1 Sendana are relatively low. The above problems are obtained, it is very important to make new breakthroughs in students' analytical thinking skills. The achievement of students' thinking skills is greatly influenced by the learning process which depends on the teacher's task in creating, designing, and planning a learning resource by taking into account the characteristics and social environment of students in order to create fun, creative, and innovative learning so that learning objectives are achieved according to the demands of the main

curriculum in improving students' analytical thinking skills.

One of the learning resources in the learning process that can be developed is a physics teaching module containing science literacy that is adjusted to the characteristics of students and the environment. This means that the material in the teaching module developed is not only a general concept but relates the concepts and processes of science (physics) in real life, so as to create concern for the environment and life, especially in training students' analytical thinking skills. Integrating science literacy in learning can improve more complex thinking skills and learning objectives can be achieved optimally (Adawiyah et al., 2020). This is in accordance with quality of teaching in physics learning in the classroom that raises science literacy is needed to trigger thinking skills (Winarto et al., 2022).

Sagala et al. (2019) also suggests that science literacy requires more complex thinking skills categorized in higher-order thinking skills, one of which is analyzing, so that it can help students understand and analyze problems to be able to find solutions to a problem by relating it to various scientific facts. Furthermore, according to Nofiana et al. (2018a) science literacy also has the potential to form a superior person, have the ability to think logically, analytically, creatively, solve problems, and master technology so that it is adaptive to changes and developments of the times. The necessity of loading science literacy in teaching modules is also motivated by the science literacy status of students in Indonesia (Afnan et al., 2023).

This status can be seen from the results of the Program for International Student Assessment (PISA) assessment released by the OECD in 2018 showing that students' science literacy ability achieved an average score of 396 ranked 74 out of 78 countries. Indonesia's ranking always decreases every period of PISA results. In this assessment, science literacy not only measures knowledge, but also assesses the ability of students to apply knowledge in real situations involving analysis Related to the results of PISA and the problems above, it can be seen how necessary the physics teaching module contains science literacy.

Method

This type of research is R & D. This research was conducted to produce physics teaching modules based on science literacy to improve students' analytical thinking skills. Research and development uses a 4D development model consisting of four stages, namely define, design, development, and dissemination (Nurdianah et al., 2022). The activities carried out at each stage of the development of science literacy-based physics teaching modules are explained as follows.

At the defining stage, the development of science literacy-based physics teaching modules begins with conducting a beginning-end analysis to determine the background of problems in physics learning in high school, school conditions, and the completeness of learning media. Furthermore, student analysis is carried out to examine the characteristics of students which include the background knowledge of students, learning styles, and the level of analytical thinking skills of students. The results of the study are used as consideration for the design and development of learning tools, namely science literacy-based teaching modules. Then, concept analysis is carried out to identify and systematically compile the main concepts that students will learn as reference material for researchers in the preparation of science literacy-based physics teaching modules.

This stage really needs to be done with the aim of knowing learning resources in the form of appropriate teaching modules in improving students' analytical thinking skills. Finally, the formulation of learning objectives based on the elements and learning outcomes in the independent curriculum based on the results of the analysis of concepts with the intention of making it more operational. The learning objectives that have been formulated become a reference in designing and compiling science literacy-based teaching modules in accordance with the topic of the material that has been chosen. The design stage is carried out after the researcher has completed all parts at the defining stage. At this stage, a design was obtained for physics teaching modules based on science literacy with stages starting from the selection of teaching modules designed to support the physics learning process.

After the selection of teaching modules, a format was selected to adjust the format of physics teaching modules based on science literacy according to the needs of the defining stage, namely the adaptation of the component format for preparing physics teaching modules based on the independent curriculum used at SMAN 1 Sendana. Furthermore, at this stage, an initial design of product development was carried out in the form of an initial draft of physics teaching modules based on science literacy and research instruments. The main stage carried out before the teaching module is developed is to prepare initial design needs such as teaching module design, images, learning videos, materials, questions, frames, and others prepared before being developed. Images of the material are obtained from personal documents and downloaded from Google Picture. Learning videos are obtained from YouTube. The materials and questions are obtained from references to class X physics books, Basic Physics books 7th Edition, and question bank books. Cover design, teaching module contents, frames, and some material

images obtained using the design application, Canva. After all the initial design needs are collected, it is then compiled into teaching modules by utilizing the Microsoft Word application based on the standard format of teaching modules.

Furthermore, the development stage contains content validation activities carried out by experts on the developed modules and research instruments and field tests are carried out on analytical thinking ability test instruments. Furthermore, the item was revised for limited trials of the developed product. The trial aims to get a feasible final product to determine the improvement of students' analytical thinking skills after using science literacy-based physics teaching modules in learning. The research design used to conduct limited trials is a one-group pretest-posttest design. In this design, an initial test (O1) was first carried out to determine the analytical thinking skills of students then the class was given treatment using science literacy-based physics teaching modules during the learning process. Finally, a final test (O2) was carried out after the application of the treatment to obtain data and information on improving analytical thinking skills. The results of the before and after tests of the class are observed, then the results are compared. According to Sugiyono (2019), the product trial design is presented in Figure 1.

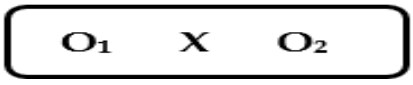

Figure 1. One group pretest-posttest trial design

Finally, the dissemination stage is to ask for practitioner responses using practitioner assessment questionnaires that have been validated and published in e-journal.

Result and Discussion

Results of Validity of Science Literacy-Based Physics Teaching Modules

The initial design of the science literacy-based physics teaching module that has been prepared is then validated by experts to determine the feasibility of science literacy-based physics teaching modules before limited trials are carried out. The aspects of content validity assessed by the three expert aspects of content feasibility, presentation, language, and graphics. The average acquisition of expert validity test scores on all four aspects of assessment using content validity coefficient analysis (Aiken's V) is presented in Table 1 below.

Table 1. Results of Analysis of the Validity of the Content of the Science Literacy-Based Physics Teaching Module

Aspect	Number of Validity Item Scores	V	Criteria
Contents Eligibility	13.67	0.80	Valid
Serving	11.67	0.78	Valid
Language	13.89	0.77	Valid
Graphics	12	0.80	Valid

Table 1 shows that the validity results provided by experts have strong consistency responses. This means that the physics teaching module based on science literacy developed is declared to meet the requirements of valid criteria. Science literacy-based physics teaching modules that are declared valid mean science literacy-based physics teaching modules that have been developed as a whole, the content or material and assessment aspects of science literacy-based physics teaching modules are consistent with each other. The assessment aspect in question is the suitability of the content presented with learning outcomes and the applicable curriculum, linking the material with problems that relate daily life, interesting and using language that is easy to understand.

Furthermore, referring to the results of the analysis, and following the advice and input from experts so that the science literacy-based physics teaching module developed obtained the results that the science literacy-based physics teaching module was valid and feasible to be used at the trial stage. This is in accordance with the results of previous research conducted by Insani et al. (2023) with research results in the form of developing Basic Physics I modules based on science literacy having high validity criteria which means they are suitable for use in the learning process. Masruroh et al. (2023), in their research also stated that the expert assessment of product development in the form of science literacy-based LKPD in physics learning in the assessment aspect was valid. Meanwhile, according to Yulkifli et al. (2023) the development of high school/MA class X semester 1 physics teaching materials containing science literacy is declared valid by experts so that it is very feasible to be used in learning.

Results of Practitioner Assessment of Science Literacy-Based Physics Teaching Module

Practitioners' responses to science literacy-based physics teaching modules aim to determine the responses of physics subject teacher practitioners who are members of the physics MGMP in Majene Regency. Practitioners' assessment of science literacy-based physics teaching modules includes aspects of content feasibility, presentation feasibility, language feasibility, and graphic feasibility. The results of obtaining

assessment scores from practitioners are grouped according to the criteria in Table 2.

Table 2. Results of Analysis of Practitioners' Assessment of Science Literacy-Based Physics Teaching Modules

Assessed aspect	Percentage (%)	Criteria
Contents Eligibility	86	Very good
Serving	86	Very good
Language	85	Very good
Graphics	85	Very good

From Table 2, it can be seen that practitioners rate all aspects as above 61% (Vlachopoulos et al., 2017; A. I. Wang et al., 2020), which means that practitioners respond very well or positively to the science literacy-based physics teaching module that has been developed so that it can be said to be practical to use in learning. The results of this analysis are in line with research conducted by Lestari et al. (2023), and Dwivedi et al. (2023), that the results of practical trials of science literacy-based practicum modules for science learning are in very practical criteria and get a positive response so that they can be used as practicum guides. Furthermore, according to Amini et al. (2020) in their research that the development of teaching materials based on scientific literacy on magnetic materials is valid, easy and very practical to use in learning.

Results of the Effectiveness of Using Science Literacy-Based Physics Teaching Modules to Improve Students' Analytical Thinking Skills

The effectiveness of using science literacy-based physics teaching modules was measured using a pretest-posttest test instrument for analytical thinking skills given to grade X 5 students at SMAN 1 Sendana. The results of the analysis of students' analytical thinking skills test scores before (pretest) and after (posttest) given science literacy-based physics teaching modules can clearly be seen in Figure 2.

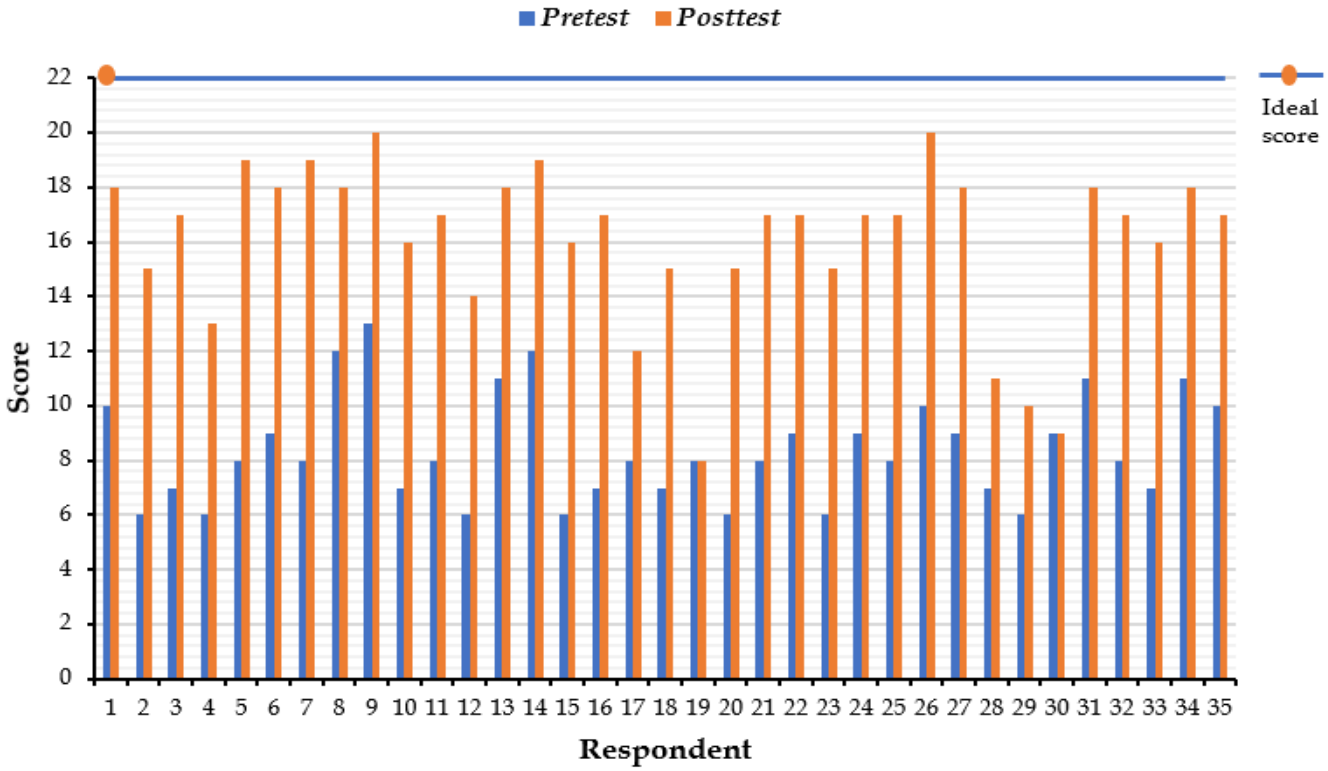

Figure 2. Pretest and posttest learners' analytical thinking skills

The results of the students' analytical thinking skills test before and after the use of science literacy-based physics teaching modules, then an N-Gain Score analysis was carried out to see whether there was an increase in students' analytical thinking skills. The following results of the N-gain score analysis can be seen in Table 3 below.

Table 3. Percentage of Interpretation Effectiveness Gain score Thinking Ability Analysis of Students

Interval (%)	Criteria	Frequency	Percentage
g ≤ 55	ineffective	8	23%
g ≥ 56	effective	27	77%
Total		35	100%

Based on Table 3, showing that the results of the analysis show that more than 70% of students in general are on the effective criteria, it can be interpreted that there is an increase in students' analytical thinking skills. Based on this, the science literacy-based physics teaching module developed is effective in improving students' analytical thinking skills. The results of the assessment can be seen from the pretest-posttest assessment analysis where after the use of science literacy-based physics teaching modules, students are able to understand and apply physics concepts in real life and problem solving related to problem cases in the three analytical thinking indicators after being given the application of the developed science literacy-based physics teaching module. This is in line with research conducted by Samsu et al. (2020), Darling-Hammond et al. (2020), and Siswanto et al. (2023), that the science literacy of developing students will guide students in using their knowledge to face and solve problems in everyday life, so that they have the ability to solve problems in these situations.

On the other hand, the physics teaching module based on science literacy developed raises physics topics and their implementation in the real life of students that are easy to understand and adjusted to the characteristics of students (Maison et al., 2021; Wati et al., 2021). The content of this module also contains examples of questions arranged based on analytical thinking indicators that can train students' analytical thinking skills. Then, the teaching module developed also presents several activities carried out by students such as making projects and some easy-to-understand questions and problem videos that are packaged with integrating science literacy that can stimulate students' analytical thinking skills. In line with research conducted by Niate et al. (2022), and Putranta et al. (2019) suggests that science literacy requires more complex thinking skills categorized in higher-order thinking skills such as analyzing, because it can help students understand and analyze problems to find solutions to problems and relate scientific facts. Furthermore, according to Nofiana et al. (2018b), and Andaresta et al. (2023), science literacy also has the potential to form a superior person, have the ability to think logically, analytically, creatively, solve problems, and master technology.

The above statement is also reinforced from the results of the effectiveness test analysis using the N-gain score test and supported by previous studies. As stated by Sugiarto et al. (2023), and Nurjannah et al. (2022), stated that the development of physics teaching materials based on analytical skills for students was declared effective as shown from the results of the analytical ability test of students who achieved KBM. In addition Ismaniati et al. (2023) and Arifuddin et al. (2021), the development and trials that have been carried out on learning tools using electronic modules based on physical science literacy are declared valid, practical and effective so that they are feasible and can be used as alternative physics teaching modules.

Conclusion

Based on the results of research and discussion, it can be concluded that: The results of the validity test of the contents of the science literacy-based physics teaching module developed have met the valid criteria so that they are suitable for use, practitioners' responses to the developed science literacy-based physics teaching module are in the very good category so that they meet practical criteria, and The effectiveness of using science literacy-based physics teaching modules to improve analytical thinking skills Students using N-Gain score obtained more than 70% are on the effective criteria. This means that there is an increase in students' analytical thinking skills and the teaching modules developed are declared effective in learning.

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Author Contributions

Conceptualizes research ideas, research methodology, data analysis, obtaining funding, thesis preparation process, writing original drafts, software in teaching module design needs, management responsibility, coordination for research planning and implementation of activities; N. A. A. ; wrote-reviewed and edited, supervised and validated the teaching modules and instruments used in the research : M. A., H. A.

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Conflicts of Interest

The author declares no conflict of interest.

References

Adawiyah, R., Badruzsaufari, & Yunus, R. (2020). Development of Integrated Science Modules to Train Students' Critical Thinking Skills. *Journal of Advances in Education and Philosophy*, 4(6), 260–269. https://doi.org/10.36348/jaep.2020.v04i06.006

Afnan, R., Munasir, M., Budiyanto, M., & Aulia, M. I. R. (2023). The Role of Scientific Literacy Instruments For Measuring Science Problem Solving Ability.

IJORER: International Journal of Recent Educational Research, *4*(1), 45–58. https://doi.org/10.46245/ijorer.v4i1.271

Almulla, M. A. (2023). Constructivism learning theory: A paradigm for students' critical thinking, creativity, and problem solving to affect academic performance in higher education. *Cogent Education*, *10*(1), 2172929. https://doi.org/10.1080/2331186X.2023.2172929

Amini, R. (2020). The development of teaching materials use an inductive-based 7E learning cycle for elementary school students. *Journal of Physics: Conference Series*, *1521*(4), 042114. https://doi.org/10.1088/1742-6596/1521/4/042114

Andaresta, O., Muliani, M., Safriana, S., Sakdiah, H., & Novita, N. (2023). Development of Assessments to Measure Students' Science Literacy Ability: Rasch Modeling Analysis. *Jurnal Pendidikan Fisika Dan Teknologi*, *9*(2), 356–365. https://doi.org/10.29303/jpft.v9i2.6092

Arifuddin, M., Hidayah, N. P., & Mahtari, S. (2021). The development of electronic modules with science literature through direct instruction of impulse and momentum materials. *Journal of Physics: Conference Series*, *2104*(1), 012016. https://doi.org/10.1088/1742-6596/2104/1/012016

Asri, A. N., Imron, A., & Suryadi, S. B. (2022). Development of English Teaching Module for Electrical Engineering Study Program. *SAGA: Journal of English Language Teaching and Applied Linguistics*, *3*(1), 69–80. https://doi.org/10.21460/saga.2022.31.120

Assegaff, A., & Sontani, U. T. (2016). Upaya meningkatkan kemampuan berfikir analitis melalui model problem based learning (PLB). *Instruksional*, *1*(1), 38–48. https://doi.org/10.24853/instruksional.2.1.10-16

Blegur, J., Mahendra, A., Mahardika, I. M. S., Lumba, A. J. F., & Rajagukguk, C. P. M. (2023). Construction of Analytical Thinking Skills Instruments for Micro Teaching Courses. *Journal of Education Research and Evaluation*, *7*(2), 184–196. https://doi.org/10.23887/jere.v7i2.57025

Darling-Hammond, L., Flook, L., Cook-Harvey, C., Barron, B., & Osher, D. (2020). Implications for educational practice of the science of learning and development. *Applied Developmental Science*, *24*(2), 97–140. https://doi.org/10.1080/10888691.2018.1537791

Dwivedi, Y. K., Kshetri, N., Hughes, L., Slade, E. L., Jeyaraj, A., Kar, A. K., Baabdullah, A. M., Koohang, A., Raghavan, V., Ahuja, M., Albanna, H., Albashrawi, M. A., Al-Busaidi, A. S., Balakrishnan, J., Barlette, Y., Basu, S., Bose, I., Brooks, L., Buhalis, D., … Wright, R. (2023). Opinion Paper: "So what if ChatGPT wrote it?" Multidisciplinary perspectives on opportunities, challenges and implications of generative conversational AI for research, practice and policy. *International Journal of Information Management*, *71*, 102642. https://doi.org/10.1016/j.ijinfomgt.2023.102642

Fadly, W. (2021). Profile of Students Analytical Thinking Skills In Learning Style For Completing Substance Pressure Problems. *Jambura Physics Journal*, *3*(1), 1–15. https://doi.org/10.34312/jpj.v3i1.9792

Hanicza, Y., Putri, D. H., & Hamdani, D. (2021). Identification of debriefing 21 st century skills on aspects of critical thinking skills and communication skills in Bengkulu high school students in physics subjects. *Journal of Physics: Conference Series*, *1731*(1), 012069. https://doi.org/10.1088/1742-6596/1731/1/012069

Insani, P. N., Su'ad, S., & Hariyadi, A. (2023). Development of Blended Learning-Based Science Module on Sound Material to Improve Learning Outcomes of Fourth-grade Elementary School Students. *AL-ISHLAH: Jurnal Pendidikan*, *15*(2), 2182–2191. https://doi.org/10.35445/alishlah.v15i2.2791

Ismaniati, C., & Iskhamdhanah, B. (2023). Development of Interactive E-Modules to Increase Learning Motivation and Science Literacy in Elementary School Students. *Jurnal Iqra' : Kajian Ilmu Pendidikan*, *8*(1), 156–173. https://doi.org/10.25217/ji.v8i1.2699

Lestari, D. P. (2023). Effect of science virtual laboratory combination with demonstration methods on lower-secondary school students' scientific literacy ability in a science course. *Education and Information Technologies*, *28*(12), 16153–16175. https://doi.org/10.1007/s10639-023-11857-8

Lodge, J. M., Kennedy, G., Lockyer, L., Arguel, A., & Pachman, M. (2018). Understanding Difficulties and Resulting Confusion in Learning: An Integrative Review. *Frontiers in Education*, *3*, 49. https://doi.org/10.3389/feduc.2018.00049

Maison, & Wahyuni, I. (2021). Guide inquiry science e-module development for improving junior high school students' scientific literacy. *Journal of Physics: Conference Series*, *1876*(1), 012089. https://doi.org/10.1088/1742-6596/1876/1/012089

Margot, K. C., & Kettler, T. (2019). Teachers' perception of STEM integration and education: a systematic literature review. *International Journal of STEM Education*, *6*(1), 1–16. https://doi.org/10.1186/s40594-018-0151-2

Masruroh, V., Lusiana, R., & Susanti, V. D. (2023). Development of Student Worksheets Oriented to Problem Based Learning Integrated 21st Century Skills. *AL-ISHLAH: Jurnal Pendidikan*, *15*(1), 519–532. https://doi.org/10.35445/alishlah.v15i1.2466

Niate, M., & Djulia, E. (2022). Profil Kemampuan Literasi Sains Kelas X pada Aspek Kompetensi Materi Vertebrata. *Biologi Edukasi: Jurnal Ilmiah Pendidikan Biologi*, *14*(2), 33–41. https://doi.org/10.24815/jbe.v14i2.29859

Nofiana, M., & Julianto, T. (2018a). Upaya Peningkatan Literasi Sains Siswa Melalui Pembelajaran Berbasis Keunggulan Lokal. *Biosfer : Jurnal Tadris Biologi*, *9*(1), 24. https://doi.org/10.24042/biosf.v9i1.2876

Nofiana, M., & Julianto, T. (2018b). Upaya Peningkatan Literasi Sains Siswa Melalui Pembelajaran Berbasis Keunggulan Lokal. *Biosfer : Jurnal Tadris Biologi*, *9*(1), 24. https://doi.org/10.24042/biosf.v9i1.2876

Nurdianah, E., & Sudira, P. (2022). Developing Mobile Career Learning Model for Electronics Engineering Vocational High School. *Elinvo (Electronics, Informatics, and Vocational Education)*, *7*(1), 27–40. https://doi.org/10.21831/elinvo.v7i1.44425

Nurjannah, L., & Sucahyo, I. (2022). Development of RLC Teaching Aids as Learning Media for Alternating Voltage Circuits to Improve Student Learning Outcomes. *Prisma Sains : Jurnal Pengkajian Ilmu Dan Pembelajaran Matematika Dan IPA IKIP Mataram*, *10*(3), 647. https://doi.org/10.33394/j-ps.v10i3.5393

Prastiwi, M. N. B., & Laksono, E. W. (2018). The ability of analytical thinking and chemistry literacy in high school students learning. *Journal of Physics: Conference Series*, *1097*, 012061. https://doi.org/10.1088/1742-6596/1097/1/012061

Putranta, H. (2019). Synthesis of the Cognitive Aspects' Science Literacy and Higher Order Thinking Skills (HOTS) in Chapter Momentum and Impulse. *Journal of Physics: Conference Series*, *1397*(1), 012014. https://doi.org/10.1088/1742-6596/1397/1/012014

Rosenberg, J., & Lawson, M. (2019). An Investigation of Students' Use of a Computational Science Simulation in an Online High School Physics Class. *Education Sciences*, *9*(1), 49. https://doi.org/10.3390/educsci9010049

Sagala, P. N., & Andriani, A. (2019). Development of Higher-Order Thinking Skills (HOTS) Questions of Probability Theory Subject Based on Bloom's Taxonomy. *Journal of Physics: Conference Series*, *1188*, 012025. https://doi.org/10.1088/1742-6596/1188/1/012025

Samsu, N., Mustika, D., Nafaida, R., & Manurung, N. (2020). Analisis Kelayakan dan Kepraktisan Modul Praktikum Berbasis Literasi Sains untuk Pembelajaran IPA. *Jurnal IPA & Pembelajaran IPA*, *4*(1), 29–40. https://doi.org/10.24815/jipi.v4i1.15546

Siswanto, J., Suyidno, S., Mahtari, S., Fitriyani, F., Febriani, W., & Sari, E. (2023). The Barriers to Developing Students' Scientific Literacy in Learning Physics of Quantities and Measurements. *Jurnal Pendidikan Sains Indonesia*, *11*(2), 206–220. https://doi.org/10.24815/jpsi.v11i2.27767

Sugiarto, A., Sartika, R. P., Hl, N. I., & Syarifuddin, S. (2023). Development of E-Module Using ROPES Strategy Assisted with Sigil Software to Improve Students' Critical Thinking Skills. *Jurnal Kependidikan: Jurnal Hasil Penelitian Dan Kajian Kepustakaan Di Bidang Pendidikan, Pengajaran Dan Pembelajaran*, *9*(2), 633. https://doi.org/10.33394/jk.v9i2.7527

Susanti, V. D., & Krisdiana, I. (2021). The Effect of Literacy Skills on the Critical Thinking Skills of Mathematics Education Students. *AL-ISHLAH: Jurnal Pendidikan*, *13*(1), 72–79. https://doi.org/10.35445/alishlah.v13i1.371

Tuela, A. I., & Palar, Y. N. (2022). Analysis of Higher Order Thinking Skills (HOTS) Based on Bloom Taxonomy in Comprehensive Examination Questions. *Jurnal Kependidikan: Jurnal Hasil Penelitian Dan Kajian Kepustakaan Di Bidang Pendidikan, Pengajaran Dan Pembelajaran*, *8*(4), 957. https://doi.org/10.33394/jk.v8i4.5885

Vlachopoulos, D., & Makri, A. (2017). The effect of games and simulations on higher education: a systematic literature review. *International Journal of Educational Technology in Higher Education*, *14*(1), 22. https://doi.org/10.1186/s41239-017-0062-1

Wang, A. I., & Tahir, R. (2020). The effect of using Kahoot! for learning – A literature review. *Computers & Education*, *149*, 103818. https://doi.org/10.1016/j.compedu.2020.103818

Wang, J., Guo, D., & Jou, M. (2015). A study on the effects of model-based inquiry pedagogy on students' inquiry skills in a virtual physics lab. *Computers in Human Behavior*, *49*, 658–669. https://doi.org/10.1016/j.chb.2015.01.043

Wati, M., Safiah, S., & Misbah, M. (2021). How to train problem-solving skills in physics using authentic learning. *Journal of Physics: Conference Series*, *1760*(1), 012009. https://doi.org/10.1088/1742-6596/1760/1/012009

Winarto, W., Cahyono, E., Sumarni, W., Sulhadi, S., Wahyuni, S., & Sarwi, S. (2022). Science Teaching Approach Ethno-SETSaR to improve pre-service teachers' creative thinking and problem solving skills. *Journal of Technology and Science Education*, *12*(2), 327. https://doi.org/10.3926/jotse.1367

Yulkifli, Y., Risma, M., Festiyed, F., & Azis, H. (2023). Validity of e-module integrated scientific literacy using the smartphone-assisted IBL model to improve student competence. *Journal of Physics: Conference Series*, *2582*(1), 012051. https://doi.org/10.1088/1742-6596/2582/1/012051