RESEARCH ARTICLE

Profile and validity of PBL-SETS interactive multimedia to train learners' science literacy

Siti Addinul Nasihah[a,1], I. Isnawati[b,2,*], Hasan Subekti[a,3]

[a] Postgraduate – Science Education, Faculty of Mathematics and Natural Sciences, Universitas Negeri Surabaya, Jl. Ketintang, Ketintang, Gayungan, Surabaya, East Java 60231, Indonesia

[b] Postgraduate – Biology, Faculty of Mathematics and Natural Sciences, Universitas Negeri Surabaya, Jl. Ketintang, Ketintang, Gayungan, Surabaya, East Java 60231, Indonesia

[1] siti.23011@mhs.unesa.ac.id, [2] isnawati@unesa.ac.id*, [3] hasansubekti@unesa.ac.id

Abstract: The background of this research is the low science literacy of Indonesian students based on PISA results caused by non-contextual learning and conventional methods. This study aims to develop and validate an interactive multimedia program based on the Problem-Based Learning-Science, Environment, Technology, and Society (PBL-SETS) approach to train students' science literacy. This research uses an R&D (research and development) approach with define, design, develop, and disseminate (4D) model, which is limited to only the validation stage of development. Although many studies have shown the effectiveness of interactive multimedia in improving science literacy, the combination of PBL, SETS, and interactive multimedia still needs to be researched, especially in Indonesia. The results showed that the developed PBL-SETS interactive multimedia had very valid criteria, with an overall average score of 94.15%. These results indicate that PBL-SETS interactive multimedia is valid and feasible to be used as a learning alternative to train students' science literacy in school.

Keywords: interactive multimedia; PBL-SETS; science literacy

For correspondence:
isnawati@unesa.ac.id

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Introduction

The digital era has brought about significant changes in various aspects of human life (Rahayu, 2017). The rapid development of technology has encouraged people to continue adapting to dynamic changes, especially to improve the quality of life (Santos et al., 2021). It transformation also has a significant impact on the world of education, requiring a paradigm shift from traditional learning models to approaches that are more innovative and relevant to the demands of the 21st century (Sekarsari & Aznam, 2019; Thornhill-Miller et al., 2023). In this context, science literacy emerges as one of the essential competencies that learners need to master. Science literacy includes understanding scientific concepts and the ability to think critically, evaluate, and apply scientific knowledge in everyday life (Bramastia & Rahayu, 2023; Sholikah & Pertiwi, 2021; Virtič, 2022).

The Organization for Economic Cooperation and Development (OECD) defines science literacy as competence in formulating explanations of scientific phenomena, evaluating and designing scientific investigations, and interpreting scientific data and evidence (OECD, 2018). In other words, science literacy equips learners with the necessary tools to make rational and responsible decisions in both personal and public contexts, especially in the face of various global challenges (Awaludin et al., 2024). Based on the Program for International Student Assessment (PISA) measurement results related to science literacy, Indonesia shows an interesting pattern to study. In the most recent PISA assessment uploaded in 2022, although Indonesia experienced an increase in rank, the resulting score was relatively stable or slightly decreased compared to the PISA assessment (OECD, 2023b; Schleicher, 2023). This phenomenon reflects a global trend, where almost all PISA-participating countries experienced a decrease in scores in various aspects of the assessment after the COVID-19 pandemic. This shows that the challenge of improving science literacy is not only faced by Indonesia but is also a global concern that requires a comprehensive strategy.

According to research conducted by Sholikah and Pertiwi (2021), in addition to non-contextual learning, several other factors cause low science literacy, including conventional learning methods, lack of interest in reading, and weak understanding of basic concepts that students possess. A similar phenomenon was identified through a case study in one of the schools in Tulungagung. The results of interviews with biology teachers revealed that the learning process was still dominated by traditional methods, which focused on the delivery of government textbook-based material. In this case, the implementation of contextual learning still needs to be improved, especially for materials that are conceptual and difficult to visualize concretely (Hero & Lindfors, 2019; Verhoef et al., 2015). Although the school has adequate technological facilities, optimizing their use in learning has yet to be achieved. This condition has a significant impact on the understanding of biological concepts and the level of scientific literacy of the students, as reflected in the results of the scientific literacy test, which shows that 45.45% of the students are in the low category, 50% in the medium category and only 4.55% reach the high category. This data indicates the urgency of changing the learning approach, which needs to be more comprehensive and contextualized to familiarize students with science literacy.

To develop science literacy, students need a comprehensive understanding of science learning using appropriate models according to the learning objectives (Townley, 2018). Therefore, innovative and relevant learning, such as problem-based learning (PBL), is needed to address these issues. PBL model provides a concept that involves students in solving real-world problems and is relevant to their daily lives (Sulistiyo et al., 2021). In this case, the teacher is a facilitator, providing direction and guidance as needed (Ghani et al., 2021; Sunnemark et al., 2023). Such a learning process promotes the development of students' higher-order thinking skills, which are essential for understanding and analyzing complex scientific problems. Thus, students can gradually improve their scientific process skills, including explaining scientific issues and everyday scientific phenomena and using scientific data (Nainggolan et al., 2021).

However, the PBL implementing often has significant limitations. Rachmawati and Rosy (2021) identified two main weaknesses of PBL, i.e. the incompatibility of model with theoretical learning materials and the challenges in managing the heterogeneity of students in groups. These limitations can affect learning effectiveness and the achievement of expected learning objectives. To overcome these limitations, the Science, Environment, Technology, and Society (SETS) approach can be one of the potential solutions. The SETS approach provides a learning framework that integrates abstract concepts with real-world situations (Nisa et al., 2021) so that learning remains contextual and meaningful. The characteristics of SETS, which combine factual knowledge with scientific attitudes, also help students to understand theoretical material through a more comprehensive perspective (Yulistiana, 2015).

On the other hand, Khasanah (2015) says that SETS approach can be a solution to overcome the challenges of group heterogeneity in the implementation of PBL due to their flexibility in adapting learning to the needs and abilities of students. Thus, integrating the SETS approach can complement and strengthen the effectiveness of problem-based learning. The SETS approach emphasizes connecting science to everyday life and developing critical, creative, and collaborative thinking skills (Yulianti & Herpratiwi, 2024). Thus, students can better understand relevant scientific issues by integrating environmental, technological, and social aspects into the learning process (Sulistiyo et al., 2021). This is in line with the goals of contextualized learning. In addition, to avoid conventional teacher-centered learning, SETS learning also offers aspects of technology as a tool for delivering learning materials and solving problems. In this context, technology is not only an object of learning but also a means to increase the effectiveness and relevance of science education (Mahlianurrahman et al., 2023).

In this context, technology suitable for learning is needed to support the effective implementation of PBL-SETS, one of which is interactive multimedia. Interactive multimedia is often referred to as multimedia for learning (MPI). According to Surjono (2017), MPI is an integrated learning program that combines two or more media elements such as text, images, sound, video, and even animation and simulation. This program aims to engage with learning materials through computers or similar devices. Thus, certain learning can be created interestingly and effectively. Im and Park (2014) showed that learning through web-based interactive multimedia is an effective method in the educational process. This approach allows students to learn more actively without being limited by time and place.

In contrast to conventional methods, web-based learning provides high flexibility. Thus, learning can focus on each learner's needs (El-Sabagh, 2021). From the teacher's perspective, learning with interactive multimedia offers many advantages. Teachers can easily prepare quality learning materials without being limited by time and space. The variety of applications and online resources available supports this. Therefore, teachers can focus more on developing creativity and innovation in learning (Haleem et al., 2022).

Several studies are related to developing interactive multimedia to train and improve students' science literacy. In their research, (Hapsari et al., 2020) developed interactive multimedia focusing on gravity and aimed at science literacy. The results showed that the product was rated as very valid, with a high percentage of validity in both media and content coverage. In addition, pre-service physics teachers responded very positively to the developed multimedia, especially in improving science literacy. Furthermore, in their research, Ahied et al (2020) says that developed interactive multimedia led science literacy improvement by presenting physics material. The results showed that interactive multimedia proved to be effective in improving science literacy and students' interest in learning physics concepts. Widodo et al (2020) says that the effectiveness of gadget-based interactive multimedia are able to improve the science literacy of zoomers' students. The results showed that interactive multimedia effectively improved students' science literacy. In addition, students responded positively to interactive multimedia but suggested improvements in visuals, audio, and music. In their research, Shofawati et al (2023) describe the effect of interactive multimedia on energy flow material on students' science literacy in the new normal era and find out students' responses to learning. The results showed that interactive multimedia learning on energy flow received positive student responses and could improve science literacy skills in the new normal era.

Based on the explanation presented, it can be understood that PBL can encourage students to think critically, solve problems, and actively construct knowledge (Sari et al., 2021). On the other hand, the SETS approach provides a relevant context for science learning by linking scientific concepts to issues in various fields (Mahlianurrahman et al., 2023). Meanwhile, interactive multimedia can present information in an interesting, interactive, and flexible way to increase students' learning motivation (Sidabutar & Sembiring, 2023). In addition, previous research also mentioned that PBL and SETS approach have proven to be effective in teaching students science literacy. In 21st-century learning, interactive multimedia has also been recognized as a potential tool to support learning. However, research investigating the integration of these three elements still needs to be completed, especially in the Indonesian educational context. Combining these three elements has excellent potential to develop students' scientific literacy.

The great potential of PBL-SETS, interactive multimedia, and the potential of schools, this research aims to develop PBL-SETS-based interactive multimedia to train students' science literacy. The research will focus more on testing the built interactive multimedia's validity to ensure that the materials and activities presented meet the learning objectives and can train students' science literacy. Specifically, the material presented in the interactive multimedia is virus material. This material was chosen because it is still relevant to the current situation, namely the endemic period, which is a sign of the end of the COVID-19 pandemic.

The development of this interactive multimedia relates to the science literacy competencies of the PISA 2025 framework. These competencies consist of (1) explaining scientific phenomena, (2) constructing and evaluating designs for scientific inquiry and critically interpreting scientific data and evidence, and (3) researching, evaluating, and using scientific information for decision-making and action (OECD, 2023b). Thus, the students' worksheet learning activities and science literacy tests presented in interactive multimedia are designed to measure the extent to which students have achieved science literacy competencies according to international standards. This research aims to develop multimedia learning that are expected to be used by teachers in the classroom to improve the quality of science learning through combining PBL and SETS approach.

Method

Reasearch design

This type of research uses the research and development (R&D) method. This interactive multimedia development research design applies the 4D model, which consists of four steps i.e. define, design, develop, and disseminate (Thiagarajan et al., 1976). This research was conducted at the Postgraduate Study Program of Science Education, Universitas Negeri Surabaya.

Context and participants

This research was involved Islamic Senior High School of Al-Azhaar – Tulungagung, as the research subject. Adopting the 4D development model, this research begins with an in-depth analysis of learners' learning needs through in-depth interviews with biology teachers in the school. The results of this analysis can eventually be used to formulate specific learning objectives that meet the needs of the students.

The most effective media for delivering complex science literacy materials are selected in the design phase. Aesthetic and interactivity considerations also play a role in the design of the visual appearance and interactive features. The prototype was then developed based on the design prepared. The third stage is the development stage, which includes product validation by experts and revision based on suggestions or input from the validation results. This research is limited to developing and validating products through interactive multimedia for science literacy training. Validation was conducted by three validators: two expert lecturers and one biology teacher. The input from each validator is used to improve and refine the product until it meets the validity criteria. Thus, the final product, interactive multimedia, is ready to be used in learning science literacy.

Data Source

The data collection method uses the validation method. The data used in this study comes from non-test instruments developed by researchers. The instruments used to collect data on the validity of interactive multimedia are validation sheets for interactive multimedia components in general, validation sheets for students' worksheets (LKPD) as learning activities, and validation sheets for science literacy tests as evaluations.

Data Analysis

The results of the interactive multimedia validation were analyzed quantitatively and descriptively. The validity analysis is obtained by collecting validator scores, which are then calculated as percentages. Validation data for product development is determined using a Likert scale in Table 1.

Table 1. Scoring criteria

Score	Assessment Criteria
5	Very Good
4	Good
3	Moderately
2	Less
1	Very Less

The percentage of the validation score is calculated using Formula 1, then the results are interpreted based on the provisions in Table 2.

$$p = \frac{\sum x}{\sum x1} \times 100\% \quad (1)$$

Description:
P = Percentage
∑x = Number of validator scores in an aspect
∑x1 = Maximum number of scores in an aspect
100% = Constant number

Table 2. Score interpretation criteria

Score (%)	Interpretation Criteria
81 - 100	Very Valid
61 - 80	Valid
41 - 60	Moderately Valid
21 - 40	Less valid
0 - 20	Invalid

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Results and Discussion

This development research with the 4D model aims to produce products in the form of PBL-SETS-based interactive multimedia to train students' science literacy with valid criteria. The interactive multimedia is systematically organized and structured with a focus on relevant virus issues so that teachers can use it as teaching materials and teaching media related to virus material when learning takes place in class. In addition, this product is flexible enough to allow students to learn independently outside of school hours.

The Define Stage

Development process was beginning with the define stage, which involves a series of in-depth analyses of students' learning needs through interviews with biology teachers at Al-Azhaar. This defined stage includes beginning-end analysis, learner analysis, concept (material) analysis, task analysis, and specification of learning objectives. The main purpose of this stage is to formulate the learning problems that need to be overcome and to determine the specifications of the development products that meet the needs.

Based on the interviews with the biology teachers, it was found that there needed to be a greater gap between the potential of the school resources and the implementation of learning. According to the teacher's explanation, classroom learning is still dominated by conventional methods (Figure 1.a), relying on textbooks as the main learning resource. Although the school has adequate computer lab facilities (Figure 1.b), the teachers admit its use is still limited to ICT subjects and has yet to be optimized in another subject, especially in biology learning.

(a) (b)

Figure 1. Disparity between the school's potential resources and their actual implementation in biology learning (a) conventional learning conditions in biology classrooms with limited interaction and use of technology (b) computer lab facilities that have yet to be optimally utilized in biology learning

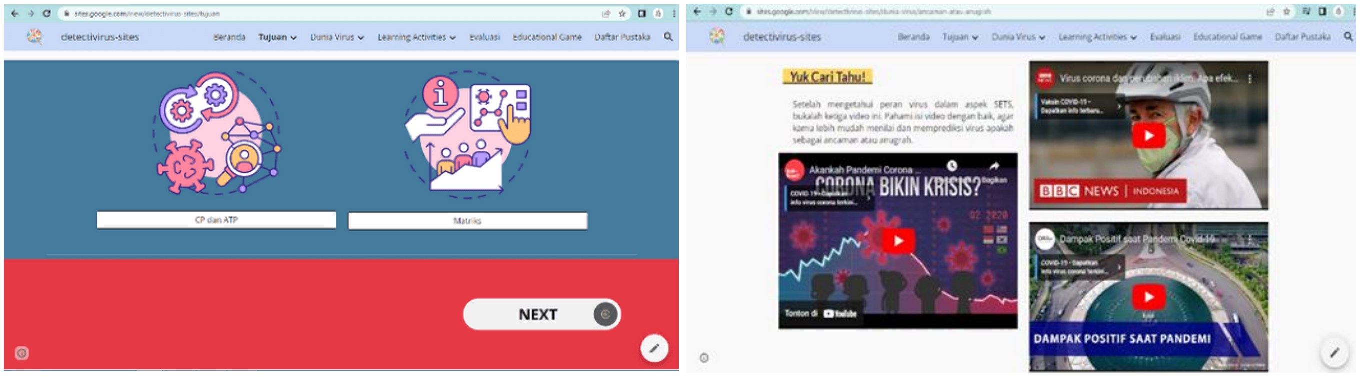
The results of the beginning-end analysis through interviews revealed several learning challenges. Firstly, the delivery of virus material is still done conventionally and does not actively involve students. Moreover, teachers recognize the importance of contextualized learning, which integrates current issues but experiences barriers to implementation. Lastly, based on teachers' observations, students' shows greater interest in material presented interactively and contextually. Implementing the Merdeka Curriculum allows teachers to determine the learning process (Kemendikbudristek, 2022), and teachers say that curriculum flexibility opens up opportunities for more innovative learning development. Learner analysis shows the need for more interactive and visual learning, especially for abstract virus material. The conceptual analysis led to selecting virus material as a focus for development because of its alignment with the learning outcomes and its relevance to students' lives.

The task analysis formulated with the teacher resulted in the design of learning activities that include information gathering, data analysis, and decision-making to train scientific literacy. Learning is planned in four sessions, covering virus characteristics, replication mechanisms, the role of viruses in life, and strategies for preventing viral diseases. Based on the comprehensive analysis results, PBL-SETS-based interactive multimedia has been developed that not only focuses on the presentation of material but is also equipped with learning activities and assessments tailored to science literacy competencies. This development aims to optimize the use of available technological facilities while meeting the needs of contextual learning. The interactive multimedia is designed to integrate aspects of science, environment, technology, and society, hoping that it can support learning to train students' science literacy through a problem-based learning approach by the input and needs provided by biology teachers.

The Design Stage

The design stage includes instrument preparation, media selection, format selection, and initial product design. In this stage, the instrument consisted of three validation sheets, including a validation sheet that evaluates the interactive multimedia components in general, a validation sheet that evaluates the students' worksheet as a learning activity, and a validation sheet that evaluates the science literacy test as an assessment. The interactive multimedia developed in this study uses one of Google's site builder services, Google Sites. Learning through the use of Google Sites can have many benefits for both students and teachers. Rajeshwari et al (2021) says that Google Sites as interactive learning media can make learning more interesting. Teachers can easily store learning materials (autosaved, which is easily recovered), and students get more diverse learning materials easily and quickly. In addition, Google Sites have other advantages, such as being user-friendly, easily connected to other Google services and various other interactive online elements, and highly compatible and adaptable to learning needs (Ramadannisaa & Hartina, 2021).

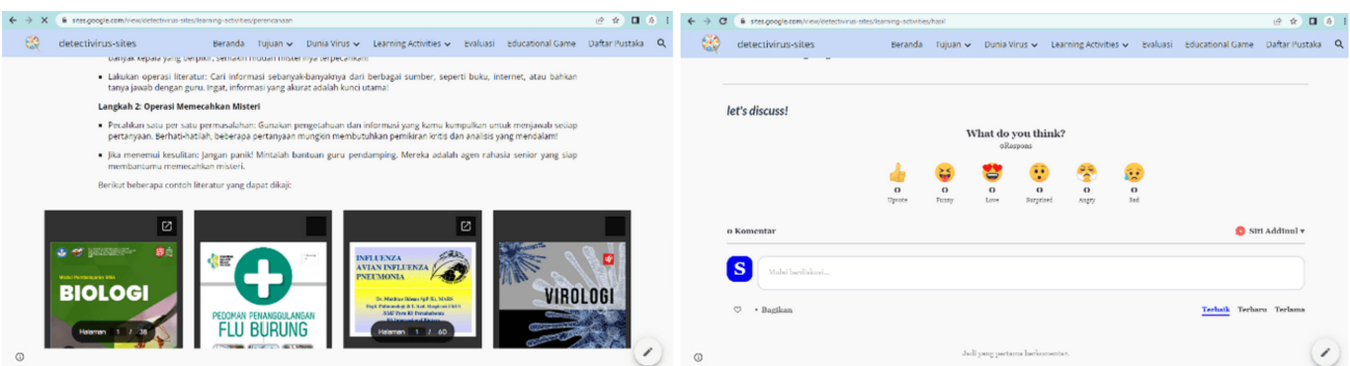
The choice of the interactive multimedia format is adapted to the characteristics of the virus material and the set learning objectives, namely, the training of scientific literacy based on the scientific competencies in the PISA 2025 framework (OECD, 2023a). The content related to the virus material is presented based on learning outcomes (CP), flow of learning objectives (ATP), and SETS aspects. In addition, learning activities include the presentation of learner worksheets and assessments in the form of science literacy tests that relate to science literacy competencies. The learning activities are also adapted to the PBL syntax with concepts integrated with SETS approach.



(a) (b)

Figure 2. Interactive multimedia display; (a) displays of navigation button of interactive multimedia, (b) integrated contextual problem to stimulate students' scientific literacy.

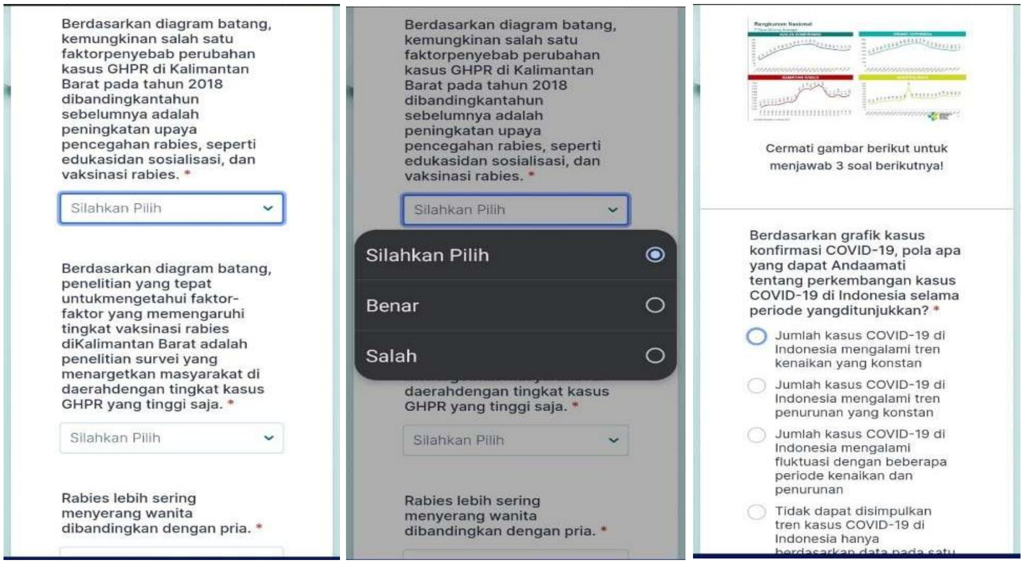
This interactive multimedia is designed with a user-friendly interface and intuitive navigation (Figure 2.a). The main page or home page becomes the entry point for users, presenting an attractive appearance with general information about the product. The main menus are displayed so users can easily access the desired content. The learning objectives lied in "*tujuan pembelajaran"* menu. It provides a detailed description of the learning objectives to be achieved, ranging from learning outcomes (CP) to science literacy skills (Figure 2.b). The core virus-related material is systematically presented in the "*Dunia Virus*" menu, where the material is divided into several subtopics relevant to the learning objectives. One of the interesting features of this interactive multimedia is the learning activities menu, which invites users to participate actively in the learning process. This menu provides various learning activities based on PBL syntax. Users can find learning worksheets, related literature, and online discussion platforms on this menu. Thus, users are not only passively receiving information but are also invited to interact more deeply with the learning material.



(a) (b)

Figure 3. Interactive multimedia features to develop students' scientific literacy; (a) a scientific design investigation through PBL model, (b) students' open space to peer-discuss.

This interactive multimedia is an innovative learning medium to develop students with comprehensive science literacy. In line with the PISA 2025 framework, this media focuses on three main aspects of science literacy, i.e. (1) explaining phenomena scientifically; (2) developing and evaluating designs for scientific inquiry and critically interpreting scientific data and evidence; and (3) researching, evaluating, and using scientific information for decision-making and action (OECD, 2023c). Therefore, the interactive multimedia is equipped with several interesting features. Firstly, to facilitate the ability to explain phenomena scientifically, in-depth material on viruses is presented, equipped with interactive visual animations and real case studies related to disease outbreaks. Furthermore, to train students in designing scientific investigations, a module related to virus material and the types of experiments that can be carried out on viruses is provided. In addition, a link to the learner worksheet related to these activities is presented as a practice of conducting scientific investigations (Figure 3). Lastly, to foster the ability to make decisions based on scientific evidence, various problem scenarios related to viruses are presented along with authentic data (Figure 4). Students are invited to analyze data, evaluate information, and make the right decision. The worksheet also presents activities for making decisions related to virus prevention. In addition, the online discussion feature allows students to share opinions and collaborate with peers.



(a) (b) (c)

Figure 4. Science literacy test display; (a) science literacy test display on interactive multimedia, (b) some questions with true-false format (phone display), (c) questions with authentic data analysis.

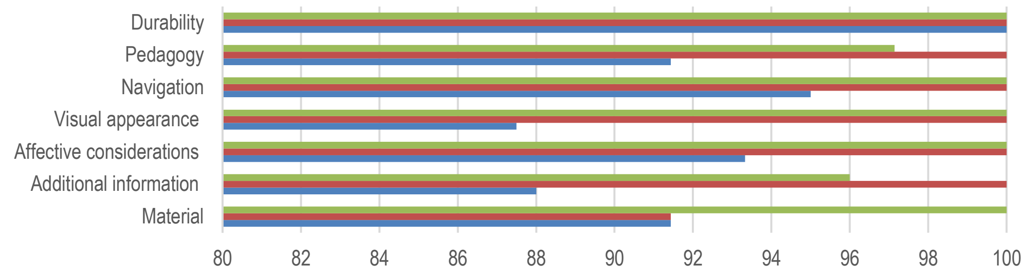
The Development Stage

The third stage is the development stage, which includes product validation by experts and revision based on suggestions or input from the validation results so that the product can be feasibly used in the learning process. In this case, the validation conducted can also identify the shortcomings or weaknesses of the product before its use. The validation process involves a thorough evaluation of the product from various aspects, including content (material), presentation (design), and language (Rofieq et al., 2021).

Validity of interactive multimedia

According to Surjono (2017), interactive learning multimedia quality assessment can be evaluated based on content, instruction, and display. In this case, the three aspects can be translated into seven more detailed aspects. The content and material presented must be relevant to the learning objectives, appropriate for the students, and have a logical structure (Li et al., 2022). Furthermore, auxiliary information, which is additional information such as hints and conclusions, should be clear and support the main material (Reece, 2005) while the affective considerations aspects such as learning motivation, need to be considered (Efklides, 2014; Greenstein, 2012). The other aspects should be considered is the interface's appearance. As a primary component, it must be attractive and easy to use by paying attention to visual, audio, and video elements (Khaleyla et al., 2021). Moreover, the multimedia navigation, which is the navigation that must be simple and consistent so that users can easily use it (Sadeghi et al., 2022). The final aspects are pedagogy (learning methodology, interactivity, and feedback) and product durability to function (Kho & Chen, 2017; Ramadannisaa & Hartina, 2021). All these aspects need to be evaluated by material experts and media experts. The PBL-SETS-based interactive multimedia developed by the researchers has validation results, as shown in Figure 5.

The results of the validation of PBL-SETS-based interactive multimedia show a high level of validity, with an average score of more than 80%. Overall, the average validation percentage for material aspects is 94.29%, additional information 94.67%, affective considerations 97.78%, visual appearance 95.83%, navigation 98.33%, pedagogy 96.19%, and durability 100%. Thus, the final percentage of interactive multimedia validation is 96.73%, with very valid criteria. This shows that the developed interactive multimedia products met the expected quality standards.



	Material	Additional information	Affective considerations	Visual appearance	Navigation	Pedagogy	Durability
Validator 3	100	96	100	100	100	97,14	100
Validator 2	91,43	100	100	100	100	100	100
Validator 1	91,43	88	93,33	87,5	95	91,43	100

Validator 3 Validator 2 Validator 1

Figure 5. Validation results of interactive multimedia

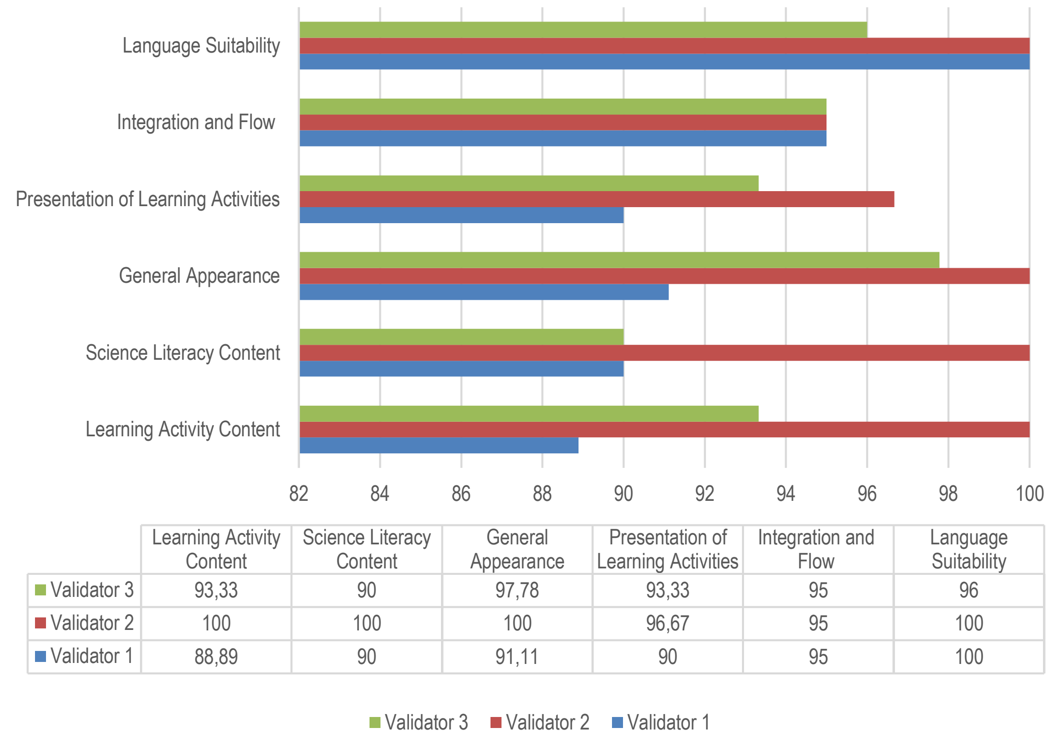
Further analysis showed that the pedagogy and robustness aspects received the highest average scores, 97.14%, and 100%. This indicates that the learning design applied to the interactive multimedia is based on the principles of effective learning, and this product has good durability for long-term use. Meanwhile, the visual appearance aspect received the lowest average score, 93.96%. Overall, the validators rated the interactive multimedia positively, indicating that all components were satisfactory and comprehensive. However, the validation results also showed some constructive feedback that needs to be considered to improve the quality of this interactive multimedia. In particular, the validators highlighted the visual design aspects that need to be improved. The design of the learning objectives menu needs to be improved to make it more attractive and informative. In addition, the font size on the CP and ATP sentences could be more optimal. It is recommended that the font size be increased or that a thicker font be used to make the text easier to read and understand by users, especially those with visual impairments.

Another input that needs to be considered relates to the science literacy competency matrix presentation. Validators suggested that the matrix be presented more comprehensively and visually. It is important to provide users with a clear picture of how each feature and activity in this interactive multimedia relates to each science literacy competency to be trained according to the PISA 2025 framework. This way, users can more easily understand how this interactive multimedia can help them develop science literacy skills.

Validity of students' worksheets

The students' worksheet validation results show that the average percentage of scores obtained is more than 80% in each aspect of the assessment (Figure 6). Overall, the average percentage of validation for the content aspect of learning activities is 94.07%, science literacy content is 93.33%, presentation of general appearance is 96.3%, presentation of learning activities is 93.33%, language integration and flow is 95%, and language proficiency is 98.66%. Thus, the final percentage of validation of worksheet is 94.84%, based on very valid criteria. This shows that the developed worksheet has met the expected quality standards.

Further analysis showed that the language appropriateness aspect received the highest average score, 97%. This indicates that the language used in students' worksheet is by good and correct Indonesian language rules and is easily understood by students. Meanwhile, the content aspect of learning activities received the lowest average score, 94.07%. Based on the validator's assessment, the developed worksheet met the PBL-SETS learning criteria for science literacy training in the context of virus material. However, the validation results also identified some areas for improvement. One of the main findings was the need for more clarity in the problem formulation at the beginning of the learning activities. More specific and challenging problem formulation can help students identify relevant variables, design experimental procedures, and achieve learning objectives. Therefore, a thorough revision of the worksheet is needed, especially in the problem formulation section. This revision ensures that the problem statement can effectively guide students in conducting scientific investigations to develop a deeper understanding of virus-related concepts (Figure 7).



	Learning Activity Content	Science Literacy Content	General Appearance	Presentation of Learning Activities	Integration and Flow	Language Suitability
Validator 3	93,33	90	97,78	93,33	95	96
Validator 2	100	100	100	96,67	95	100
Validator 1	88,89	90	91,11	90	95	100

Figure 6. Validation results of the students' worksheet

Figure 7. After improvement by presenting a column of questions related to problem formulation

Validity of science literacy test

On the evaluation menu page, PBL-SETS-based interactive multimedia presents a science literacy test. This test measures students' science literacy skills after completing the entire series of interactive multimedia lessons. The test is prepared based on the science literacy competencies in the PISA 2025 framework. Experts have validated 15 true-false and multiple-choice questions about viral materials. Validation was conducted to ensure the questions were relevant and accurate and could measure students' scientific literacy. The validation process includes assessment of content, presentation, and language aspects (Rofieq et al., 2021). In this case, the content aspect assesses the relevance of each question to science literacy competencies. Meanwhile, the presentation and language aspects assess whether each question is prepared according to the student's cognitive level, clear, easy to understand, and unambiguous. The results of the validation of the science literacy test can be seen in Figure 8.

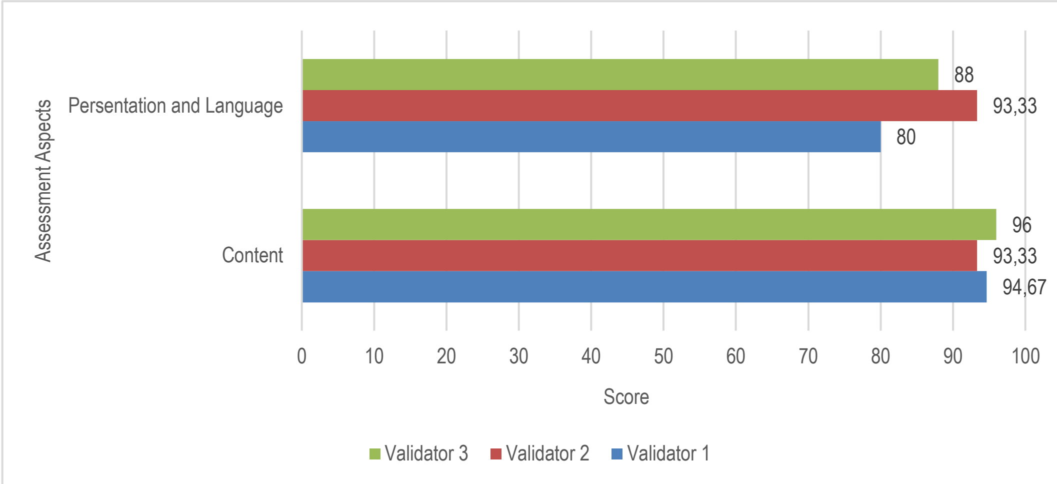


Figure 8. Validation results of the science literacy test

The results of the validation of the science literacy test showed that the average percentage of scores obtained for each aspect exceeded 80%. Overall, the average percentage of validation for the content aspect is 94.67%, while for the presentation and language aspect is 87.11%. Thus, the final percentage of the science literacy test's validation is 90.89%, a very valid category. This indicates that the developed science literacy test meets validity standards.

Further analysis showed that the content aspect received a higher average score than the presentation and language aspects. This indicates that the material presented in the test relates to the measured science literacy concepts (Glaze, 2018; Novick & Catley, 2016). In addition, based on the validators' assessment, the science literacy test developed by the researchers is consistent with the science literacy competencies described in the PISA 2025 framework. However, the validation results also showed that some areas need to be improved in this science literacy test. One aspect that needs attention is the technical consistency in the preparation of the questions. Some inconsistencies must be corrected to ensure that all questions have a balanced difficulty and format. In addition, the cognitive demands analysis showed that the test could be improved overall to stimulate higher-order thinking in students. Therefore, it is necessary to revise some questions to measure more complex cognitive skills (Dwyer et al., 2014; Greenstein, 2012).

Based on the feedback from the validators, there are important recommendations regarding the proportion of question types. The validators suggested increasing the number of questions that present virus cases in a more complex context by excluding questions that measure only basic understanding (C1 and C2). This change aims to measure students' ability to analyze, evaluate, and apply knowledge about viruses in more real-world situations. As a result, the resulting science literacy test is expected to provide a more accurate picture of students' overall science literacy.

Conclusion

The research findings indicate that the PBL-SETS-based interactive multimedia product meets the highly valid criteria (>80%). These findings are corroborated by the results of the validity of highly valid criteria across all components, namely the interactive multimedia component (96.73%), LKPD (94.84%), and the science literacy test (90.89%). Consequently, the overall validation results for the interactive multimedia developed by researchers yielded an average score of 94.15%. Therefore, the developed product is suitable for implementation in the educational process at the school level.

This research contributes to the development of innovative learning media. However, further research is needed to test the direct implementation of interactive multimedia on students. Such a test could provide data on the impact of using interactive multimedia on improving students' science literacy. In addition, further research is needed on integrating PBL-SETS in other topics to improve science literacy. This would enable a broader generalization of the research findings.

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Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

Author Contributions

S. A. Nasihah: methodology; analysis; writing original draft preparation; and review and editing. **I. Isnawati:** review, editing and lecture. **H. Subekti:** review, editing and lecture.

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