Jambura Journal of Educational Chemistry
Volume 7 Issue 2, August 2025
p-ISSN: 2655-7606, e-ISSN: 2656-6427
Journal Homepage: http://ejurnal.ung.ac.id/index.php/jjec

Development of Teaching Modules Based on Problem Based Learning Integrated with Scientific Literacy on Acid Base Material

Ilham Septiana[1*], Ratna Sari Siti Aisyah[1], Nela Fatmasari[1]

[1]*Universitas Sultan Ageng Tirtayasa, Serang 42163, Indonesia*

Article Info

Article history:
Received: 03-02-2025
Revised: 27-06-2025
Accepted: 16-08-2025
Available online: 22-08-2025

Keyword:
Teaching Module; Problem Based Learning; Scientific Literacy; Acids and Based.

***Corresponding author:**
ilhamseptiana38@gmail.com

Abstract

Scientific literacy in Indonesia is not yet a major concern, this is proven by data from the Program for International Student Assessment (PISA) which shows that Indonesia's scientific literacy ranking is in 71st position out of 77 countries. The Problem Based Learning (PBL) model is a learning model that can improve students' scientific literacy skills in explaining problems in everyday life, including those related to acids and bases, based on scientific data. The PBL model is suitable for application in an independent curriculum. One of the problems faced by educators in the independent curriculum is a lack of understanding in compiling teaching modules. The aim of this research is to develop a teaching module based on problem-based learning integrated with scientific literacy in acid-base material. This research is research and development research with the ADDIE model (analysis, design, development, implementation, evaluation). Data collection techniques used validation tests from material experts, media experts and limited trials on 30 students. Analysis of validation data using the Aiken's formula with a V table value of 0.79. The research results show that the Vcount value ≥ Vtable, the material validation Vcount value is 0.88, while the media validation value is 0.90 so it can be declared valid. The limited trial for students obtained a percentage score of 91.18% in the "very good" category. Based on the research results, the teaching module developed was declared valid and suitable for use as a learning tool.

How to Cite: Septiana, I., Aisyah, R. S. S., & Fatmasari, N. (2025). Development of Teaching Modules Based on Problem Based Learning Integrated With Scientific Literacy on Acid Base Material. *Jambura Journal of Educational Chemistry, 7*(2), 53-63. https://doi.org/10.37905/jjec.v7i2.30460

1. INTRODUCTION

Chemistry is a branch of natural science that studies matter, its structure, properties, changes or reactions, and the energy involved in these changes. Chemical concepts are often difficult to understand because of their abstract nature, so many students feel that their benefits in everyday life are limited. This is due to the lack of connection between chemistry learning and everyday life, so that learning becomes less meaningful (Hadinugrahaningsih et al., 2019) . In chemistry learning, there are three representations, namely macroscopic, microscopic and symbolic, which are challenges for students (Rahmawati, 2023). The rapid development of science and technology has an impact on science education which is more focused on increasing scientific literacy and chemical literacy (Nurisa & Arty, 2019).

Science literacy is the focus of development in developed and developing countries today in the field of science education (Fadly et al., 2022) . In the context of 21st-century competencies, scientific literacy constitutes a fundamental skill that individuals are expected to acquire, complementing other crucial abilities such as creativity, innovation, critical and analytical thinking, problem-solving aptitude, effective communication, collaborative capacity, information and technology literacy. Science education, especially chemistry, can be a facility in improving 21st century skills, one of which is science literacy (Setyasih et al., 2022) . Science literacy

https://doi.org/10.37905/jjec.v7i2.30460

in Indonesia is still not a major concern, this is evidenced by the latest data from *the Organization for Economic Cooperation and Development* (OECD) in 2022 through *the Program for International Student Assessment* (PISA) Indonesia is included in the 20 countries with the lowest science literacy skills (Kemendikbudristek, 2023). The ability to analyze and implement scientific concepts in everyday problem-solving necessitates that students acquire strong science literacy competencies (Jufrida et al., 2019) . This is because the problem-solving process in the context of everyday life will lead students to understand scientific concepts in depth, training them to think critically, creatively and scientifically in responding to various problems in everyday life. One of the factors that causes students' low scientific literacy skills is the inappropriateness of the learning models and methods used (Jusniar et al., 2024).

The use of learning models in the classroom has an influence on learning success (Dirmanto et al., 2021) . The use of conventional learning models is still often used in chemistry learning, causing students to be less involved in argumentation related to problems, resulting in minimal interaction (Mufhtih et al., 2021) . It is essential that the learning process facilitates the cultivation of critical and creative thought in students (Agus Supriyadi et al., 2023) . The *Problem Based Learning* (PBL) learning model is a learning model that can improve students' scientific literacy skills in explaining problems in everyday life based on scientific data (Ardianto & Rubini, 2016) . Scientific literacy is the ability to use scientific knowledge to make decisions, solve problems, and understand scientific issues relevant to everyday life. The PBL model conceptually supports the development of scientific literacy because it places students at the center of learning. PBL learning activities are characterized by the presentation of contextual problems relevant to everyday life. Through the PBL learning process, students are encouraged to identify and formulate problems, explore scientific information, design scientific investigations, and evaluate problem solving.This is emphasized by the study of the effect of PBL on scientific literacy skills by Setyasih (2022) which found that the implementation of the PBL model positively affects students' scientific literacy skills, as reflected in the disparity of posttest scores between the groups receiving the treatment and those that did not.

Chemistry learning can be integrated into science literacy because chemistry learning involves contextual experiences in everyday life (Yulita & Amelia, 2020) . Learning chemistry is of great significance for students, considering the discipline's strong association with various phenomena encountered in daily life (Rahmawati et al., 2024) . Acids and bases are one of the 11th grade chemistry materials that are closely related to human daily life (Azizah et al., 2021) . Acid-base material contains dimensions of factual, conceptual and procedural knowledge (Yani et al., 2020) . Based on research conducted by Handayani (2022), most students consider acid-base material to be difficult material, especially if it is only explained using the lecture method, a learning method is needed that can direct students to be active and can solve a problem.

Based on the results of Siregar's research (2020), there is a positive and significant correlation between the level of student activity in the learning process and the results of learning achievement when using problem-based learning methods on acid-base material. The PBL model is one of the most widely used learning models in class and is suitable for application in the implementation of the independent curriculum (Arsyad & Elsya Febiana, 2023).

Currently, the independent curriculum is being used, which is a replacement for the 2013 curriculum. The independent curriculum is a curriculum that gives educators the freedom to be more creative and innovative in preparing learning that is expected to maximize the potential of students (Jannah & Rasyid, 2023) . The change in curriculum has an impact on changes in several things, one of which is the naming of the Learning Implementation Plan (RPP) in the 2013 curriculum as a teaching module in the independent curriculum. The teaching module is a learning tool that can be used to help direct the course of learning because it contains a learning implementation plan (Syahidi et al., 2023).

Ideally, an educator should be able to create good and relevant teaching modules, but in fact there are still educators who do not understand how to compile independent curriculum teaching modules . If educators cannot compile teaching modules properly, it is feared that the delivery of learning materials to students will not run well and systematically, so that learning will seem uninteresting and students will tend to get bored (Maulida, 2022).

https://doi.org/10.37905/jjec.v7i2.30460

Based on the explanation explained above, this study aims to develop a teaching module based on problem-based learning integrated with scientific literacy on acid-base material.

2. METHOD

The type of research used is a type of development research or R&D (*Research and Development*) by adapting the ADDIE development model (*Analysis, Design, Development, Implementation, Evaluation*). The ADDIE research model consists of five interrelated stages, namely analysis, design, development, implementation, and evaluation (Cahyadi, 2019). Research data were obtained from the results of the analysis of educators' needs, the results of media and material expert validation of the developed module and the results of student responses after a limited trial. Thus, the instruments used to collect research data include the educator needs analysis questionnaire sheet, The material expert validation document, the media expert validation document, and the questionnaire used to obtain student responses.

In the early stages of data collection, an analysis of educator needs was conducted. The data analysis technique from the results of filling out the educator needs analysis questionnaire was processed using the percentage formula (Sugiyono, 2018).

$$P = \frac{F}{n}\ x\ 100\% \quad (1)$$

P = Percentage
F = Frequency indicating how much Lots selected option
n = Total number Respondent

At the design or creation stage of the teaching module, the Canva application is used to compile and edit the appearance of the teaching module before the validation process is carried out at the development stage.

At the development stage, data collection was carried out through assessment of teaching modules by media expert and material expert validators using media expert and material expert validation sheets. Data analysis for the feasibility test of the teaching module being developed is by using the following Aiken's formula:

$$V = \frac{\Sigma s}{[n(c-1)]} \quad (2)$$

Information :
V = validity content .
S = Score given by each validator minus score lowest in the category that used (s = rI , with r = score given by the validator and I = score lowest scoring).
n = Number of validators.
c = Amount categories selected by the validator (Wasthi & Loka, 2023).

The validators in this study were 6 people with 5 scale options and an error rate of 5% or $p < 0.05$ so that the V value obtained was at least 0.79 to be declared valid.

Table 1 Aikens table V value decisions

V Table Value	Information
V ≥ 0.79	Valid/fit for use
V ≤ 0.79	Invalid/Not suitable for use

The implementation or application of the teaching module was carried out at SMAN 1 Cilograng involving 30 grade XII students. The response questionnaire given to students was in the form of a Likert scale. The Likert scale used was a 5-scale form in the form of alternative answer choices. After obtaining the results of the student response questionnaire, the results of the questionnaire were then calculated using the following Practicality Percentage formula:

$$P = \frac{fi}{n} \times 100\% \quad (3)$$

Information :
P = Percentage practicality
fi = Total Score
n = Maximum score value to i

The percentage value produced is in accordance with the calculation of the formula, adjusted to the values and criteria with the categories in the following table:

Table 2. Percentage Result Category

Percentage	Category
81 – 100	Very good
61 – 80	Good
41 – 60	Enough
21 – 40	Not enough
0 – 20	Very less

(Arini & Lovisia, 2019).

3. RESULT AND DISCUSSION

3.1. Result

Following shown result data research conducted in accordance with The stages of the ADDIE model consist of from stage analysis, stage design, stage

https://doi.org/10.37905/jjec.v7i2.30460

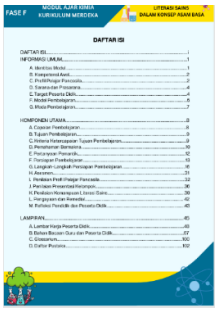
development, stage implementation and stages evaluation. Stage First that is stage analysis, at the stage This done three stages analysis, namely analysis need educator, analysis curriculum independence and analysis studies literature.

Table 3. Results of the analysis of educator needs

Results of needs analysis
1. Teaching modules are one of the teaching tools that are often used in chemistry learning.
2. The PBL-based learning model is one of the approaches applied in chemistry learning.
3. PBL-based learning models can help in chemistry learning.
4. Scientific literacy skills are a very important aspect for students to have.
5. Acid-base material can be linked to the concept of scientific literacy
6. Learning acid-base chemistry can be linked to events in everyday life.
7. The availability of teaching modules using the PBL learning model is still insufficient/not yet available.
8. Educators agreed to develop a PBL-based teaching module integrated with scientific literacy on acid-base material.

At the stage second that is stage design, teaching modules are designed and arranged at stage This. The teaching module contains acid-base material integrated with everyday phenomena related to the topic. Furthermore, the module presents problems related to daily life that must be solved by students. The teaching module has been developed in accordance with regulations issued by the Ministry of Education.. As for the composition and design teaching modules are shown in the table following:

Table 4. Teaching Module Preparation Format

Teaching Module Components	Design
Front page/Cover	
List of contents	
General Information a. Module Identity b. Initial Competence c. Pancasila-Based Student Character Profile d. Educational Facilities and Supporting Infrastructure e. Expected Student Competencies f. Learning Model g. Learning Mode	
Main Components a. Learning Outcomes b. Learning objectives c. KKTP d. Meaningful understanding e. Starter question f. Learning Preparation g. Steps for Learning Activities h. Assessment i. Pancasila Student Profile Assessment j. Group Presentation Assessment k. Science Literacy Skills Assessment	 
Attachment a. Student Worksheet b. Reading Materials for Teachers & Students c. Glossary	

https://doi.org/10.37905/jjec.v7i2.30460

Stage third that is stage development, at the stage This The validation process is carried out by media experts and experts material. Validation materials and media were carried out by 6 experts consisting of from One Chemistry Education lecturers, 4 S1 chemistry teachers and 1 S1 chemistry teacher. Based on the results data validation that has been processed, then obtained average value as following:

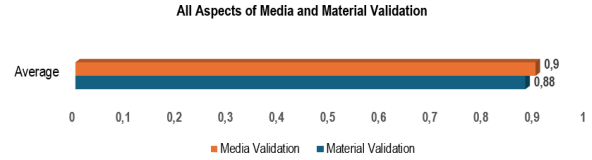


Figure 1. Average Value of Material and Media Validation Results

Stage to four that is implementation , At the stage implementation done implementation teaching modules that have been developed to participant educate grade 12 high school. The results response participant educate served in the following diagram this.

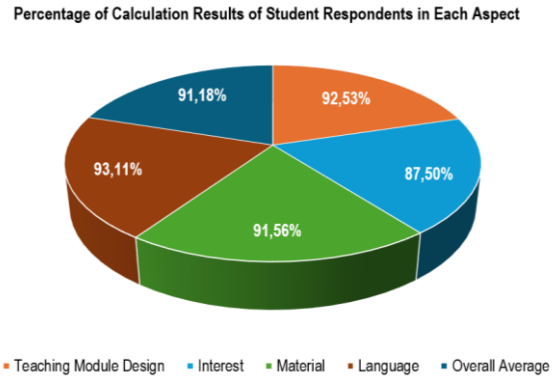


Figure 2. Percentage of Response Results Learners

Results data response participant educate, at the stage implementation in getting result data achievement Study participant educate. The following is percentage achievement Study participant educate.

Table 5. Percentage Learning Outcome Achievement Learners

PBL Module Stages	Aspects of Scientific Literacy	Percentage	Category
Introducing students to the core issue Assigning students to discussion groups	Science Context	78%	Good
Supporting learners in conducting personal and group explorations	Content (Science Knowledge)	83%	Very good
Develop and present results	Science competency (Science Process)	**80%**	Very good

Stage final in ADDIE model that is evaluation , At the stage This done evaluation from stages previously . At the stage analysis researcher do evaluation , namely with addition analysis need educators who do it in schools place research , reduction amount meeting Study teach in class . At stage design evaluation conducted is addition aspect literacy science listed processed learning and adding KKTP in teaching module . At the stage development evaluation adapt with suggestions and input from media and material validators . At this stage implementation that must be be noticed is related learning process support like projector and screen must be prepared before learning started so that the material show and video can displayed as well as facilities and infrastructure like laboratory that can For used .

3.2. Discussion

Development learning module based *problem based learning* integrated literacy science on acid-base material is studied using the ADDIE research model. Based on the research that has been conducted, the data obtained in the study are from 1) the results of the analysis of educators' needs for integrated PBL teaching modules for science literacy on acid-base material, 2) analysis of literature studies, 3) analysis of the independent curriculum, 4) results of validation by material experts and media experts, 5) results of student responses. The following is a presentation of the data from the research conducted in accordance with ADDIE model stages.

Stage First is analysis, At the stage This done three stages analysis, namely analysis need educator, analysis curriculum independence and analysis studies literature . Analysis need for research This conducted at SMA Negeri 1 Cilograng which is located in Lebak Regency, Banten Province. The analysis need done with spread questionnaire in a way direct to chemistry teachers at SMA Negeri 1 Cilograng. Analysis need done

researcher For collect the necessary data in study development integrated PBL based teaching module literacy science on matter sour base. Fill in chemistry teacher questionnaire totaling 3 people with a total of questions referring to development the teaching module is 10 questions. Based on results data analysis processing need educator so can withdrawn conclusion that the teaching module is one of the teaching tools that are often used in learning Chemistry, Ability literacy science is very important aspect For owned by participants educate and obey educator ability literacy science participant educate Still low. Educator state that the learning model PBL based can help in learning chemistry and materials sour language can associated with life everyday, so that educator agree developed learning module based integrated problem based learning literacy science on matter sour language. In addition to analysis Education needs, analysis is also carried out studies literature For support and strengthen results analysis need.

Stage second that is design, at the stage design teaching module is stage compilation appropriate teaching module with Achievements Learning Objectives (CP) and Learning Objectives (TP) as well as material . At the stage design there is a design process beginning teaching module (prototype) and design Merdeka curriculum teaching module. Selected media For compile teaching module is application *canva* as a digital media place design main including For make material learning in power point slide form. *Canva* chosen as a medium in making teaching module due to easy accessed both on mobile phones and laptops. *Canva* is design program application online based with various features type For support need activity learning, office, entrepreneurship and others. Advantages from application canva is own diversity design graphic Good That templates, animations, and options color as well as size, besides That application *canva* own good resolution and every the template can printed (Admelia et al., 2022). *Microsoft Word* 2021 used in compilation teaching module as a medium for word processing and improvement spelling before copied to in *canva.* In the process of designing the teaching module, various images of phenomena that occur in everyday life are placed inside which are caused by acid-base compounds and integrated with various questions in the form of problems that must be solved. The teaching module based on PBL integrated with scientific literacy means a teaching module that contains acid-base chemistry material that will be taught to students using the PBL model. Students will be encouraged to read reading materials that contain events in everyday life, analyze and then conclude what has been read to find the background of the problem. Inside there is a description of problems related to everyday life caused by acid-base compounds in the form of questions that students must work on with scientific answers. The teaching module based on PBL integrated with science that has been prepared will then be validated by the validator.

Stage third is development, At the stage This teaching modules that have been arranged will validated by expert validators materials and media. Validation materials and media were carried out by 6 experts consisting of from One Chemistry Education lecturers, 4 S1 chemistry teachers and 1 S1 chemistry teacher. The data obtained from validation furthermore will be processed with using Aiken's V test. Values obtained from the validator will compared to with mark V_{table} . If the value $V_{count} \geq$ value V_{table} that is of 0.79 then can declared valid, with level error or mark significance of 0.05. So that V value obtained minimum 0.79 to be able to declared valid. From the results calculation so obtained V value calculate the average for media validation is 0.90 and validation material 0.88. The value is obtained from results evaluation each aspects of validation materials and media. In the validation instrument expert material There are five aspects assessed that is aspect eligibility content, aspect conformity material in teaching module with aspect literacy science, aspects conformity use of PBL model, aspects eligibility presentation and aspects Language eligibility. In the aspect of eligibility Contents there are sub statement items with mark highest namely the item "Integrated PBL- based teaching module" literacy science on matter sour language push participant educate think critical " with mark V_{count} 0.91. Participant - focused learning educate in finish a problem in form question will push participant educate For think in a way structured and critical with put forward proof scientific. Literacy science be one of from skills think critical which is very important in the era of knowledge and understanding about knowledge knowledge and technology become role central in life (Rafi'y et al., 2023).

In terms of the suitability of the material in the teaching module with the scientific literacy aspect, the

sub-item with the highest score is the statement "There is scientific evidence presented in the teaching module related to acids and bases" which received a score of 0.95, this indicates that the teaching module has presented acid-base material supported by relevant scientific evidence. The results obtained are relevant to the aspects of PISA in assessing scientific literacy, which include formulating questions, providing scientific explanations of phenomena, designing scientific investigations, and applying scientific evidence. (Dewi & Rahayu, 2022).

In the aspect of the suitability of the use of the PBL model, there is a sub-item with the highest assessment, namely "The teaching module can guide individual or group experiences" with a Vcount value of 0.91, these results are based on the application of the third PBL syntax, namely guiding individual and group investigations, which basically students focus on working together to solve problems in a group. The PBL model challenges students to solve problems that exist in life related to science through cooperation in groups so that learning is rich in opinions and concrete solutions (Abarang & Delviany, 2022).

In the aspect of the feasibility of presentation, the sub-item with the highest assessment is the statement "The phenomena in everyday life presented are in accordance with the material" which obtained a value of 0.91, this strengthens that the evidence in the form of events presented is in accordance with the acid-base material. Most of the chemical materials, one of which is acid-base, Can be integrated with real-life contexts and occurrences, for example the sour taste of fruits, the use of base compounds in stomach ulcer drugs, the use of lime in the process of neutralizing agricultural soil with high acidity, and others (Andriani, 2019).

In the aspect of language suitability, there is a sub-item with the highest assessment, namely the statement "Understanding of information", which obtained a value of 0.95, This demonstrates that the instructional material in the module is accessible and understandable for learners, because basically the researcher compiles the contents of the teaching module using language and sentences that are simple and easy for readers to understand.

In the media expert instrument, there are two aspects that are assessed, namely the graphic aspect and the learning design aspect. The graphic aspect obtained an average value of 0.91 and the learning design aspect obtained a value of 0.88. Based on the results of the validation data processing, the Vcount value of each question item from the indicator in the graphic aspect obtained a value above 0.79 with an average of 0.91 so that it can be declared valid. In the teaching module size indicator, the sub-item "module size according to ISO" received the largest Vcount value of 0.95, this indicates that the designed teaching module is in accordance with ISO standards. The paper size used in the teaching module is A4 or 210 mm x 297 mm and this size is in accordance with ISO standards (Sugianto et al., 2018).

In the module content design indicator, there is a sub-item with the highest value, namely "Suitability of teaching module material to learning objectives" with a V_{count} value of 0.91, this indicates that the material presented in the appendix is in accordance with the learning objectives in the content section. Basically, learning objectives must contain important points in learning, so that they can be tested with various types of assessments as a benchmark for student understanding after carrying out learning activities (salsabilla, 2023).

In the interactivity indicator, there is a sub-item that received the highest score with a V_{count} of 0.91, namely the item "PBL-based teaching modules integrated with scientific literacy can be used to help students learn independently, because they are presented with materials that are relevant to everyday life". Researchers have combined PBL syntax with the concept of scientific literacy in acid-base material whose applications are found in everyday life, With the intention of making learning more appealing to students. A good learning design will produce something good, Learning outcomes are likely to be enhanced, supporting students in developing autonomous learning abilities (Rafi'y, 2023).

The fourth stage is implementation. The implementation stage is the stage of applying the developed product in the form of teaching materials in the learning process (Kurnia et al., 2019). Basically, the implementation stage is the stage of testing the module that has been validated and revised to students (Nesri & Kristanto, 2020). At the implementation stage, the PBL-based teaching module integrated with scientific literacy was tested on 30 grade 12 students of SMA Negeri 1 Cilograng. The study utilized purposive sampling, a method that selects participants who meet particular

https://doi.org/10.37905/jjec.v7i2.30460

criteria, making them appropriate for inclusion as research samples. (Septiani et al., 2020). The researcher prepared a questionnaire that would later be filled out by students after the implementation of the teaching module was completed.

Limited trials were conducted to determine the responses and assessments of students towards the developed teaching module. Students assessed four indicators including the design of the teaching module, interest, material and language. The results of the assessment from students were then calculated using a percentage formula. Based on the average value, all aspects were categorized as very good because they obtained a value above 81. The design aspect of the teaching module obtained a percentage of 92.53%, the interest aspect obtained a percentage of 87.50%, the material aspect obtained a percentage of 91.65%, the language aspect obtained a percentage of 93.11%, if averaged overall obtained a result of 91.18%. Based on this assessment, it can be concluded that almost 30 students agreed and strongly agreed for all aspects of the assessment that referred to the teaching module. In the design aspect of the teaching module that had been obtained, there was a statement item that obtained the largest percentage, namely "the images of each phenomenon/event displayed in the LKPD and reading materials are very clear and help students understand the acid-base material" obtained a value of 94.67%. The meaning of "very clear reading material" is the choice of fonts, images and colors, which are easy and clear to read and understand the meaning. Providing images in learning media is an effort by teachers to create meaningful learning for students and the learning materials will have clearer meaning so that students can hopefully understand the material (Magdalena et al., 2021).

In terms of interest, the statement item "using this teaching module can make chemistry learning less boring" received the highest percentage, at 89.33%. The PBL model directs students to actively discuss in groups to solve problems related to the learning material. In addition, students must have the ability to convey the conclusions of their group discussions in class. The two-way learning process encourages students to actively ask and answer questions. The application of the PBL model in the learning process has a positive influence on critical thinking skills and the level of student engagement . (Zahro & Lutfianasari, 2024).

In the material aspect, the statement that obtained the largest percentage was "the material in this teaching module is related to everyday life" with a percentage of 93.33%. The understanding of chemical concepts obtained by students is something abstract and has not reached practical needs in life, so a contextual approach is needed (Andriani, 2019). In the language aspect, the statement "the language used in the teaching module is simple and easy to understand" obtained the highest percentage, namely 93.33%. The use of language in learning media must be simple and easy to understand by students to make it easier to understand (Laraphaty et al., 2021).

The data obtained during the limited trial included, but were not restricted to, student evaluations of the module usage, but also obtained from the assessment of student learning outcomes using the PBL model integrated with scientific literacy. The scientific context aspect obtained the smallest percentage, namely 78%, this happened because students did not analyze in detail the problems caused by acid-base substances in everyday life, resulting in limited detailed and scientific explanations when answering questions. One of the abilities that must be developed by students is the ability to analyze which is the basis for high-order thinking (Irawati & Mahmudah, 2018). The aspect that obtained the largest percentage was the content aspect (science knowledge) with 83%, this was based on the ability of students who had understood the acid-base material in theory, thus providing basic knowledge related to acids and bases and examples in everyday life. The scientific competency aspect obtained a percentage value of 80%, while the scientific attitude aspect was not included in the assessment because the acid-base practicum process could not be carried out by all students, this was due to limited supporting facilities such as laboratories, tools and practicum materials. In the teaching module, the procedure for acid-base experiments on making natural indicators has been written, so that it can help educators to implement practical activities in the learning process.

The final stage is evaluation, the evaluation stage is intended to evaluate the entire series of development of the teaching module in this study with the aim of knowing the location of errors and deficiencies so that improvements can be made later. At the evaluation

stage there are formative and summative evaluations. Formative evaluation is carried out at each stage to collect data and make improvements, Meanwhile, summative assessment is implemented at the end of the program to evaluate its influence on student performance and the general quality of learning. Nevertheless, this study employed only formative evaluation, as it was directly aligned with the phases of development research aimed at refining the resulting products (Puspasari, 2019). Formative evaluation has been carried out step by step at each stage of the ADDIE model in accordance with its development procedures in order to minimize errors so that a valid and suitable teaching module product is produced. At the analysis stage, the researcher conducted an evaluation, namely by adding an analysis of the needs of educators carried out at the school where the research was conducted. The evaluation carried out at this stage was to reduce the number of teaching and learning meetings in the classroom, where previously there were 4 meetings to 3 meetings. At the design stage, the evaluation carried out was the addition of aspects of scientific literacy that were included in the learning process and the addition of the Learning Objective Achievement Criteria (KKTP) in the teaching module. At the evaluation development stage, adjust to the suggestions and input from media and material validators, including assessment questions that must be based on Google Forms, Learning Objective Flow (ATP) that does not need to be included in the learning activity process, previous Learning Outcomes (CP) that are replaced by using the latest CP and revised learning objectives using the Audience, Behavior, Condition and Degree (ABCD) concept. At the implementation stage, what must be considered is related to supporting the learning process such as projectors and screens that must be prepared before learning begins so that broadcast materials and videos can be displayed as well as facilities and infrastructure such as laboratories that can be used.

4. CONCLUSION

Based on the conducted research, it can be concluded that the PBL-integrated science literacy module for acid-base material has been validated as appropriate and effective for instructional use, supported by the evaluations from content and media experts and feedback from students. The Aikens'V value with an error rate of 5% obtained a $_{\text{calculated V value}} \geq V_{\text{table}}$, the $V_{\text{table value}}$ is 0.79 while the $_{\text{calculated V value}}$ on the aspects of content feasibility, material suitability aspects, aspects of suitability of the use of the PBL model, presentation feasibility aspects, language feasibility aspects, graphic aspects and learning design aspects obtained values of 0.86, 0.90, 0.87, 0.88, 0.88, 0.91 and 0.88 respectively. Overall, the validity of the material gets an average value of 0.88 and the results of the media validity get an average $_{\text{calculated V value of}}$ 0.90, so it is declared valid. The results of student responses after implementing the integrated PBL-based teaching module of scientific literacy on acid-base material obtained a percentage of ≥ 81% so that it obtained a very good category. In the design aspect of the teaching module, it obtained an average value of 92.53%, the interest aspect obtained an average value of 87.50%, the material aspect obtained an average value of 91.56% and the language aspect obtained a value of 93.11%, so that the total average value of the student response results was 91.18% with a very good category.

The PBL-based module integrated with scientific literacy on acid-base material has been tested for its validity, but its application is still on a limited scale. Further research needs to be conducted on a larger and more detailed scale to determine the effectiveness of the teaching module in influencing students' scientific literacy skills.

5. ACKNOWLEDGEMENTS

The author would like to thank the principal of SMAN 1 Cilograng who has given permission to the author to conduct research at SMAN 1 Cilograng. The author would also like to thank the chemistry teacher of SMAN 1 Cilograng who has helped the research process, to the students of grade XII who have been willing to be research participants, and to the media expert validators and material experts who have helped in the validation process of the developed teaching module.

6. REFERENCES

Admelia, M., Farhana, N., Agustiana, S. S., Fitri, A. I., & Nurmalia, L. (2022). Efektifitas penggunaan aplikasi Canva dalam pembuatan modul pembelajaran interaktif Hypercontent di Sekolah Dasar Al Ikhwan. *KACANEGARA Jurnal Pengabdian pada Masyarakat*, *5*(2), 177.https://doi.org/10.28989/kacanegara.v5i2.1087

Agus Supriyadi, Desy Desy, Yayat Suharyat, Tomi Apra Santosa, & Aulia Sofianora. (2023). The Effectiveness of STEM-Integrated Blended Learning on Indonesia Student Scientific Literacy: A Meta-analysis. *International Journal of Education and Literature*, *2*(1), 41-48. https://doi.org/10.55606/ijel.v2i.53

Ardianto, D., & Rubini, B. (2016). Literasi Sains dan Aktivitas Siswa Pada Pembelajaran Ipa Terpadu Tipe Shared. *Unnes Science Education Journal 5* (1). https://doi.org/10.15294/usej.v5il.9650

Arini, W., & Lovisia, E. (2019). Respon Siswa Terhadap Alat Pirolisis Sampah Plastik Sebagai Media Pembelajaran Berbasis Lingkungan di SMP Musi Rawas. *Thabiea: Journal of Natural Science Teaching,* *2*(2), 95-104. http://dx.doi.org/10.21043/thabiea.v212.59.50

Cahyadi, R. A. H. (2019). Pengembangan Bahan Ajar Berbasis Addie Model. *Halaqa: Islamic Education Journal*, *3*(1), 35–42. https://doi.org/10.21070/halaqa.v3i1.2124

Dewi, C. A., & Rahayu, S. (2022). Pentingnya Mengoptimalkan Literasi Kimia Melalui Pembelajaran Berbasis Isu-isu Sosiosaintifik di Abad Ke-21. *In Proceeding Seminar Nasional IPA* (pp. 348-359)

Dinda Nur Azizah, Irwandi, D., & Saridewi, N. (2021). Pengaruh Model Pembelajaran Problem Based Learning Berkonteks Socio Scientific Issues Terhadap Kemampuan Literasi Sains Siswa pada Materi Asam Basa. *JRPK: Jurnal Riset Pendidikan Kimia*, *11*(1), 12–18. https://doi.org/10.21009/JRPK.111.03

Dirmanto, A., Cahyono, E., & Sulistyaningsih, T. (2021). The Effectiveness of Problem Based Learning on Acid-Base Materials to Improve Scientific Attitude and Creativity of SMAN 1 Comal Students. *Journal of Innovative Science Education, 10*(2), 193-198.

Fadly, D., Rahayu, S., Dasna, I. W., Yahmin, Y. (2022). The Effectiveness of a SOIE Strategy Using Socio-scientific Issues on Students' Chemical Literacy. *International Journal of Instruction*, *15*(1), 237–258. https://doi.org/10.29333/iji.2022.15114a

Hadinugrahaningsih, T., Rosita, & Kurniadewi, F. (2019). Pengaruh Strategi "REACT" Terhadap Literasi Kimia Peserta Didik Kelas X MIA Pada Pembelajaran Reaksi Redoks. *JRPK: Jurnal Riset Pendidikan Kimia*, *9*(1), 14–20. https://doi.org/10.21009/JRPK.091.02

Handayani, D., Anwar, Y. A. S., Junaidi, E., & Hadisaputra, S. (2022). Pengembangan Modul Pembelajaran Kimia Materi Asam Basa Berbasis Problem Based Learning (PBL) untuk Meningkatkan Motivasi Belajar Siswa. *Chemistry Education Practice*, *5*(1), 107–114. https://doi.org/10.29303/cep.v5i1.2765

Irawati, T. N., & Mahmudah, M. (2018). Pengembangan Instrumen Kemampuan Berpikir Analisis Siswa SMP dalam Menyelesaikan Soal Pemecahan Masalah Matematika. *Kadikma: Jurnal Matematika dan Pendidikan Matematika,* *9*(2)., 1-11. https://doi.org/10.19184/kdma.v9i2.8529

Jannah, M. M., & Rasyid, H. (2023). Kurikulum Merdeka: Persepsi Guru Pendidikan Anak Usia Dini. *Jurnal Obsesi : Jurnal Pendidikan Anak Usia Dini*, *7*(1), 197–210. https://doi.org/10.31004/obsesi.v7i1.3800

Jufrida, J., Basuki, F. R., Kurniawan, W., Pangestu, M. D., & Fitaloka, O. (2019). Scientific literacy and science learning achievement at junior high school. *International Journal of Evaluation and Research in Education (IJERE)*, *8*(4), 630. https://doi.org/10.11591/ijere.v8i4.20312

Jusniar, Syamsidah, Sakinah, Z., Munthalib, & Sentot, K. (2024). Effectiveness of Problem-Based Learning to Improve Critical Thinking Ability of Chemistry Students on Acid-Base Material. *Jurnal Penelitian Pendidikan IPA*, *10*(9), 6464–6472. https://doi.org/10.29303/jppipa.v10i9.8434

Kurnia, T. D., Lati, C., Fauziah, H., & Trihanton, A. (2019). Model Addie Untuk Pengembangan Bahan Ajar Berbasis Kemampuan Pemecahan Masalah Berbantuan 3d Pageflip. *In Prosiding Seminar Nasional Pendidikan Matematika (SNPM), 1*(1), 516-525

Laraphaty, N. F. R., Riswanda, J., Anggun, D. P., Maretha, D. E., & Ulfa, K. (2021). Review: Pengembangan Media Pembelajaran Modul Elektronik(E-Modul). *Prosiding Seminar Nasional Pendidikan Biologi.*

Magdalena, I., Pratiwi, S., Pertiwi, A., & Damayanti, A. P. (2021). Penggunaan Media Gambar Dalam Meningkatkan Minat Belajar Siswa Kelas IV di SD Negeri 09 Kamal Pagi. *PENSA: Jurnal Pendidikan dan Ilmu Sosial, 3*(2), 334-346

Maulida, U. (2022). Pengembangan Modul Ajar Berbasis Kurikulum Merdeka. *Tarbawi : Jurnal Pemikiran*

dan Pendidikan Islam, 5(2), 130-138. https://doi.org/10.51476/tarbawi.v5i2.392

Mufhtih, G. P., Irwandi, D., & Bahriah, E. S. (2021). The Effect of Problem-based Learning with Reading Questioning Answering Strategy on Students' Metacognitive Skills of Acid Base Concept. *JURNAL PENDIDIKAN SAINS (JPS)*, *9*(2),161.https://doi.org/10.26714/jps.9.2.2021.161-170

Nesri, F. D. P., & Kristanto, Y. D. (2020). Pengembangan Modul Ajar Berbantuan Teknologi untuk Mengembangkan Kecakapan Abad 21 Siswa. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *9*(3), 480.https://doi.org/10.24127/ajpm.v9i3.2925

Nurisa, I., & Arty, I. S. (2019). Measuring Students' Chemistry Literacy Ability of Acid and Base Concepts. *Journal of Physics: Conference Series*, *1233*(1), 012018. https://doi.org/10.1088/17426596/1233/1/012018

Puspasari, R. (2019). Pengembangan Buku Ajar Kompilasi Teori Graf dengan Model Addie. *Journal of Medives : Journal of Mathematics Education IKIP Veteran Semarang*, *3*(1), 137. https://doi.org/10.31331/medivesveteran.v3i1.702

Rafi'y, Muh., Ferry Irawan, & Dharma Gyta Sari Harahap. (2023). Pengembangan Bahan Ajar Interaktif Berbasis Problem Based Learning untuk Meningkatkan Kemampuan Literasi Sains Peserta Didik. *Indo-MathEdu Intellectuals Journal*, *4*(2), 669-682. https://doi.org/10.54373/imeij.v4i2.243

Rahmawati, Y., Erdawati, E., Ridwan, A., Veronica, N., & Hadiana, D. (2024). Developing students' chemical literacy through the integration of dilemma stories into a STEAM project on petroleum topic. *Journal of Technology and Science Education*, *14*(2), 376. https://doi.org/10.3926/jotse.2221

Septiani, Y., Aribbe, E., & Diansyah, R. (2020). Analisis Kualitas Layanan Sistem Informasi Akademik Universitas Abdurrab Terhadap Kepuasan Pengguna Menggunakan Metode Sevqual (Studi Kasus: Mahasiswa Universitas Abdurrab Pekanbaru). *JURNAL TEKNOLOGI DAN OPEN SOURCE*, *3*(1), 131–143. https://doi.org/10.36378/jtos.v3i1.560

Setyasih, B. R., Rusdi, R. R., & Ristanto, R. H. (2022). Studi Meta Analisis: Problem-Based Learning terhadap Keterampilan Literasi Sains Peserta Didik. *Bioedusiana: Jurnal Pendidikan Biologi*, *7*(1).https://doi.org/10.37058/bioed.v7i1.4251

Siregar, N., Sahirah, R., & Harahap, A. A. (2020). Konsep Kampus Merdeka Belajar di Era Revolusi Industri 4.0. *Fitrah: Journal of Islamic Education*, *1*(1), 141–157. https://doi.org/10.53802/fitrah.v1i1.13

Sugianto, S. D., Ahied, M., Hadi, W. P., & Wulandari, A. Y. R. (2018). Pengembangan Modul Ipa Berbasis Proyek Terintegrasi Stem Pada Materi Tekanan. *Natural Science Education Research*, *1*(1), 28–39. https://doi.org/10.21107/nser.v1i1.4171

Syahidi, K., Triandini, W., Mardi, E. S., & Fartina, F. (2023). Penerapan Model Project Based Leraning Melalui Lesson Study dalam Meningkatkan Kemampuan Berpikir Kritis Peserta Didik. *Jurnal Pendidikan, Sains, Geologi, dan Geofisika (GeoScienceEd Journal)*, *4*(2), 44–48. https://doi.org/10.29303/goescienceed.v4i2.268

Wasthi, S., Burhanudin, B., Loka, I. N., & Sofia, B. F. D. (2023). Development Of Chemistry E-Module Based On Science Process Skills On Hydrocarbon Compound Materials. Chemistry Education Practice, 6(2), 248-254. https://doi.org/10.29303/cep.v6i2.5535

Yani, Y. P., Hardeli, H., Oktavia, B., & Kurniawati, D. (2020). Development of an Integrated E-Module of Scientific Literacy and Video Demonstration Using a Problem-Based Learning Model for High School Students on Acids and Bases. *Jurnal Penelitian Pendidikan IPA*, *8*(2), 452–462. https://doi.org/10.29303/jppipa.v8i2.1306

Yulita, I., & Amelia, T. (2020). Pelatihan Mengembangkan Bahan Ajar Kimia Berbasis Literasi Sains Mengintegrasikan Konteks Kemaritiman. *Jurnal Anugerah*, *2*(2), 51–65. https://doi.org/10.31629/anugerah.v2i2.2685

Zahro, M., & Lutfianasari, U. (2024). Penerapan Model Pembelajaran *Problem-Based Learning* Terhadap Kemampuan Berpikir Kritis dan Aktivitas Belajar Peserta Didik pada Materi Hidrolisis Garam. *Jurnal Inovasi Pendidikan Kimia*, *18*(1), 17–22. https://doi.org/10.15294/jipk.v18i1.45567