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Development of a Problem Based Learning Module to Improve Scientific Literacy Capability and HOTS on The Material Buffer Solution

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Abstract: This research aims to determine the results of expert validation and student responses to problem based learning based modules on buffer solution material. The research was carried out at the Cinta Kasih Catholic High School, Tebing Tinggi City using a sampling technique, namely purposive sampling of 35 people. This type of research uses the Research and Development (R&D) research and development method with a 4D development model and research is carried out only up to the development stage. The research instruments that will be used in this research are validation sheets and questionnaires. The design of the module to measure students' level of scientific literacy and HOTS on buffer solution material is suitable for use with the results of expert validation of the module producing an average percentage value for content suitability of 90% with very high criteria. Meanwhile, student responses to the module were generated from the student response questionnaire sheet with the average percentage of student responses to the module obtained being 88%, including very high criteria, 27 students and 20% of students including high criteria (8 students). Based on student responses, it can be concluded that creating a module that aims to measure students' scientific literacy and HOTS regarding buffer solution material could be something more interesting, useful and interesting to use.

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Introduction

The important role of scientific literacy for the development of science is in chemistry, so mastery of scientific literacy skills is very necessary. In reality, in the learning process, students only memorize concepts and theories, and are less able to use the concepts they have or it could be said that students' literacy skills have not yet been formed (Yusuf et al., 2023). These abilities are included in higher order thinking abilities (HOTS). In other words, students need high-level thinking skills in literacy (Rohmah & Ni'mah, 2021).

The low results of students' scientific literacy and HOTS results are one of the reasons why students are not familiar with scientific literacy questions, which causes low mastery of scientific literacy so they are not used to working on questions that use discourse (Permatasari & Fitriza, 2019). One effort to increase scientific literacy that can be done is by implementing

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modules based on problem based learning models which are able to encourage students to develop their concepts, through a contextual scientific approach (Suparya et al., 2022).

The PBL learning model is included in high-level thinking skills or known as HOTS (High Order Thinking Skill). Which requires students to think at a higher level and is able to make students more interested in reading chemistry modules (Anggraeni & Erviana, 2019). Students' scientific literacy can be developed through learning learning materials that are related to everyday life, which can be in the form of problems and their solutions. In chemistry learning, one material that fits these characteristics is buffer solution material (Purwanti et al., 2022). Previous research conducted by Febyarni Kimianti entitled "Development of a Science E-module Based on Problem Based Learning to Improve Students' Science Literacy" concluded that the science e-module based on problem-based learning which was created by operating online is practical, flexible and independent so that it can facilitate students' scientific literacy skills so they can solve problems in everyday life and meet global challenges (Kimianti & Prasetyo, 2019).

Based on the results of interviews with chemistry teachers at Cinta Kasih Catholic High School, Tebing Tinggi City, the school uses teaching materials in the form of printed books and PowerPoint and so far chemistry teachers still use HOTS questions in the form of multiple choices which do not require students' reasons for choosing answers. The results of the interviews showed that the teaching materials used did not contain material that was integrated with problems that exist in real life. The results obtained show that students still have difficulty answering questions and analyzing ideas in reading texts. Therefore, alternative solutions are needed to overcome the problem of students' and teachers' needs for teaching materials, one of which is by developing problem-based learning modules that are integrated with scientific literacy and HOTS.

Research Method

The research will be carried out at the Cinta Kasih Catholic High School, Tebing Tinggi City. The sample collection technique in this research was a purposive sampling technique, namely 35 people. This type of research uses the Research and Development (R&D) research and development method, which is a research method used to produce certain products, and test the effectiveness of these products. The development model used in this research is the 4D development model, the 4D development process was only carried out at the stages: Define, Design, and Develop.

The research instruments that will be used in this research are validation sheets and questionnaires. The types of data used in this research are qualitative data and quantitative data. Qualitative data will be obtained from criticism and suggestions from two validators and respondents, while quantitative data will be obtained from validation results by validators and teacher responses. The instrument was prepared according to the National Education Standards Agency BSNP, for more clarity the validation of media experts and student response sheets can be seen in the scale table, namely:

Table 1. Likert Scales

Instrument Item Answers	Score
Very well	4
Good	3
Not enough	2
Very less	1

The data analysis technique used uses the following formula:

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$$\% X_{in} = \frac{\Sigma S}{Smaks} x\ 100\%$$

Information :
% X in = percentage of answers to question i in the questionnaire
Σ S = total answer score for the ith statement
S max = maximum expected score on statement i

The results of the questionnaire analysis are interpreted based on table 2.

Table 2. Questionnaire Percentage Criteria

Presentace (%)	Criteria
80,1-100	Very high
60,1-80	High
40,1-60	Currently
20,1-40	Low
0-20	Very Low

Result and Discussion

This module development uses the 4D development model from Thiagarajan with 4 stages, namely 1) define, (2) design, and (3) development. The following are the research results obtained at each development stage.

1) Define

The definition stage can involve several stages, including front end analysis, learner analysis, task analysis, concept analysis, and learning objective specification. Front end analysis was carried out to find the problems faced by teachers in the learning process at the research school. The results obtained are that the teacher has not been optimal in implementing the PBL learning model, the learning media used is only Powerpoint and the learning resources used are only textbooks from school and the teacher has never applied Modules during the teaching and learning process, so teaching materials are needed that are able to help participants. students in improving students' scientific literacy and HOTS. Based on research conducted by Fatmianeri et al., (2021), front end analysis aims to surface and determine the basic problems faced in learning. So that from the analysis you will get a picture that will make it easier to determine the development of the teaching materials that will be developed.

After further research on students in class XII B, it was found that 40% of students could understand the basic material of buffer solutions. Because of the conventional learning model, students only listen, take notes, read and repeat what the teacher does. Therefore, teachers participate more actively in this learning than students. As a result, students do not understand the chemical concepts of buffer solution topics, which is indicated by the students' low chemistry scores. Teachers use open materials in the learning process, especially buffer solutions, when delivering material. Printed books and PowerPoint are the open materials used. Chemistry teachers still use HOTS multiple choice questions which do not require students to give reasons for choosing answers. In the next step, namely the analysis task, the author chooses buffer solution material to be used in the module to be developed because this material uses a lot of learning concepts related to everyday life. Therefore, this material is suitable for the product to be developed, namely a PBL-based module which focuses on buffer solution material.

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In addition, task analysis is carried out to assess initial competencies and core components in accordance with the independent curriculum and determine learning outcomes. Formulating goals is the final stage in the definition stage. This step is taken to ensure that the author sticks to the standards and content that have been set. This is in line with research by Salsabila et al. (2023) which states that concept analysis is carried out to identify concepts that need to be studied regarding the subject matter and develop learning objectives that students must achieve in order to meet the demands of the curriculum that will be presented in the resulting teaching materials.

2) Design

At the design stage, the researcher carried out media selection, format selection and initial design of a Problem Based Learning (PBL) based module on buffer solution material. Media selection using Canva, Microsoft Word to design modules into book displays. The format used in developing the Module consists of Cover, Foreword, Table of Contents, Glossary, Concept Map, Introduction (Module Identity, Elements, Initial Competencies and Core Components, Learning Achievements, Learning Objectives), Instructions for Using the Module, Material, material with stages PBL, sample questions, evaluation questions, summary, bibliography and author bio.

Next, the initial design of the product being developed. In making the Module, the color used was a combination of the more dominant blue and brown in making the initial design of the Module because color is one of the important things in building and strengthening the students' information foundation so that it is easily accepted. As in research by Nainggolan & Nainggolan (2024), choosing the color blue can give a confident and pleasant impression. Then in this initial design, determine the problems that will be addressed in the Problem Based Learning (PBL) learning model. The problems contained in the first learning activity are: definition of buffer solutions, types of buffer solutions and principles of buffer solutions where the problem of this material is buffer solutions in blood. Where participants are able to explain buffer solutions, know the relationship between blood and the capacity of buffer solutions (Hakim et al., 2023). At the investigation stage, students collect information regarding the components of buffer solutions, types of buffer solutions and the principles of buffer solutions and react pairs of acids and conjugate bases in groups. At the results stage, students make conclusions from the information obtained and present the results of the discussion in front of the class. At the evaluation stage, students analyze and evaluate the results of presentation group discussions with teacher guidance and provide comments, suggestions or input. Next, the second learning activity discusses how to calculate pH and the benefits of buffer solutions in everyday life. The problem in this second learning activity is the role of buffer solutions in the industrial sector. At the learning organization stage, students form groups to look for information on the components of buffer solutions found in industrial fertilizers, as well as students' opinions on the problems given. At the investigation stage, students determine the pH of the buffer solution. At the results stage, students make conclusions from the information obtained and present the results of the discussion in front of the class. At the evaluation stage, students analyze and evaluate the results of presentation group discussions with teacher guidance and provide comments, suggestions or input (Zakaria et al., 2024).

3) Development

Media validation was carried out by material experts as lecturers in Chemistry Education at Medan State University. Next, the Module is assessed using validated instruments to obtain assessments, suggestions and input which will be used as a reference in revising the Module so that it is declared valid. The results of the media expert validator questionnaire

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assessment of the Module showed that the average percentage of media expert lecturers' assessments was 90% in the "very high" category. towards the PBL-Based Module on the buffer solution material in table 3.

Tabel 3. Average Percentage Of Media Expert Questionnaire Validation Assessments

No	Assessment Aspects	Validator Score (%)
1	Clarity component	83
2	Components of content accuracy	100
3	Relevance component	88
4	Components of content validity	100
5	Components have no bias	75
6	Components of language accuracy	92
	Average percentage 90%	90%
	Criteria	**Very high**

Based on table 3, the questionnaire that will be used is declared feasible with an average of 0.90 in the very high category. So it is concluded that the module is suitable for use for research.

Student response questionnaires are used to measure student responses to the module (Sugiyono, 2013). The results of this questionnaire can also be used to determine student responses, ease and clarity of the module. In addition, the total score for each student is calculated and converted into a percent value. States that a percent value between 70.01 and 85.01% meets the high criteria, and a percent value between 85.01 and 100% meets the very high criteria. The results of calculating student response questionnaires can be seen in table 4.

Table 4. Results of Analysis of Student Responses to the Module

No	Final Score	Maximum Score	Persentace (%)	Criteria
1	90		90%	Very high
2	90		90%	Very high
3	85		85%	High
4	90		90%	Very high
5	85		85%	High
6	85		85%	High
7	87		87%	Very high
8	90		90%	Very high
9	82		82%	High
10	85	100	85%	High
11	88		88%	Very high
12	83		83%	High
13	85		85%	Very high
14	88		88%	Very high
15	87		87%	Very high
16	95		95%	Very high
17	90		90%	Very high
18	95		95%	Very high
19	85		85%	Very high

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20	82	82%	High
21	87	87%	Very high
22	83	83%	High
23	87	87%	Very high
24	95	95%	Very high
25	89	89%	Very high
26	88	88%	Very high
27	87	87%	Very high
28	86	86%	Very high
29	89	89%	Very high
30	89	89%	Very high
31	90	90%	Very high
32	96	96%	Very high
33	91	91%	Very high
34	90	90%	Very high
35	95	95%	Very high
	Mean	**88%**	**Very high**

The average percentage of student responses to the module was 88%, including very high criteria as many as 27 students and 20% of students including high criteria (8 students). The results of the analysis of student response questionnaires show that the test tools are creative and easy to use. Based on student responses, it can be concluded that creating a module that aims to measure students' scientific literacy and HOTS regarding buffer solution material can be something more interesting, useful and interesting to use.

Development of a PBL-based module on buffer solution material is the next step. At this stage, research instruments such as material expert validation questionnaires, media expert validation, and student response questionnaires were created. These instruments will be used throughout the research process. As explained in research by Mudhakiyah et.al (2022), validation of questionnaire instruments aims to be a tool in conducting research and obtaining valid and objective results. The results of instrument validation by one of the expert lecturers were found to be suitable for use with revisions for use in research. Then change some of the editorial words on the questionnaire instrument so that they match the indicators and are easy to understand.

In addition, the module is validated by one lecturer who has expertise in the material and media. The assessment results of the average validation percentage of media experts are 90 percent with a very high category that can be used, and the results of the assessment of the average percentage of validation for material experts are 97 percent with a very high category that can be used, but there are several changes. According to research by Safriani and Lazulva (2021), validation is carried out to find and correct errors in learning media. Vaidator consists of material experts and media experts; After experts declare it feasible, the module developed can be used for testing.

Furthermore, the student response questionnaire contained 31 items related to the PBL-based module and the resulting buffer solution material. This questionnaire was given to 35 class XI B students of Cinta Kasih Catholic High School, Tebing Tinggi City; the average response rate was 88%, which is very high. to ensure that PBL-based modules that focus on

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buffer environments are well received and ready to be used in educational activities. According to research by Nurhayati et al. (2021), if the module structure is supported by an appropriate and interesting learning model, students will be more motivated and pay attention to what they are learning.

The advantage of this PBL-based module on buffer solution material is that it is a learning resource that can help students discover PBL-based learning on buffer solution material. This PBL-based module can also be used at any time as needed, and helps teachers as a learning medium and learning resource apart from the textbooks provided by the school. The module allows students to express and explain what they know about buffer solution material. This allows teachers to measure students' levels of scientific literacy and HOTS and students' learning levels. The disadvantage of this PBL-based module is that the module is printed using a conventional printing machine, which produces images that are not optimal because the images are only downloaded from websites and some pages have images that are out of focus.

The findings when applying the PBl-based Module to buffer solution material were that students were more enthusiastic about learning because the learning that would be carried out was problem-based learning, where problem-based learning is very rarely done in class. Then student participation increases because learning uses school facilities in the form of a projector/infocus which is able to increase students' focus on the teacher when providing explanations and directions during learning.

Conclusion

Based on the results of the research and discussion in the previous chapter, it can be concluded that the application of the Problem Based Learning learning model can improve literacy and HOTS. The design of the module to measure students' level of scientific literacy and HOTS on buffer solution material is suitable for use with the results of expert validation of the module producing an average percentage value for content suitability of 90% with very high criteria. Meanwhile, student responses to the module were generated from the student response questionnaire sheet with the average percentage of student responses to the module obtained being 88%, including very high criteria, 27 students and 20% of students including high criteria (8 students). Based on student responses, it can be concluded that creating a module that aims to measure students' scientific literacy and HOTS regarding buffer solution material could be something more interesting, useful and interesting to use.

Recommendation

The research that has been conducted is expected to be able provide assistance from various parties as useful information for future progress. The parties include. 1. Test modules and instruments must be created not only for buffer solution material so that students' ability to understand other buffer solution material can also be measured. 2. Field trials must be carried out in several locations with a smaller number of respondents so that the feasibility and effectiveness of the modules used can be assessed.

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