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DEVELOPMENT OF CONTEXTUAL-BASED CHEMISTRY TEACHING MATERIALS ON THE SUBJECT OF BUFFER SOLUTION IN SENIOR HIGH SCHOOL

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ABSTRACT

This study was aimed to analyse: (1) Development of contextual-based chemistry teaching materials on the subject of BSNP standardized buffer solutions, (2) Validity of lecturers and chemistry teachers on developed chemistry teaching materials, (3) Improvement of student learning outcomes with the use of contextual-based chemistry teaching materials on the subject of developed buffer solutions. The research method uses R&D with ADDIE model.The instruments used are in the form of interview sheets, BSNP standardized teaching material validation sheets, student response questionnaire sheets, and test question instruments as many as 20 valid questions. After being validated, this teaching material was tested to students of class XI IPA 1 SMA N 11 Medan in the 2023/2024. The research results obtained, namely: (1) The development was carried out using the R&D method with the ADDIE development model which was adjusted to the BSNP eligibility standards, (2) The results of validation obtained an average value of 3,64 with valid criteria and feasible to use and based on student response questionnaires to teaching materials obtained an average value of 92,23% with very good criteria (3) The results of the N-Gain analysis obtained by 0,33 with a medium category,there is an increase in student learning outcomes.

Keywords: contextual; buffer solution; teaching materials; ADDIE

INTRODUCTION

Education is the process of learning the knowledge, skills and practices of a group of people, which is transmitted from generation to generation through teaching, training and research. Learning is essentially interactive process between students and learning resources. Thus, the role of a teacher is needed to develop the potential and abilities of each student. In accordance with the statement of Slameto that "A teacher must be able to generate an individualized spirit of learning", by giving students the freedom to develop the ability to think innovatively and creatively in learning (Rahman, 2022).

Recently, the quality of education had became a serious agenda for discussion, both among education practitioners, politicians, the public and those who made policies. Many people believed that, in comparison to neighboring countries, the leveled of education in this country was inadequate. Quality of our education getted worse when compared to other large countries. Whereas education was an important variable in the intelligence of the nation (Jasnawi, 2019).

Based on Political and Economical Risk Consultant (PERC) report places Indonesia's educational system 12th out of 12 Asian nations. Indonesia was ranked lower than Vietnam. Based on the data from The World Economic Forum Sweden (2000), Indonesia, which only comes in at number 37th out of 57 countries surveyed worldwide, has low competitiveness. Furthermore, based on a poll conducted by the same organization across 53 nations worldwide, Indonesia was only ranked as a follower of technology, not a leader. As the

twenty-first century approached, Indonesia's educational sector grew enthusiastic. The excitement stemmed more from understanding of the risks associated with Indonesia's school system's underdevelopment than from the country's excellent educational system. (Agustang, et al., 2022).

Based on observations on 2nd November , 2023 at SMA N 11 Medan with a chemistry teacher, it is known that chemistry was a subject that was considered difficult to understand, so students was less interested in learning it. This is related to the characteristics of abstract science concepts that make chemistry difficult to learn. One of the chemistry materials that are considered difficult to learn is buffer solution material. The results of observations or observations and interviews with teachers and students show that the learning approach used tends to be teacher centered approach. The chemistry learning process tends to be monotonous and less interesting. Students only receive an explanation of the material and then do the questions. Therefore, the value of chemistry subjects has not reached the optimal level.

The learned process involving teachers and students would not separated from taught materials, even though the teacher could explained the material clearly and completely, the needed for taught materials remained a priority. The quality of learned was low when educators was only fixated on conventional teaching materials, without any creativity to developed these teaching materials innovatively (Munna, 2021).

One of the efforts founded to been made to improved the quality of education was to developed taught materials into various formed of taught materials. Teaching materials had many varieties and formed. To developed study materials, teachers, that is constantly improved their abilities. If you did not had the ability to develop varied teaching materials, the teacher would have trapped in a monotonous learned situation and tended to be bored for students (Hamdani, 2011), teaching materials should be able to qualify as learned materials because many teaching materials used in learned activities, generally tended to contained only subject information and was not well organized (Pratiwi, 2021). One of the easiest teaching materials for teachers to made was modules because they did not require expensive tools and high skills. Modules are one of the various forms of printed teaching materials. Printed teaching materials could have been in the form of student worksheets (LKS), handed outs, leaflets, wilcharts, booked, modules, brochures, and others (Hamdani, 2011).

According to Burhanuddin the curriculum was considered to play an important role in the world of education, this is because the curriculum was used as a learning design in all learning activities which means it will determine the process and results of education, so the curriculum is the key to success in the world of education. With teaching materials, teachers will be more guided in delivering material to students (Burhanuddin, 2022).

One of the easiest teaching materials prepared by teachers is printed teaching materials. Teachers should also not work haphazardly when developing teaching materials. Everything must be done systematically. The content of the

study material should also arouse the interest of students or readers. Because the purpose of
developing learning materials is to help students get alternative learning materials other than textbooks. It should also make learning activities more interesting (Rizaldi, et.al., 2020).

Some research on student self-learning packages includes a series of learning experiences that was systematically planned and designed to help learners achieve learning objectives. According to Russel in Wena (2014), the module learning system will make learning more efficient, effective, and relevant. Modules are teaching materials that could be used as a means of student learning, because the modules are equipped with instructions for independent learning for students (Depdiknas, 2008). The role of the teacher in learning using modules is as a facilitator rather than dominating learning (Pratiwi, 2021).

In ordered to been more supportive in addition to innovative taught materials, it was also important to used methods related to everyday life, namely contextual learned. According to contextual learned theory, learned only occurred when students process new information or knowledge in such a way that the information or knowledge was understood by them in their owned framed of reference (memory, experience, and response). In contextual-based learned and approaches or known as CTL (Contextual Taught and Learning), students expected to learn through 'experiencing' not 'memorizing' (Hartono and Afni, 2020).

Contextual Teaching and Learning (CTL) is a concept that helps teachers connect classroom material to real situation. CTL motivates students too take responsibility for their own learning and connect knowledge and its application to various situations in their lives: as families, citizens, and workers. In Indonesia, contextualized learning (situated teaching and learning) is understood as a learning concept that helps teachers connect the learning materials taught with students' real-life situations and connect students' knowledge with applications in everyday life (Hasudungan, 2022).

According to Samriani (2020) , Contextual Teaching and Learning (CTL) is learning that focuses on the process of helping students discover material and connect it to real-life situations so that they can apply it in their lives. From the above definition, it can be seen that students are able to absorb lessons when they understand the academic material they receive, and they are able to understand school assignments when they use the knowledge and experience they already have to learn new information.

According to Blanchard, Berns, and Erickson stated that, Contextual teaching and learning (CTL) is a pedagogical approach that emphasizes connecting academic content to real-world situations, experiences, and applications. The primary goal was to make learning more meaningful and relevant for students by integrating subject matter with practical, everyday contexts (Komalasari, 2017).

According to Hasibuan,contextual learning was defined as a system that stimulates the brain to form patterns that

create meaning. Additionally, Elaine points out that contextual learning is a way of learning that is aligned with how the brain functions, creating meaning by connecting academic content to students' everyday situations.On the other hand, Howey R. Keneth describes CTL (Contextual Teaching and Learning) as “Learning that enables a learning process in which students apply their academic understanding and skills in a variety of situations both inside and outside of school to solve simulated or real-world problems independently or in collaboration with others." (Hasibuan, 2014).

Based on research by Tukan, et al (2021), that the implementation of taught materials that had standardized in learned showed that contextual-based taught materials could helped students to achieve competencies according to curriculum demanded. Teaching materials was very effective in improved student learned outcomes in teaching buffer solution material, all indicators of contextual booked teaching materials was well achieved. This supported by data from the teaching material trial results which showed that each indicator in each questionnaire reached an interpretation valued above 70%. Thus, contextual booked teaching materials on buffer solution materials could have used as a companion to learned media in class XI science high school chemistry subjects.

METHOD

The research method used in this study was research and development methods (R&D). Product development is invoked using the pattern ADDIE, namely,analysis, design, development, implementation and evaluation. In this study,reserarch design in the form of a one-group pre-test and post-test design was used. This design was chosen because there was only one group (class) that was sampled and there was no control class as a comparison group. The population in this study are all chemistry lecturers at UNIMED, all chemistry teachers at SMA N 11 Medan and all grade XI students..This study was conducted in the even semester of the 2023/2024 academic year in class XI IPA 1 with a sample of 35 students at SMA N 11 Medan. Data collection techniques in this study was in the form interview sheets, validation sheets for BSNP standardized teaching materials, student response questionnaires, and test instruments as many as 20 valid questions.

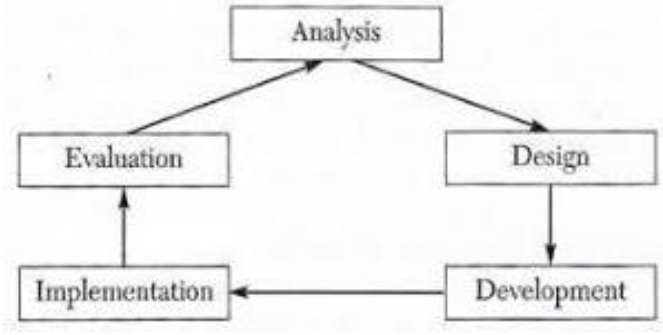

Figure 1. Steps of the ADDIE Model

RESULTS AND DISCUSSION

Analysis

The most important activities at this point conducting a needs analysis, analyzing student reserve and analyzing learn objectives in the class XI IPA 1 SMA N 11 Medan. The results of the analysis was as follows stage:

a) Requirement Analysis

At this stage of the requirement analysis, researchers conducted initial activities in the formed of interviews and observations of the used of taught materials used by Chemistry teachers in class XI IPA1 during taught and learned activities. Based on the results of interviews with chemistry teachers at SMA N 11 Medan, Medan City, it founded that in learned Chemistry had not used a variety of teaching materials, only used textbooks available at school. The results of observations and interviews with teachers showed that the learned approached used also tended to been teacher centered approached, therefore students only received explanations of material and then worked on questioned, as a result the valued of chemistry subjects had not reached the optimal leveled, so researchers interested in developed chemistry taught materials for buffer solution materials, in ordered to better supported in addition to innovative teaching materials, it was also important to had done with the used of ways or methods related to everyday life, namely with a contextual approached.

b) Analysis of Student Characteristic

The process of analyzing learner characteristics was an understood of the specific skills, prior knowledge, learned styles, and attitudes of learners to been ready to carried out the learned process used teaching materials. Accurate identification of learner characteristics could helped in chose and determining the learned strategies that would have used information (Dewi, 2023).

Based on the results of several student interviews, that students interested in chemistry lessons was still lacking. Students felt that chemistry subjects was difficult and unpleasant, and during the learned process only used textbooks at school and the approached taken by the teacher during the learned process tended to been teacher-centered, so researchers developed innovative taught materials and an appropriate approached needed so that chemistry lessons was easily understood by students.

c) Formulating Learning Objectives

At this stage, Learning objectives needed to formulated in advance to provided limitations to researchers so that researchers did not wrote taught materials excessively (Mulyatiningsih, 2012). Learned objectives was made based on the analysis of KI, KD, and indicators that adjusted to the 2013 curriculum and subject syllabus. KI, KD, and indicators are displayed in taught materials so that students could saw the material to been studied.

Khaidir et al., (2021), in their researched stated that the media development process based on a needed analysis that had carried out previously, that the media was currently needed in the learned process for both teachers and students. Therefore, the teaching materials developed must based on the needed analysis carried out. Taufik (2019), in his researched stated that the analysis of the initial abilities of students in developed a medium or taught material is an activity of identified students based on needs and characteristics the specifications and qualifications of changed in behavior or goals and materials. Then according to Widodo and Jasmadi in the booked (Lestari,

2013) stated in his research that teaching materials was a set of learned tools or tools that contained learned materials, methods, boundaries, and ways to evaluate which was systematically designed and attractive in ordered to achieve the expected goals, namely achieving competencies and subcompetencies with all their complexity.

Design

This stage was carried out to provided an overview of the material and learned activities that would have contained in the teaching naterials. At this stage, if there was a mismatch between the design made the needed of users, then some improvements needed. At this stage also, if the developer planned to developed a learned design or taught design, then the developer needed to design according to what is researched. If the developer in this case developed teaching materials, the developer must been able to learned objectives, task analysis and assessment criteria in accordance with the teaching materials to be compiled.

The project phase was the phase of product (media) planning that includes making teaching material design, preparation of materials, exercises, and assignments, and collection and creation of background, cover and layout :

a) Making Teaching Material Design

The design of teaching materials describes the overall relationship between the parts in the the study materials, the design of the study materials was prepared so that process of making further teaching materials and functions like a map in the guide to making teaching materials. The design of the teaching material draft, presented in table 2.

Table 2. Draft Teaching Materials

No	Draft Learning Materials	Learn Materials
1	Cover	**I. Introduction to Buffer Solutions** (Constructivism) **II. Buffer Solution Materials** **Recall** A. **Defenition of Buffer Solution** - Material - Chemistry in Everyday Life B. **Component of Bufer Solution** - Material - Question Example - Discussion - Strong & Weak Acid-Base Name List Weak - Scientific Activity 1: Determination of Buffer Solution - Chemistry in Everyday Life - Learning Video **Recall** C. **Calculation of pH of Buffer Solution** - Material - Chemistry Info - Question Example - Learning Video - Chemistry Facts - Evaluation 1 - Chemistry in Everyday Life D. **Preparation of Buffer Solution** - Material - Chemistry Info
2	Preface	
3	Table of Contents	
4	Instructions for use of teaching materials	
5	Material Overview - Core Competencies - Basic Competencies	
6	Concept Map	
7	Learning Objectives	
8	Material Discussion	
9	Illustration	
10	Chemistry Info	
11	Info Link	
12	Recall	
13	Chemistry Figures	
14	Chemistry in Everyday Life	
15	Summary	
16	Reflection	
17	Competency Test	
18	References	
19	Glosary	
20	Answer Key	
21	Index	
22	Periodic System of Elements	

		- Lets Discuss (Inquiry Activity) E. **Effect of Adding a Little Acid or Base, Dilution on Buffer Solution** - Material - Question Example - Evaluation 2 - 10 acid and base facts - Chemistry in Everyday Life - Learning Video

b) Preparation of Materials, Exercises, and Assignments

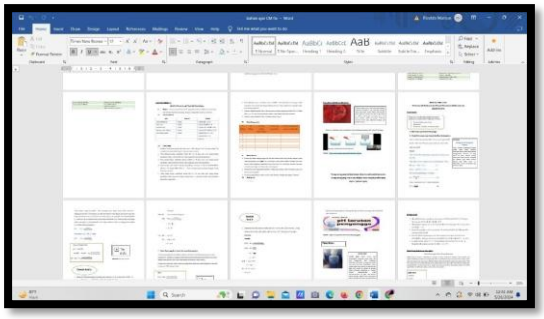

Figure 2. Typing Material in doc format

Based on figure 2, typing material in doc format, the materials, exercises and activities contained in the teaching materials awascompiled from various references. The materials presented in the teaching materials are typed in calibri format with fonts sizes 12 and 16, using Microsoft Word 2010.

c) Collection and Creation of Background, Cover and Layout

Figure 3. Cover Layout

Based on figure 3, cover layout, the images and backgrounds used in making teaching material covers was done using the Adobe Illsutrator application. Volume of study material chosen uses A4 paper (21 x 29.7 cm). The images used are downloads from various sources from the internet.

d) Preparation of teaching materials evaluation tools

Preparation of teaching material assessment instruments in the form of teaching material assessments, student response questionnaires, and test questions. The test formulation strategy was very important in the development of teaching materials, because it was useful for measuring the level of students' understanding of cognitive aspects useful for measuring the level of student understanding while studying teaching materials. In addition, it was also a tool to measure the performance of the teaching materials being developed. Kurniawan, (2021) states that attractive teaching materials have self instructional characteristics, namely presenting assessment instruments such as exercises/tasks and self-tests that aim to evaluate the learning activities that have been carried out. learning activities that have been carried out. As stated by Idrus,

(2019) the purpose of the test was to determine the level of student performance in the learning process and to inform students how much support can be given for their shortcomings. The goal was to place students in a more appropriate learning situation according to their skill level. While its function is to continue to support the process, progress and development of student learning outcomes.Febriana & Sakti, (2021) suggest that the first step in the design stage was the preparation of a standardized test as a reference to determine changes in students' knowledge.This underlies the importance of evaluation in the learning process, this learning evaluation was carried out to determine whether or not the learning objectives are achieved. This is in line with research Siagian & Sarwandi, (2021) that the preparation of test standards was based on the results of analysis of learning objective specifications and learner analysis. From this, a lattice of learning outcomes tests is compiled, the purpose of compiling the test is to find out the students' understanding after teaching students' understanding after teaching using the teaching materials developed.

Development

It was implemented in the development phase by developing the results of the design at the design stage into teaching materials and according to needs. Contextual-based teaching materials will be developed based on the syllabus, and from previously analyzed chemistry books (Utami and Kurnia, 2022). The results at this stage include all content and material, validation of teaching materials, revision of teaching materials.

Producing material content, this stage was the product realization stage, namely the manufacture of contextual-based chemistry teaching materials on the subject of buffer solutions in high school. After that, teaching materials are givento expert validators, namely academics and chemistry teachers, who
then evaluate the cartoon. Learning media are said to be good to use if they have gone through several stages of evaluation. The purpose of evaluating this learning material is to determine the quality of the product before it is issued to students. All data and input are used as a consideration for improving teaching materials. The results of the analysis of the feasibility test assessment of teaching materials based on the BSNP questionnaire are shown in Table 3.

Table 3. Feasibility of Teaching Materials by Validators

BSNP Feasibility	Validators	
	Lecture	**Teacher**
Content Feasibility	3,66	3,50
Presentation Feasibility	3,50	3,37
Language Feasibility	3,90	3,63
Graphics Feasibility	3,75	3,55
Contextual Assesment	3.77	3,88
Average	3,71	3,58
Average Total	**3.64**	

From the analysis of the assessment of contextual-based teaching materials in table 3, the average valued of the feasibility test based on BSNP is 3.64 with the criteria of valid.

The results of the assessment of the feasibility of teaching materials from expert validators in the questionnaire sheet conveyed that the teaching materials as a whole were valid and feasible to be tested.However, before being implemented, there are several suggestions given as follows: (i) correct typing errors in learning objectives and add a few pictures (ii) improve index writing, and (iii) improve bibliography writing. After the teaching materials was evaluated, then some revise had been improved as follows:

Figure 4. Learning Objectives,before revision

Figure 5. Learning Objectives,after revision

Based on Figure 4, before revision, the design of learning objectives made with pictures in addition to the description of learning objectives. After the Teaching Materials were given to the validators, the Teaching Materials received comments and suggestions for improvement, where the learning objectives included must be in accordance with the Learning Implementation Plan, there are also typing errors, and there is still white empty space, especially at the top which is not illustrated at all. Therefore, revisions were made by rearranging the layout of letters and spaces in teaching materials as in figure 5, after revision.

Figure 6. Index numbers,before revision

Figure 7. Index numbers,after revision

Based on figure 6, before revision in the initial design of writing the index numbers of several chemical compounds, there were errors in writing the index numbers. After being validated and given comments and suggestions for improvement by the validator, the teaching materials were revised as shown in figure 7, after revision.

Figure 8. Bibliography,before revision

Figure 9. Bibliography,after revision

Based on figure 8, before revision in the initial design of the bibliography, there were still few additional references, after being validated and given improvement suggestions by the validator, the teaching material references were added so that the material coverage was wider as in figure 9, after revision.

It was consisting to the research of Rama, et al., (2022) stated that the purpose of validation is to obtain assessments, input, and suggestions for validation is to obtain assessments, input, and suggestions for improving and refining the learning module so that it will be obtained. Improvement and refinement of the learning module so that it will be obtained learning module products that avoid errors so that they are worth testing try out. The next stage is to make revisions or improvements as necessary to the learning module according to the input and suggestions of experts. Syafi "i & Mariono, (2022) in their research found that the teaching material media developed obtained very good feasibility on the results of material and media validation. Further research conducted by Nurdin,et.al, 2023 shows that the results of media validation obtained a score of 94% with a very feasible category, the results of material expert validation obtained a score of 80% with a decent category, the results of linguist validation obtained a score of 82% with a very decent category, and the results of the first teacher's response score with a percentage of 80% with a decent category, the results of the second teacher's response obtained a score with a percentage of 81% with a very decent category.

Implementation

At this stage, the application of contextual-based chemistry teaching materials is carried out to 35 students of class XI IPA 1 which aims to determine student learning outcomes. To measure student learning outcomes on the trial of contextual-based chemistry teaching materials, a pretest was given before teaching treatment, then continued with teaching using chemistry teaching materials that had been developed. After that at the end of the treatment a posttest was conducted.

Figure 10. Learning Using Developed Teaching Materials

Based on Figure 10, the implementation stage is used to assess the learning results of students who are taught using created and printed teaching materials. The learning process is tailored to the Teaching Process Design (RPP). Learning about buffer solution material is done with specially designed instructional materials.

Based on research by Tukan, et al., (2021), that the implementation of teaching materials that have been standardized in learning shows that contextual-based teaching materials can help students to achieve competencies according to curriculum demands. Teaching materials are very effective in improving student learning outcomes in teaching buffer solution material, all indicators of contextual book teaching materials are well achieved. This was supported by data from the teaching material trial results which show that each indicator in each questionnaire reaches an interpretation value above 70%. According to some research on contextual learning strategies, this learning strategy is effective for improving student learning activities and outcomes. Research by Utami and Fajar Nur Aktorika Dwi Saputri (2014) provides results that the increase in student learning activities through a contextual approach is indicated by the percentage of Visual Activities aspects of 85.00% (very active) and an increase in student learning outcomes can be seen from the effect size is done by taking pretest and postest scores obtained by students by comparing the KKM scores at school. . In addition, research by Elvinawati (2012) shows that the application of Contextual Teaching and Learning (CTL) which requires active involvement of students in building and making links between the concepts learned can improve student mastery of the subject matter.

Contextual learning is a teaching and learning concept that helps teachers link the material taught in the classroom with real world situations and encourage students to make connections between their knowledge and its application in their lives as individuals, family and community members. Contextual learning helps students find creative ideas in the learning process through discovery, reinforcement,

and connection in the real world that is directly experienced by students, students will work hard to achieve their learning goals by using previous experiences and knowledge to build new knowledge, then students reuse their understanding and abilities in contexts outside of learning so that students will easily understand and remember what they learn. Applying the principles of contextual learning is expected to make learning more meaningful for students, because students will work scientifically and experience themselves not just transferring teacher knowledge to students (Muhartini, 2023).

Evaluation

The evaluation stage was carried out with the aim of validating teaching material products that have been developed through expert tests and product tests. At each stage of the development of teaching materials, there are evaluations and revisions made to improve the products produced. At the Evaluation stage is done by looking at student responses. To see students' responses to the teaching materials developed, students were given a student response questionnaire with 3 indicators of assessment, namely interest, material and language of teaching materials. Thus the results of the analysis and trial of contextual-based teaching materials received a positive response from respondents and can be used as a companion book in learning buffer solution chemistry.

CONCLUSION

Based on the results of the research that has been done , it can be concluded that this contextual-based chemistry teaching material can be developed with the ADDIE model. The average value of the feasibility test based on BSNP is 3.64. Students are really excited about the content being taught. There is an increase in student learning outcomes when using context-based chemistry teaching materials in buffer solutions. The results of the N-gain analysis show a value of 0.33 in the medium category, and student responses to teaching materials reach an average value of 92.23% with the criteria. The instructional materials are excellent and very practical to utilize. This study concludes that this teaching material is efficient for use in teaching chemistry, particularly buffer solutions.

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