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Development of Learning Media Integrated with Problem Based Learning Model Using Android-Based Application

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Abstract: *The use of learning media is influenced by technological advances in education. This is because the educational process is pressured to improve the quality of learning by producing more applicable and engaging content. Mobile technology can be utilized as an alternative learning medium because the use of mobile devices greatly expands the educational process's potential. The purpose of this research is to create a learning medium that combines a problem-based learning model with an Android-based application. The model used for development is the 4D model, which consists of four stages: Define, Design, Develop, and Disseminate. The results of the study indicate that 93.8% of respondents agree with the existence of android learning media for chemical bonding subjects, that 90.1% of the material from the material expert was categorized as "very valid," and 87.39% of the media from the media expert was deemed "very valid," and that 80.69% of student responses were categorized as "very good" so that the developed of learning media get positive response from students.*

Keywords: *Learning media; Android-based application; Problem Based Learning; 4D Model; Chemical Bonding.*

INTRODUCTION

The development of information technology is one of the primary pillars of education in the 21st century. The 21st century education paradigm emphasizes students' abilities to think critically, develop knowledge in the real world, master information technology, and communicate and collaborate. This has a positive impact on education. Education is a process of learning so that students can reach their full potential.

Effective learning with effective media is how students' potential is developed. Effective learning is learning that involves the student's participation to optimally attain the learning objectives. The core of the learning process is the communication between the message source (the instructor) and the message recipient (the students). A learning medium must match the characteristics of the material to be communicated to facilitate the process of message transmission. Using appropriate learning media in the learning process can generate new desires and interests, encourage students to take an active role, and stimulate learning activities that can have a psychological effect on students (Kurniawan & Hidayah, 2021).

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Chemistry is the study of the composition and properties of an object, as well as its changes and formation, and is a branch of natural science that encompasses concepts, rules, laws, and theories (Saputra et al., 2021). Majority chemistry concepts include macroscopic, submicroscopic, and symbolic representations, which make them especially difficult for students to grasp. In chemical learning, oral submission of material is insufficient. Therefore, it must be supported using media that functions as a teaching aid in the process of learning. Chemical bonding is a challenging concept that can lead to misunderstandings (Mugitsah et al., 2020).

Chemical bonding is the physical interaction of attractive forces between atoms or molecules that stabilizes diatomic or polyatomic compounds (Zulfadhilah et al., 2020). It is challenging to contextually employ the abstract concepts of chemical bonding. Concepts in chemical bonding require a great deal of imagination; therefore, chemical bonding material must be visualized as a picture for students to comprehend. This visualization is also known as a learning medium. There are numerous forms of learning media available today, but online learning media are the most suitable option due to technological advancements.

The utilization of learning media is influenced by technological advancements. This is because the educational process is pushed to improve the quality of learning by producing more applicable and engaging content. Using learning media, students can gain a deeper understanding of chemistry and develop a fondness for it. Utilizing widely-owned technology devices is one method of assisting these learners (Saputra et al., 2021). A lot of students are interested in obtaining information from online sources as opposed to traditional media. As a result, mobile technology can be utilized as an alternative learning medium, as the use of mobile devices greatly expands the educational process's potential (Zulfadhilah et al., 2020).

In addition to learning media, instructors must select the most effective model to convey a concept to students. The chemistry materials have close ties to human existence and must be observed to solve problems within. Therefore, the appropriate learning model is the Problem-Based Learning (PBL) model (Dakabesi & Luoise, 2019). The Problem-Based Learning model is one of the learner-centered models because it challenges students with real-world issues. The Problem-Based Learning (PBL) model is a method of presenting lesson content in which students use the problem as a starting point to discover solutions or answers.

According to initial observations and interviews conducted at SMAN 11 Medan, there were several obstacles to the learning process, including a teaching and learning process that was still teacher centered. This is evident from the students who recorded the teacher's instructions more frequently. This can result in students becoming inactive and less enthusiastic about completing assigned tasks. Teachers have also discovered that learners continue to have difficulty comprehending chemical bonding material in school. Class X of SMAN 11 Medan already displays an Android-based smartphone. Nonetheless, there are no learning resources that utilize smartphones, particularly learning applications. Seeing this potential, the development of cell phone-based learning media aims to create Android-based learning media for all Smartphones running the Android operating system. Android, which has distinctive features and can be used anywhere and at any time, and is supported by appealing visuals, can assist students in comprehending the chemical bonding of materials.

Based on the description above, the researcher is interested in conducting research in the form of developing a learning media with the title "Development of Learning Media Integrated with Problem Based Learning Model Using Android-Based Application on Chemical Bonding Material".

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LITERATURE REVIEW

The term media is defined with multiple, both narrow and broad meanings. The emergence of diverse definitions as a result of disparities in perspective, intent, and purpose. The media consists of films, audio, recordings, and photographs. All of these are considered learning media when used to convey messages for the purpose of education. Learning media serves as a conduit for learning messages and data. Effective instructional media will significantly aid students in achieving their academic objectives (Ramdhani & Muhammadiyah, 2015). Learning media is important in the learning process because it is a tool or channel for messages that can represent the teacher in conveying information in a more thorough, clear, and engaging manner and makes it simpler for students to comprehend the learning material presented (Okta Priantini, 2021). Learning media is a tool that can be used to convey messages and stimulate the learning process in order to elucidate the meaning of messages conveyed to students in acquiring knowledge, skills, or attitudes (Novaliendry et al., 2020).

Android is a mobile-device operating system (Lukman et al., 2020). Android is an operating system that comprises an operating system, middleware, and applications for Linux-based mobile devices. Based on a modified variant of Linux, Android is a mobile operating system. The Android operating system was initially developed by the corporation Android Inc., whose name was eventually adopted as the project's name. Android is a new iteration of mobile platforms, a platform that enables developers to create applications in accordance with their expectations (Putra et al., 2020). Android provides developers with an open platform for application creation. The most prevalent operating system is Android. Android's swift expansion is due to the large number of smartphone manufacturers that have adopted this operating system.

The problem-based learning model is student-centered. Problem-based learning enables students to conduct research, integrate theory and practice, and employ their knowledge and skills to create an active solution to a problem (Komisia & Aloisia Uron Leba, 2018). Permendikbud No. 22 of 2016 stated that a problem-solving-based learning approach is highly recommended for fostering students' ability to generate contextual work both individually and in groups. Problem-based learning models can train students' problem-solving skills so that they can comprehend the material by employing their existing concept skills (Carisma & Novita, 2017).

METHODS

This study employs research and development (R&D), and the development model used is the 4D model, which comprises four stages: (1) Define, (2) Design, (3) Develop, and (4) Disseminate. This study was conducted at SMAN 11 Medan, with the population and sample consisting of all class X IPA SMAN 11 Medan students in the academic year 2022/2023. The sample for this research was collected using the total technique.

This study employed instruments for requirements analysis, instruments for media and material experts, and a student response instrument. Four techniques were employed to collect data: (1) observation, (2) interview, (3) validation, and (4) documentation. Using descriptive data, the collected data on requirements will be analyzed. The results of questionnaires filled out by media and material experts yielded information regarding the product's viability. Then, the data is analyzed by calculating the value of the average score of all assessment indicators derived from the validator using the formula:

$$P = \frac{Total\ score\ of\ validators}{Maximum\ score} \times 100\%$$

Using the following criteria, interpret qualitatively the proportion of obtained results: (Kurniawan & Hidayah, 2021)

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Table 1. Product Validity Criteria

Percentage (%)	Category
0 – 20	Not valid
21 – 40	Less valid
41 – 60	Quite valid
61 – 80	Valid
81 – 100	Very valid

Student response questionnaires were administered to determine the responses of students given four answer options per query. Then, student response data is analyzed in accordance with the criteria:

Table 2. Student Response Assessment

Percentage (%)	Category
$x \geq 80\%$	Very good
$60\% \leq x < 80\%$	Good
$40\% \leq x < 60\%$	Less good
$20\% \leq x < 40\%$	Very less good

RESULT AND DISCUSSION

This development research requires to create learning materials that integrate the Problem-Based Learning (PBL) model with the "ChemLearn" android application. The Android package (apk) file size for this application is 147 MB. The 2013 curriculum is reflected in the content of this chemical bonding resource for 10th grade. Learning media employs a 4-D paradigm of development, namely Define, Design, Develop, and Disseminate.

The define phase commences with a preliminary investigation at SMAN 11 Medan. This stage's objective is to identify students' problems and requirements. There are five steps that must be completed. 1) Front-end analysis. At initial stages of the study, a front-end analysis was conducted to identify information pertaining to difficulties in the process of learning chemical bonding in class X SMAN 11 Medan. At this juncture, interviews with teachers at SMAN 11 Medan and observations of teaching and learning activities were conducted. Based on the results of observations of teaching and learning activities, teacher interviews, and the results of the needs questionnaire that was distributed to students, it can be seen that the majority of students find it difficult to learn chemical bonds. It is hoped that interesting learning media and new learning models will be developed to help students study. An Android-based application and the Problem-Based Learning model can be used as a form of instructional media. 2) Learner Analysis. At the learner analysis phase, questionnaires were distributed to assess student requirements regarding learning media and learning models. The purpose of conducting a requirements analysis through questionnaires and interviews is to determine the learning media products to be developed based on the problems in the learning process, the difficulties encountered, and the media used during the learning process (Wardani et al., 2019). After obtaining a data analysis of the requirements of students and teachers, the data is descriptively and quantitatively processed. The results of the interviews were detailed in detail based on what the respondents said, while the data from the questionnaire were processed quantitatively (Mahartika et al., 2020).

From the results of the analysis of student needs, it can be determined that the majority of students use Android smartphones for 1-12 hours per day, with the majority of this time spent on entertainment needs as opposed to educational ones. This is consistent with the findings of Cha & Seo's study, which indicates that students use electronic devices such as smartphones for longer periods of time to access social media and entertainment requirements than to meet their educational needs (Cha & Seo, 2018). The researcher then selects learning media in the form of inactive applications that can be accessed using an Android smartphone, based on the characteristics of students in relation to their smartphone usage. The purpose of this offline application is to allow students to remain focused on learning applications without being distracted by social media and other online-only entertainment.

In terms of education and learning, smartphones play a phenomenal role at the present time (Darko-Adjei, 2019). This is consistent with the number of students who concurred that the use of smartphones to

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facilitate their learning in this age is essential. According to Masiu and Chucwuere, the smartphone has also made students' lives simpler by allowing them to access school information on the device through electronic learning and mobile learning (Ifeanyi & Chukwuere, 2018). Education makes extensive use of smartphone technology with multiple operating system platforms, such as Android. As learning media, various forms of applications can be developed to support the learning process outside of school (Saputra et al., 2021).

Teachers and students of SMAN 11 Medan have never used learning media in the form of a learning media integrated with a Problem-Based Learning model utilizing an android-based application to teach and learn chemistry, particularly chemical bonding material. Consequently, the teacher and students concur with the development of the "ChemLearn" application as a learning medium integrated with the Problem-Based Learning model and an android-based application with a 93.8% agreement rate (210 students agree) because it can be an innovation in learning chemical bonds. Table 3 displays the outcomes of the student needs survey.

Table 3 reveals that 98.2% of students in class X IPA, or a total of 220 students, have utilized and utilized smartphones with the Android operating system in their daily lives. Regular use of these devices is 84.4% among pupils with a usage period of 10 years accounting for 76.3%. 82.1 percent of students use their smartphones for 1 to 12 hours per day, with 25.4 percent using them for learning and 74.6 percent for social media/games/entertainment.

Schools support smartphone facilities by not prohibiting their use if this facilitates the process of teaching and learning activities and the attainment of predetermined learning goals. A total of 166 students, or 74.1%, responded negatively when asked if they could use Wi-Fi facilities provided by their school. In subjects such as biology, mathematics, ICT, physics, and language,

95.1% of teachers employing Android learning media have implemented the use of learning media in schools.

Approximately 98.2% of students believe that the use of smartphones to facilitate learning is essential in the current era, and 96.9% believe that android learning media makes learning more enjoyable. Due to numerous factors, 87.9% of students have difficulty mastering chemical bonding subjects. As many as 197 students had difficulty learning chemical bonds due in part to the instructor's continued use of lecturing and questioning in the classroom. In the teaching and learning process of chemical bonding, teachers must adopt a new learning model, as 82.6% of students agree with.

Nonetheless, according to the results of the questionnaire distributed to assess student needs, 57.6% of students felt that the teacher's explanation was sufficient to understand chemical bonding material, while 42.4% felt that it was not sufficient to simply listen to the teacher's explanation. In teaching chemical bonding, 87.1% of students reported using textbooks and PowerPoint presentations.

Table 3. Student Needs Questionnaire Results

Question	Answer	%
Do you have an android smartphone?	Yes	98.2
	No	1.8
Do you use an android smartphone regularly?	Yes	84.4
	No	15.6
Period of use of an android smartphone	< 10 years	76.3
	> 10 years	23.7
How long have you been using an Android smartphone? (hour/day)	1–12	82.1
	> 12	17.9
For what purposes do you often use an Android smartphone?	Study	25.4
	Social media/games/entertainment	74.6

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Can all students access the Wi-Fi at school?	Yes	25.9
	No	74.1
Has your teacher used Android-based learning media in the learning process??	Yes	95.1
	No	4.9
If yes, how often is the use of android-based learning media in the learning process?	Every meeting	2.7
	Several meetings	97.3
If yes, in what subjects is the use of Android-based learning media?	Biology, mathematics, ICT, Physics, Language and other subjects.	
In this era, is the use of a smartphone a necessity in making it easier for you, especially in learning?	Yes	98.2
	No	1.8
The use of Android-based learning media in the learning process will make learning more fun	Yes	96.9
	No	3.1
Do you have difficulty in the subject of chemical bonding?	Yes	87.9
	No	12.1
What method does your teacher use in the teaching and learning process of chemical bonding?	Questions with answers	
Is the teacher's explanation enough for you to understand the chemical bond material?	Yes	57.6
	No	42.4
In your opinion, is it necessary for teachers to use new learning models in the process of teaching and learning chemical bonds?	Yes	82.6
	No	17.4
Has your teacher ever used media to explain chemical bonds?	Yes	87.1
	No	12.9
If yes, what media was used?	Book and PPT	
Do you think it is necessary to use Android-based learning media in the learning process of chemical bonding material?	Yes	81.3
	No	18.8

Do you agree that the development of learning media integrated with Problem Based Learning model using android-based application in the learning process, so that it helps in learning chemical bonding material?	Yes	93.8
	No	6.3

In contrast to the majority of students who believe it is sufficient to simply listen to the teacher's explanation, 182 students, or 81.3%, want to try new things by using devices that are frequently and even constantly present in their daily activities as learning media in the process of learning about chemical bonding material. Consequently, 210 students with a percentage of 93.8% agreed that the development of learning media integrated with the Problem-Based Learning model and an android-based application would facilitate their comprehension of chemical bonding material.
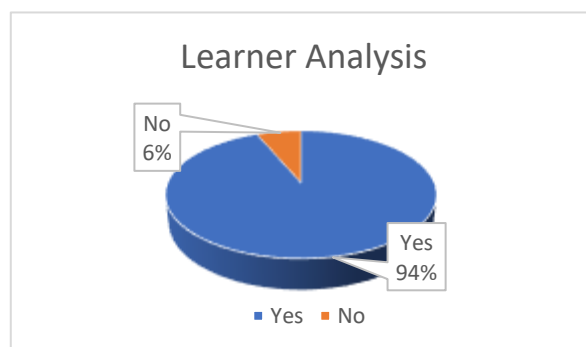
Figure 1. Graph of learner analysis

3) Task analysis. In this task analysis, fundamental competency analysis has been performed, and indicators have been described. In addition, task analysis facilitates the creation of formats and the determination of the form of learning materials to be created. The results of the required learning assignment analysis align with fundamental skills. 4) Conceptual analysis. The purpose of the concept analysis conducted by the researcher is to identify the important and main parts that will be displayed on Android-based learning media, and to systematically organize the relevant sub-material that will be presented in the developed learning media, which is comprised of multiple materials in the form of multiple documents: elemental

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stability and the use of Lewis theory, ionic bonds, covalent bonds, coordination covalent bonds and metallic bonds and their relationship to the properties of substances and the presence of problem based learning. 5) Specifying instructional objectives. The objective of the formulation of learning objectives is to summarize the results of the preceding phases, namely task analysis and concept analysis. Determine the research topic next. Here, the research object serves as the premise for researchers compiling and designing future products. The following learning objectives will be developed for the learning media, based on the concept analysis and task analysis: Students can explain the stability of the atom, the use of Lewis theory in writing Lewis structures, the formation of ionic and covalent bonds, coordination covalent bonds, and metallic bonds in relation to the properties of substances.

The design phase starts with construction of a criterion test model. The test preparation referred to at this stage is the preparation of a test in the form of a questionnaire that was previously compiled based on the questionnaire instrument grid, in the form of a validation questionnaire and a student response questionnaire. Then, the questionnaire was delivered at the time of validation, namely media expert validation and material expert validation, in order to determine the feasibility of integrating learning media with the Problem-Based Learning model using an Android-based application and student response questionnaires. Then, media selection is performed with the goal of facilitating the learning process, because SMAN 11 Medan has never developed learning media integrated with Problem-Based Learning paradigm using an android-based application.

The next step is format selection, which determines how the media flow will be selected and developed. The creation of this learning media begins with the compilation of the necessary components, such as presenting material that has been modified based on the course outline and sources from a variety of references regarding chemical bonding material. Additionally, the researcher collected videos and images related to the subject matter. The Smart Apps Creator and Canva applications are utilized by researchers in the production of this instructional media. The initial design consists of a splash screen, a home page with fundamental competencies, indicators, learning objectives, periodic tables, concept maps, materials, practice questions, and a glossary, followed by a set of practice questions. In the material section, there are related explanations, examples, and videos, as well as chemistry at a Glance and competency exams.

After completing the previous phases, namely the define and design stages, the development stage is the next step. At this point, the researcher created learning media with the assistance of the Smart Apps Creator, and then carried out the subsequent phases of development: Feasibility test/validation. The media that has been designed in this study is then validated by three media experts and three material experts in order to test the practicability of integrating learning media with the Problem-Based Learning model using an Android-based application. Each expert completed a questionnaire that had been prepared beforehand based on the aspects that had been determined and discussed with the supervisor by the researcher. This development's assessment instrument was created by referencing the BSNP assessment and employing a 5-point Likert scale. The following are the results of the validation conducted by subject matter and media experts:

Material expert validation

Three lecturers from FMIPA, Universitas Negeri Medan served as material expert validators in the development of learning media integrated with the Problem-Based Learning paradigm and an android-based application on chemical bonding material. Table 4 presents the results of material validation.

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Table 4. Material Expert Validation Results

Assessment Aspect	Validator	Category
Material	87.22%	Very valid
Presentation	85.33%	Very valid
Language	97.77%	Very valid
Average	**90.1%**	**Very valid**

According to the results of material validation in table 4, the material feasibility aspect receives an average score of 87.22 percent in the "very valid" category. The presentation feasibility aspect received an average "very valid" score of 85.33 percent. The aspect of language feasibility received an average "very valid" score of 97.77%.

Based on the above description, the results of the material expert validation as a whole achieved an average value of 90.1% in the "very valid" category, indicating that the developed learning media is suitable for use; however, there are several things that need to be revised in response to the validator's suggestions and comments.

Media expert validation

Three lecturers from FMIPA, Universitas Negeri Medan serve as media expert validators in the development of learning media incorporated with Problem Based Learning model using android-based application on chemical bonding material. The outcomes of media validation are shown in Table 5.

Table 5. Media Expert Validation Result

Assessment Aspect	Validator	Category
Software engineering	87.61%	Very valid
Visual Communication	87.17%	Very valid
Average	**87.39%**	**Very valid**

The software engineering aspect achieves an average of 87.61% in the "very valid" category, as indicated by the media validation results in table 5. The visual communication aspect received an average "very valid" rating of 87.17%.

The results of the media expert validation achieved an average value of 87.39% in the "very valid" category, indicating that the developed learning media is suitable for use; however, there are a number of things that need to be revised based on the validator's recommendations and comments.

Following the completion of the media development phases, the student's response to the media is observed. Then, the students of SMAN 11 Medan class X IPA 1 through X IPA 6 are provided with learning materials incorporating the Problem-Based Learning model and an android-based application that has been revised based on the advice of experts. This media distribution was conducted between March 20 and March 25, 2023, to ascertain students' responses to a four-point rating scale online survey regarding the media.

Table 6 displays the responses of students to learning media integrated with Problem-Based Learning using an Android-based application on chemical bond material.
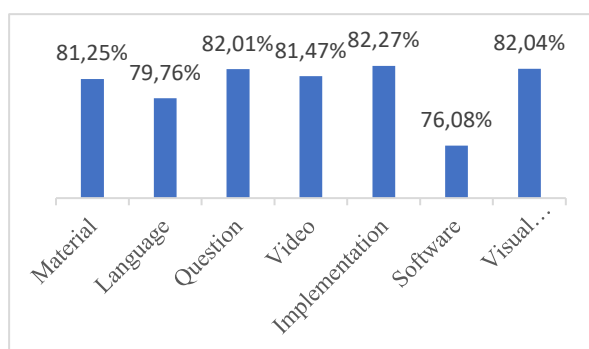
Table 6. Student Response

Aspect	Percentage	Criteria
Material	81.25%	Very good
Language	79.76%	Good
Questions	82.01%	Very good
Video	81.47%	Very good
Implementation	82.27%	Very good
Software	76.08%	Good
Visual communication	82.04%	Very good
Average	**80.69%**	**Very good**

Based on the results of student responses in the table 6, it is known that student responses to the material obtained an average score of 81.25% in the "very good" category. Students' responses to language obtained an average score of 79.76% in the

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"good" category. Student responses to questions and videos in the application obtained an average score of 82.01% and 81.47%, respectively, in the "very good" category. The percentage of student responses to implementation reached 82.27% in the "very good" category, while student responses to the software reached a percentage of 76.08% in the "good" category and student responses to visual communication reached 82.04% in the "very good" category.

The results of students' responses to the developed media as a whole averaged 80.69% in the "very good" category, indicating that the developed learning media received a very positive response from students.

Figure 2. Graph of Student Response Result

Students were tested by having the researcher present in class and directing them to view, read, observe, and study the offline-accessible "ChemLearn" learning media. Then, based on their evaluation of the developed "ChemLearn" learning materials, students were asked to complete a Google form-distributed student response questionnaire. Aspects of material, language, questions, video, implementation, software, and visual communication were evaluated in student trials.

Based on the results of students' responses to the developed media as a whole, it received an average score of 80.69% in the "very good" category, indicating that students responded positively to the developed learning media. This is consistent with the findings of Zulfadilah et al., who found that the application developed received a positive response based on the results of distributing the questionnaire during testing. According to the questionnaire, all high school students are extremely satisfied with the application's interface, features, and the information obtained as a resource for teaching chemistry in schools (Zulfadhilah et al., 2020). Based on the positive response from students, the android-based application developed is a suitable learning tool. In accordance with research conducted by Mugitsah et al., learning media takes the form of an effective application as a medium for chemistry and scientific learning that requires complex concepts (Mugitsah et al., 2020).

CONCLUSION

Analysis of students' demands for the use of learning media integrated with a Problem-Based Learning model utilizing an Android-based application on chemical bonding material indicates that students require the media. This conclusion was reached based on the usage patterns and requirements of students with Android smartphones. The final statement in the questionnaire demonstrates students' desire and interest in using learning media integrated with the Problem-Based Learning model and android-based applications in their learning activities, with 93.8% of respondents agreeing with the existence of android learning media for chemical bonding subjects.

The validator obtained for the feasibility of the material from "ChemLearn" was 90.1% categorized as very valid, and the validator obtained for the eligibility of the media was 87.39% categorized as very valid. This indicates that the developed "ChemLearn" learning media is suitable for dissemination and use as a learning media.

The average value of student responses to the developed media as a whole was 80.69% in the "very good" category, indicating that the developed "ChemLearn" learning media received positive feedback from students. Consequently, it can be stated that the "ChemLearn" learning media

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received a positive response from students and was therefore appropriate for use as a learning media.

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