



The Development of Android-Based Learning Media (Chemdroid) on The Topic Thermochemistry to Improve The Students' Achievement

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ABSTRACT

The application of technology in learning is currently increasingly sophisticated. The development of learning media is widely applied to make learning more flexible. In this article will discuss the development (R&D) of Chemistry on Android (Chemdroid). This study aims to determine the media's quality based on the chemistry teacher's assessment, determine the readability of the media based on the assessment of students who have received this material, and determine the impact of this media trial in chemistry learning. The development design used is ADDIE (Analysis, Design, Development, Implementation, and Evaluation). At the implementation stage, the posttest control group design was used by involving two classes as the control and experimental class. The variable measure is students achievement. The results obtained are that the Chemdroid learning media has been developed and declared valid by four experts. The assessment results by five high school chemistry teachers were Very Good, with a mean value of 3.31. The results of this assessment state that the Chemdroid learning media is suitable for use as a learning media for thermochemistry. In comparison, the readability test results by 16 students from 4 various senior high schools resulted in Good criteria with a mean of 3.24, which means that this media is legible and useful for students in various groups. The analysis of the implementation results states that the two classes have a significant difference.

Keywords: *Android, Learning Media, R&D, Thermochemistry*

INTRODUCTION

Teachers must have innovations so that students are more active in exploring their potential in classroom learning. Innovation in learning strategies is used to improve the learning that has been done [1]. The involvement of students to be more active makes the teacher's role in the classroom only as a learning facilitator [2]. However, the active involvement of students in learning is still very low. Problems arise

when not all students are ready for this student-centred learning [3]. Teachers must be smart in choosing methods or media that can make students more active. Involvement between teachers and students is needed in the success of learning.

Learning is a process for a person to have certain competencies, attitudes, and skills. Learning will last a lifetime, from birth to death. There is a learning process, making someone who is not educated become knowledgeable. The success of learning is a

change in behavior, namely knowledge, skills and attitudes. These three aspects are the main aspects seen in the learning process. Learning will increase knowledge, application, and the ability to store meaning, interpret and relate to the existing reality, and personal change occurs [4,5,6].

In the 21st century, the development of technology and information is growing rapidly. The impact of technological developments occurs in all fields and also applies to education. Technological developments in the field of education must be put to good use. The use of this technology continues to be developed to advance education. However, the use of this technology is usually limited to the use of PowerPoint or video playback. This utilization is still not optimal. For this reason, technology needs to be re-applied in the world of education. The use of technology in learning must positively impact students [7-8].

Learning media have a role in learning. The role of learning media is a component in learning that can increase interaction between teachers and students and between students [9]. Based on the results of interviews with students, the media used by the teacher is an essential key in attracting students' attention to learning in the classroom. Teachers usually only use Microsoft PowerPoint in delivering material. They want media that is attractive and accessible anywhere and anytime. Media participate in conveying messages from teachers to students. Learning media contains sentences and pictures [10]. Learning effectiveness can be increased by using these learning media [11-12].

Learning media are classified into conventional media and IT-based media. Choose which type of media is suitable for learning based on the ability of the teacher and the facilities available to students. Information technology-based media usually use interactive video, media integration, and hypermedia [13]. Students will usually like this media. Although selecting learning media is not arbitrary, the selection must consider the learning objectives to be achieved. Because the media will play a role in achieving learning objectives [14], for example, concepts or materials in learning media can be explained using audio-visual animation in independent learning [15]. In this case, the teacher has a role in preparing students for independent learning [3].

Chemistry is a science that begins to be studied at the high school level. Many of the materials in chemistry are abstract, such as atomic forms, chemical bonds, and chemical reactions. The abstractness of this material needs learning media that helps to explain to students. One of the materials considered difficult by students is Thermochemistry. Chemical materials that are considered difficult for students include chemical, electrochemical equilibrium, reaction rates, and thermochemistry [16].

The Chemdroid media developed has a combination of material, animation, and practicum videos. This is a novelty in facilitating student learning. In the previous study, many media developed are just descriptions of the material, a little animation, and no practicum videos. Thus, animation becomes a form of material visualization in supporting material explanation. Meanwhile,

the practicum video is a form of virtual demonstration. In learning, using a smartphone device is better than using a computer device or one that does not use it at all [17].

This research and development were carried out to know the quality of the media developed based on the chemistry teacher's assessment, and to find out the readability of this media based on the assessment of students and to find out the results of implementing this learning media according to the learning outcomes of students.

METHODS

This is research and development (R&D). The development design used by ADDIE consists of Analysis, Design, Development, Implementation, and Evaluation [18-19]. The analysis stage is conducting a needs analysis regarding the media needed for chemistry learning and the materials needed most. In addition, at this stage, a fundamental competency analysis of the material is also carried out and analyzes references related to the development of this learning media. A needs analysis was carried out by distributing needs questionnaires to 36 students and three teachers in 3 different high schools. These three schools are still in the city of Bengkulu.

The design stage is the stage of designing the media to be developed. This design includes content design, summarizing the material, making practice questions, making videos, and choosing color compositions. The next stage is the development stage. This stage is the stage of product development using the software that

has been selected. Other activities at this stage are making initial products, validating media and material experts, revising products, conducting quality tests by chemistry teachers and reading tests by students, and revising them to get the final product.

Expert validation involves two media validators and two content validators. Media validators are lecturers of the educational technology study program, University of Bengkulu, experts on Android-based learning media. At the same time, the material experts come from chemistry education lecturers who are experts in chemistry. There were 16 students involved in the readability test and five chemistry teachers in assessing this media's quality. The students involved have received the thermochemistry concepts and were randomly selected based on gender, ability in learning, and school origin. They are from four various schools in Bengkulu City. Meanwhile, The chosen chemistry teachers are teachers from different schools, have taught Thermochemistry material and taught for at least five years.

The next stage is the implementation stage. At this stage, Chemdroid media trials were carried out in the classroom. The design used in this trial was a post-test-only control group design with one control class (C-Class) and one experimental class (E-Class). The experimental class was treated with the developed Chemdroid media.

The instrument used in the quality test consists of 20 assessment items. Meanwhile, the readability test by students was 12 items. Each instrument consists of 3 main aspects. These three aspects are material, learning

aspects and technical aspects [11], [20–22]. The scale used in these two instruments is the 1-4 rating scale. The average results of this readability test and quality test are searched using the following formula.

$$\bar{x} = \frac{\text{The number of values per item}}{\text{The number of evaluators}}$$

The results are then converted into a qualitative form using the conversion guidelines in Table 1. [23]

Tabel 1. The Criteria of Readability and Quality Test Result

| Value Range | The Criteria of Readability and Quality Test Result |
|----------------------|---|
| $x \geq 3,25$ | Very Good |
| $2,75 \leq x < 3,25$ | Good |
| $2,25 \leq x < 2,75$ | Adequate |
| $1,75 \leq x < 2,25$ | Poor |
| $x > 1,75$ | Not Good |

While the instrument used in the class trial was a set of posttests consisting of 20 multiple choice questions and five open-ended questions, this set of questions was developed based on a grid compiled and validated by experts. The data analysis used was the t-test to see whether or not there was a significant difference between the two classes being tested.

RESULTS AND DISCUSSION

Chemdroid Media Thermochemistry material has been developed through 5 main stages, namely ADDIE. The ADDIE stage consists of analysis, design, development, implementation, and evaluation [18].

Analysis

The first stage is the analysis stage. Activities carried out at this stage are to analyze the needs of high school students

and high school chemistry teachers. This needs analysis was carried out by distributing questionnaires with a google form. This needs analysis is essential to make decisions about the media and material to be developed.

The needs analysis results show that learning media is needed that can be accessed anywhere and anytime. There are three topics with the highest percentage chosen by the subject: Thermochemistry 36.89%; The reaction rate is 19.44%, and Chemical Bonding is 11.11%, and the remaining 32.56% is another concept. This is in line with previous research that thermochemistry is one of the materials that require media assistance in the learning process [16]. This is also supported by the teacher's statement that thermochemistry is a material that requires mathematical ability, and students must have good stoichiometric skills to solve the problems in this chapter.

The questionnaire shows that 72.22% of students need learning media that is easily accessible anywhere and anytime, containing material and visualization in animation. Therefore, the teachers argue, learning media packaged in smartphone applications are in great demand by students. Some of them are not familiar when using similar learning media and get good responses from students [24]. However, the development of android-based media is still rarely used in the teaching-learning process [25].

These results conclude that the media to be developed can be used on smartphones with the Thermochemistry concept. The next activity is to analyze references from articles

and books related to media development with these materials. Another activity carried out is analyzing the syllabus of this thermochemical concept.

Design

the second stage designs. The activities carried out at this stage are designing the appearance and content of the Chemdroid media. The content in the Chemdroid media includes essential competencies, concept coverage in the form of mind maps, brief concepts, and practice questions. This media will also include a practicum video as one of the practice questions. This content design is done so that the concept to be searched makes it easier to understand.

The media design developed includes complete content but still with explanations that students easily understand. This concept is based on the teacher's response at the previous stage. Many of the media developed contain language that is difficult for students to understand, which makes the teacher have to re-explain the concept to students. Video development in media is based on students' psychomotor competence. Laboratory activities are often not carried out due to time and place limitations, and it is hoped that this can be used to study anywhere and anytime.

Development

The third or final stage is the development stage. At this stage, the initial product development regarding the storyboard. It was starting with the selection of shapes, layout designs and also the selection of color combinations. The next activity is to transfer the content that has

been created to the Chemdroid media. The product display can be seen in [Figure 1](#).



Figure 1. Display of Chemdroid Thermochemistry

The initial product was given to experts for the product validation process; validation was carried out by two media experts and two content experts. Media experts understand IT-based learning media, while material experts are people who understand chemistry content and learning. The four experts assessed the Chemdroid media qualitatively, and the experts stated that the Chemdroid media was suitable for research with several improvements. This improvement was carried out before the Chemdroid media was tested for quality and readability tests.

The next activity is to conduct a quality test by the chemistry teacher quantitatively by assessing the quality of the Chemdroid media and providing input on the media that has been developed. Chemistry teachers from different schools have at least five years of

teaching experience and have taught thermochemistry to students. The quality assessment carried out by the chemistry teacher consists of 3 main aspects, namely aspects of content, learning, and technique. The results of the assessment of the five chemistry teachers can be seen in Figure 2.

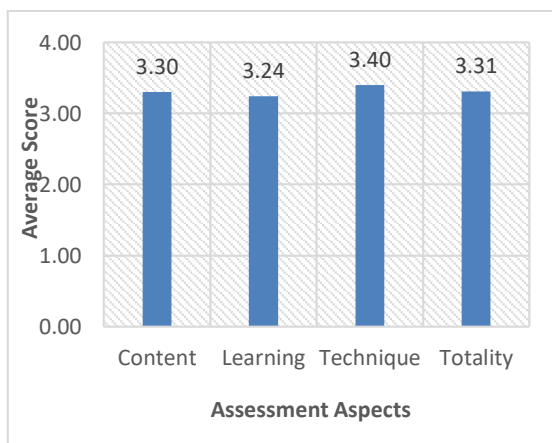


Figure 2. Results of Chemistry Teachers Assessment

The content aspect is an assessment aspect based on the content in Chemdroid media. The learning aspect relates to the use and relationship of Chemdroid media with learning in the classroom. In comparison, the technical aspect is the technical aspect regarding the use and appearance in this Chemdroid media. Based on Table 1 regarding the quality test criteria, material aspects, technical aspects and overall, Chemdroid media has very good criteria. Meanwhile, the learning aspect is in good criteria.

The content aspect consists of six assessment items; these assessment points are related to the content provided in this Chemdroid media. The results of the six assessment items for the material aspect can be seen in Table 2.

Table 2. Items Assessment of Content Aspects

| Items | Score |
|--|-------|
| Chemdroid media has accurate content | 3.40 |
| The content presented has educational value | 3.20 |
| Students easily understand the content presented in the Chemdroid media. | 3.40 |
| Exercises in the media can be used to measure the cognitive abilities of students | 3.00 |
| The contents in the Chemdroid media are complete and following existing competencies. | 3.60 |
| The components in the Chemdroid media are interrelated to make the information conveyed clear. | 3.00 |



Figure 3. Display Of Core Competencies and Basic Competencies and Their Relationship to the Material in The Chemdroid Media

The topic that development in Chemdroid is under the essential competencies of the 2013 Curriculum Revision according to Minister of Education and Culture Regulation number 37 of 2018.

Thus, there are four basic competencies, with two basic competencies of core knowledge competence and two basic competencies of the core competencies of skills. The four basic competencies were then developed into Thermochemistry material. The suitability between core competencies and basic competencies with the material in the media can be seen in [Figure 3](#).

The content in this Thermochemical Chemdroid has educational value. The content contained in this Chemdroid is system-environment, heat-work, exothermic-endothermic, thermochemical equations, standard enthalpy change, enthalpy change determination. It can be seen that the existing content is made exciting and can educate students about this thermochemical material. The question exercises can measure the ability of students in cognitive aspects. The exercises given are scattered in the sub-concept in Thermochemistry. More problems search for the magnitude of the enthalpy change in several ways. Exercise questions per section consist of 3-5 questions in the description that can measure the level of ability of these students. The teacher considers the exercises here to have not explored students' potential in solving thermochemical problems. The questions presented in the chemdroid media are not based on higher-order thinking. For this reason, it is necessary to develop practice questions that can train students' higher-order thinking skills. The display of this part can be seen in [Figure 4](#).

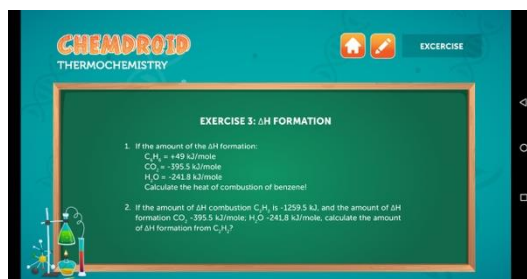


Figure 4. Display of the Exercise Section

The Chemdroid content is accurate and easy for students to understand. This accuracy is measured from the correctness of the content in this Chemdroid. The making of this Chemdroid used high school chemistry and university chemistry books and other books that were still relevant to the material. The words in Chemdroid are also adjusted to the situation of students so that they are easy to understand.

The learning aspect consists of nine assessment items, relates to the use of Chemdroid in learning. The results of the assessment of these nine items can be seen in [Table 3](#).

Table 3. Items Assessment of Learning Aspect

| Items | Score |
|---|-------|
| Chemdroid media suitability with the needs of students today. | 2.80 |
| Chemdroid media can be used to support students in achieving learning goals. | 3.40 |
| Chemdroid media can support learning using a hybrid learning communication mode. | 3.20 |
| Chemdroid media can motivate and attract the attention of students to do learning | 3.60 |
| Chemdroid media can provide learning assistance for students | 3.00 |
| The suitability of the Chemdroid visual media design with the user (high school students) | 2.80 |
| Chemdroid media can stimulate the way students think effectively | 3.60 |
| Chemdroid media can facilitate students to acquire new skills | 3.80 |
| Chemdroid media provides learning opportunities for students | 3.80 |

This media is structured so that students can learn the material and practice questions in Chemdroid media independently. After studying the material, the exercises given can support the student learning process. It can provide learning assistance for students, this assistance is in the form of media, tools, materials and learning resources, and it can facilitate students to gain new skills. After using this media, students will acquire thinking skills, practicum skills, and using current technology. Chemdroid media can support a hybrid learning mode because it is flexible. The hybrid learning model involves Online and face-to-face learning. Online learning can take advantage of current technology, including using Android-based learning media such as Chemdroid. It can be used anywhere and anytime. These results support previous research that the hybrid learning model is easy to apply [26]. This learning model can support various forms of learning activities. These activities include seminars, case studies, group work, and practice [26]. Students can understand the learning material independently, while in-class meetings are useful for developing skills [27].

Chemdroid media is adapted to the needs of students in the current era. This media is designed to support chemistry learning; students need IT-based learning media; this media can be used using Android-based smartphones. This media is expected to train students' confidence in learning the material and doing practice questions. Chemdroid's visual media design is adapted to the design trends favoured by students in

this era. Visual design affects students' learning process; an attractive visual design will make students interested in learning content.

Two aspects have a value of less than 3. Chemdroid media can be used to support learning objectives that are essential competencies and core competencies. In making this Chemdroid media, the main reference used is competence. Therefore, Chemdroid media is under the formulated learning objectives. This learning objective is fundamental in the learning process. Therefore, when these goals have been determined, the learning process refers to the learning objectives.

This media makes students think effectively. The material in the media is arranged in simple and easy-to-understand language. This language arranges to help students' thinking processes in working on thermochemical problems effectively and efficiently. For example, in Figure 5 below, students are stimulated to think about the differences between the three systems. Before the teacher moves on to the next topic, students must distinguish between these systems. It is a form that stimulates students' thinking.

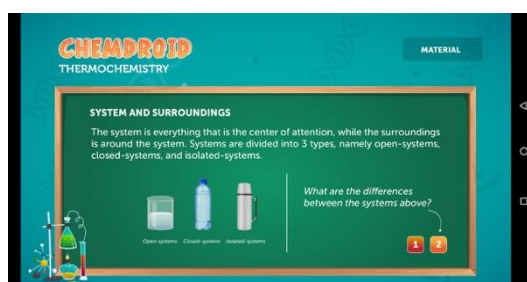


Figure 5. Display the Material That Can Stimulate Students' Thinking

According to some chemistry teachers, students' needs are more complete and easy

to understand, delivering detailed content. However, content delivery is still based on basic competencies with delivery in daily life using language that is easy to understand.

The technical aspect consists of 5 points of assessment. This assessment point relates to this media technique, starting from the font type, the colors used, and the chosen layout. The average assessment of Chemdroid media for this aspect of the technique can be seen in [Table 4](#).

Table 4. Items Assessment of Technique Aspect

| Items | Score |
|--|-------|
| Chemdroid media program has relevance to today's technology | 3.20 |
| Chemdroid media is easy for user to navigate | 3.40 |
| A combination of image and video visualization forms can be used to convey information | 3.40 |
| Compatibility between image and video objects with thermochemical material | 3.40 |
| The trimming of the selected color in the Chemdroid media | 3.20 |

This media is relevant to technology in this era, developed based on an analysis of the needs of high school students who want android-based media. Smartphones that are usually used to send messages can now be used as learning aids. Image and video visualizations are designed to fit the topic and can be used to convey information. In this media, there is one video and several image visualizations. This image visualization is used to attract students' interest indirectly image the objects depicted in the media. This is by previous research that images and visualizations displayed in the media must be clear and effective so that students can understand them [\[20\]](#), [\[22\]](#). In addition, the

use of animation or visualization can make the display of learning media attractive [\[28\]](#).

Aspects The attractiveness of the selected color and ease of navigation. The color chosen is an attractive color without striking the eye. Color is one aspect of attractiveness that makes this medium attractive. This supports previous research that the color chosen becomes the impression and image for the media [\[28\]](#). This media is easy to navigate, both from students, chemistry teachers who are young and seniors. There is a logo in navigating this media, including the home, material, next, and before buttons. Overall, Chemdroid media is suitable for use in small-scale tests or readability tests by students. These results are under previous studies that if the practicality test results are in practical or efficient criteria, the media can be used for further testing [\[29\]](#), [\[30\]](#). This due diligence step is the same as the practicality test. These two tests are to test the condition of the learning media before being used in the effectiveness or implementation test.

Students were randomly selected in a small-scale or readability test by considering several things, including coming from different schools, different ability levels, and different sexes. These students come from 3 public schools and one private school. Each school consists of two boys and two girls with one high ability student, two medium ability students and one low ability student. This consideration is intended so that this media can reach students with different variations. The results of this small-scale test or readability test can be seen in [Figure 3](#) below.

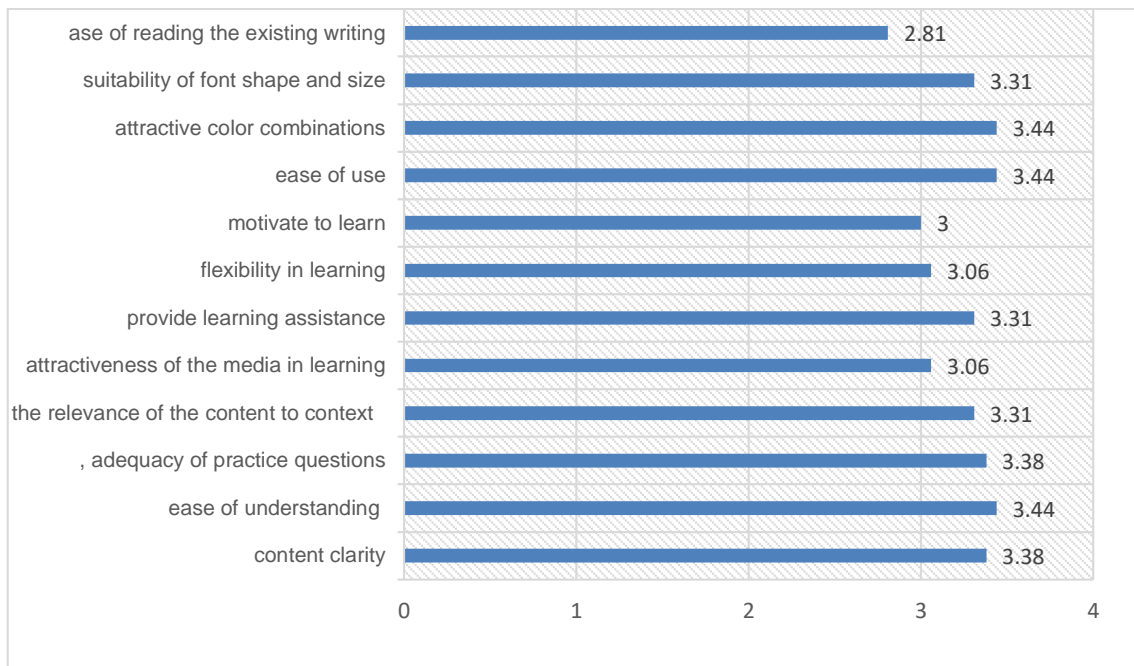


Figure 6. Result of Readability Test

There are three main aspects in a Readability Test, with each aspect consisting of four statement items, content, learning, and technique. The content aspects consist of content clarity, ease of understanding content, adequacy of practice questions, and the relevance of the material to the examples shown. The learning aspect consists of the attractiveness of the media in learning, can provide learning assistance, flexibility in learning, and can motivate to learn. At the same time, the technical aspects consist of ease of use, attractive color combinations, suitability of font shape and size, and ease of reading the existing writing.

The content presented in Chemdroid media is very clear and very easy to understand. The content in this media uses sentences that are easy for students to understand. The explanation used is also not very long. In addition, the practice questions

in Chemdroid media are also sufficient to see feedback from the learning carried out.

According to students, Chemdroid media is interesting when used in learning. This attraction is because android-based learning media are still rare. In addition, the use of smartphones in learning is still limited. With this media, learning can be done anywhere and anytime. Furthermore, this media can also provide learning assistance and can motivate learning.

Students consider this media to be very easy to use because the instructions used are very clear. In addition, the combination of Tosca green and orange is interesting to look at, and the fonts used are also appropriate and easy to read. When this media is opened on an Android smartphone with a small screen, the text will adjust to the condition of the smartphone screen. However, this is not a problem because

students can still read and understand the text well.

Implementation

After going through expert validation, quality assessment by chemistry teachers, and student readability tests, the developed Chemdroid media is ready to be tested classically. This trial involved one control class and one experimental class. In addition, each class conducts learning in one meeting to conduct a posttest. The comparison of these two classes can be seen in [Table 5](#).

Table 5. The Score Comparison

| Class | Max Score | Min Score | Average Score |
|---------|-----------|-----------|---------------|
| C Class | 73 | 46 | 61,5 |
| E Class | 76 | 55 | 67,7 |

The results of the posttest were then tested using the t-test and analyzed based on the size of the sig. The analysis results obtained that the sig 0.003 is smaller than the significance level of 0.05. This means that the two classes have a significant difference in the mean seen from the posttest scores. It means Chemdroid media has a good impact in facilitating student learning. This study is in line with previous research that instructional media positively affects student achievement [\[31\]–\[35\]](#). This positive effect can be assessed from several aspects, such as concept understanding, student creativity, metacognitive abilities, and so on. Also, this Android-based media can be used as a facility for students to learn independently. However, in this study, it was only seen from the posttest scores.

The use of Chemdroid media is an alternative in distance learning. Currently, distance learning is a topic of discussion

among educators and researchers. Learning in the current technological era does not only depend on the time and place of learning. In this case, it is the school. Learning can be done anywhere and anytime as long as it is connected to the internet network. This kind of learning becomes more practical, flexible, and can be followed by anyone. Chemdroid media is one of the facilities in this kind of learning. This media was developed based on material in chemistry books in general. The difference is, the content in this media is described using sentences that are easy to understand. Students prefer it because it is easier to digest. According to them, there are too many explanations in the book, making it difficult to understand. Students' quick understanding will impact the results of the posttest they do at the end of the meeting. The average comparison between the two classes is also different. E-Class that uses Chemdroid media has a bigger average than C-Class, which only uses chemistry books as usual. E-Class students are more interested in taking lessons. This is because of the application of technology in learning. They get other benefits from using smartphones, especially smartphones with the Android operating system. Not only for playing games or social media but smartphones can also be used as a learning tool. This supports previous research that using a smartphone application as a learning medium is an interesting strategy that teachers can apply in learning chemistry [\[36\]](#).

In an era of technology like this, educators and researchers must implement technology in learning. The development of technology-based teaching materials or

learning media is one of the efforts to maximize the role of technology in learning. Today's students are more interested in using technology-based teaching content or learning media than chemistry textbooks in general. This will increase students' understanding of learning. In addition, the use of technology in learning is proven to make students and teachers more active in learning [37].

The development of digital media must continue to be developed, especially media that can be accessed on students' smartphones. Things like this make their gadgets useful as a learning tool, not just for games and social media. In future research, it is hoped that more materials will be developed on digital media.

Evaluation

At this stage, an evaluation of the Chemdroid Thermochemical media development process is carried out. All stages have gone well so that the resulting product is also good. The needs analysis has gone well at the analysis stage but has not reached many students in schools in the district area. The Design and Development phase has also been going well. The involvement of chemistry teachers as media quality testers is still lacking. This will affect the resulting product. The more input from the chemistry teacher, the better the product will be. The implementation phase is also going well. Implementation or class testing is done with two different classes. The results obtained from this stage are also in line with the expectation that the use of Chemdroid media produces significant differences with those that are not used in terms of posttest results.

CONCLUSION

From the results and discussion above, it can be concluded that the quality test and readability test are carried out by assessing three main aspects, namely the material, learning and technical aspects. In the quality test by the chemistry teachers, overall Chemdroid media was in very good criteria with an average of 3.31. Meanwhile, from students' readability test or small scale test, this media is in good criteria or can be read with an average of 3.24. The t-test results indicate a significant difference between the control and experimental classes with a sig value of 0.003, which is smaller than the significance level of 0.05.

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