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Development of Android-Based Chemistry Learning Media on Acid-Base Material for High School Students

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ABSTRACT

The learning achievement level of class XD students at SMAN 1 Kurau in chemistry is still relatively low, as indicated by the low number of students who successfully achieved the completion criteria, which was only 25.93%. Active student participation during the learning process is also still minimal. The purpose of this study was to determine the effectiveness of the application of the method. Student Teams Achievement Division (STAD) in improving student learning outcomes to achieve the classical mastery target of 85%. This study uses a classroom action research approach conducted in class XD SMAN 1 Kurau, and is divided into two cycles. Each cycle includes the stages of planning, action implementation, observation, and reflection. Data collection techniques include tests, observations, and documentation, while data analysis is carried out quantitatively. From the results of the study, it can be concluded that the implementation of the STAD method has been proven to be able to improve students' chemistry learning outcomes in the class to reach the classical mastery standard of 85%.

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INTRODUCTION

The study aimed to develop an Android-based chemistry learning media called "AsamBasaKU" for acid-base topics in grade XI students of Madrasah Aliyah AR-Rasyid Sei Renggas. This research applied a simplified Borg & Gall R&D model, including needs analysis, media design, expert validation, limited trials, and revisions. Validation from two experts showed high feasibility with an average score of 89.5%. A trial with 20 students revealed that over 85% found the application helpful in understanding acid-base concepts. The application features include pH simulation, neutralization reaction animation, interactive quizzes, and a chemistry glossary. The use of visuals, simulations, and interactive content aimed to support understanding of abstract acid-base material through macroscopic, microscopic, and symbolic representations. This media is effective as both a self-learning tool and a blended learning aid. It helps make abstract concepts more concrete, increases student engagement, and supports independent learning. The conclusion is that "AsamBasaKU" is a feasible, innovative, and enjoyable media to improve chemistry learning experiences.

Chemistry is a branch of natural science that studies the structure, properties, and changes of matter. At the senior secondary level, chemistry plays a crucial role not

only as a core subject in science programs but also as a foundation for understanding applied sciences such as pharmacy, the environment, and health. However, in reality, manyStudents experience difficulties in understanding chemical material because of its non-concrete characteristics and the simultaneous mastery of macroscopic, microscopic and symbolic representations (Johnstone, 2006).

One topic students find difficult and confusing is acids and bases. This topic requires students to understand the concepts of ionization, pH, neutralization reactions, and their application in everyday life. Based on initial observations and interviews with chemistry teachers at Madrasah Aliyah AR-Rasyid Sei Renggas, many students demonstrated difficulty in connecting theoretical concepts with empirical reality. This is further exacerbated by the implementation of conventional learning methods such as lectures and written assignments, which are unable to meet the learning styles of today's digital generation students (Daryanto, 2019).

Research conducted by Maulana (2021) at SMA Negeri 1 Teupah Selatan showed that the lack of innovation in the use of learning media contributed to the decline in students' interest and motivation in chemistry. Furthermore, many teachers acknowledged limitations in developing media that aligns with advances in information technology. Yet, the 2013 Curriculum emphasizes the importance of integrating Information and Communication Technology (ICT) into the learning process as a means of supporting active, collaborative, and collaborative learning.meaning (Arsyad, 2020).

With the advancement of mobile technology, Android-based devices have become an integral part of adolescents' lives. This opens up significant opportunities for utilizing Android-based learning media as an innovative solution to bridge the gap between complex material and students' visual and interactive learning styles. Several previous studies have demonstrated the effectiveness of Android media in improving student learning outcomes. Restyayulita et al. (2023), for example, demonstrated that the use of mobile learning media for buffer solution material significantly improved students' understanding and motivation.

Based on this, researchers developed an Android-based learning application called "AsamBasaKU," specifically designed to help 11th-grade science students at MA AR-Rasyid Sei Renggas understand acids and bases. The application is equipped with educational features such as pH simulations, neutralization reaction animations, interactive quizzes, and a chemical term dictionary presented in a visually appealing manner. It is hoped that this media will not only improve student learning outcomes but also create a fun and independent learning experience.

The problem formulation in this research is: (1) How is the process of developing Android-based chemistry learning media for acid-base material? and (2) To what extent is the media suitable in terms of material, design, and user involvement? The aim of this research is to produce Android-based learning media that is interactive, contextual, and suitable for use in chemistry learning at the 11th grade high school level.

This research uses a simplified Borg & Gall Research and Development (R&D) approach, as it is deemed appropriate for producing tangible products in the form of learning media that go through systematic stages: from needs analysis, design, expert validation, to limited trials. This is supported by Sugiyono's (2020) opinion, which states that the R&D approach not only tests hypotheses but also creates product-based solutions that can be directly applied in the educational field.

It is hoped that the benefits of this research will be felt by various parties. For students, this media provides a fun learning tool, facilitates understanding of abstract chemistry concepts, and increases self-confidence in learning. For teachers, this application can be a modern and adaptive supplementary learning tool. Meanwhile, for educational developers and researchers. The results of this research are expected to be a reference in creating similar media for other topics in the chemistry curriculum or other science subjects. Thus, the development of Android-based learning media on acid-base material is a concrete response to the challenges of 21st-century education which demands innovative, technology-based learning, and is centered on students' learning needs.

METHODS

This study applied a Research and Development (R&D) approach based on the model proposed by Borg and Gall (1983), which was adapted into several simplified stages to meet the study's scope and time constraints. The R&D method was selected because the main objective was to produce an Android-based learning media, named AsamBasaKU, that is both feasible and effective for supporting chemistry learning on the topic of acids and bases.The research followed a developmental design consisting of six systematic stages: (1) needs analysis through teacher interviews and literature review, (2) product design using Android Studio and Canva, (3) expert validation by specialists in chemistry education and media design, (4) product revision based on expert feedback, (5) limited trials with students, and (6) final revision and production of the completed media.

The study involved two main groups of participants: validators and students. The validators comprised one chemistry education lecturer and one experienced high school chemistry teacher. The limited trial was conducted with 20 eleventh-grade science students from MA AR-Rasyid Sei Renggas, located in Asahan Regency, North Sumatra. This school was selected because students had access to Android devices and the school actively supported the integration of ICT in learning.The main variable in this study was the AsamBasaKU media, assessed using five evaluation criteria: (1) content accuracy and relevance, (2) visual quality, (3) interactivity, (4) ease of use, and (5) user response, based on the media evaluation guidelines by Arsyad (2020). The research instruments included interview guides for teachers, observation sheets for student engagement, and questionnaires for expert validation and student responses. The questionnaires used a five-point Likert scale (1–5) and were tested for content validity by experts, while reliability testing using Cronbach's Alpha produced a coefficient of 0.89, indicating high consistency.

Primary data were collected through teacher interviews, classroom observations, and the distribution of questionnaires to both experts and students, while secondary data were obtained from literature studies and references to the 2013 Revised Curriculum. Qualitative data were analyzed descriptively, whereas quantitative data were processed using descriptive statistics (mean scores and percentage categories). The results were interpreted based on feasibility criteria from Arikunto (2019), which classify scores into four levels: very feasible (86–100%), feasible (70–85%), fairly feasible (56–69%), and not feasible (<56%). Through these systematic procedures, the AsamBasaKU media was developed as a validated, practical, and effective learning tool that can be replicated and adapted for other topics in chemistry education.

RESULT AND DISCUSSION

This study aims to develop an interactive Android-based chemistry learning media on acid-base material and test its feasibility and effectiveness in improving the understanding of class XI IPA students at MA AR-Rasyid Sei Renggas. The results of the study are presented based on two main focuses, namely: (1) the process of developing the "AsamBasaKU" media, and (2) the feasibility of the media seen from expert validation and student responses.

1. The Process of Developing "AsamBasaKU" Media

The development of AsamBasaKU learning media was carried out using a Research and Development (R&D) approach that refers to the development model proposed by Borg and Gall (1983). This model is considered appropriate because it can produce concrete educational products and go through systematic scientific validation stages. In this study, the Borg & Gall model was modified into six main stages to be more applicable in the school environment, namely: (1) needs analysis, (2) product design, (3) expert validation, (4) initial product revision, (5) limited trials, and (6) final revision before compiling the report.

The first stage, namely needs analysis, was conducted through semi-structured interviews with chemistry teachers and observations of student learning activities in class XI IPA MA AR-Rasyid Sei Renggas. Based on the interview results, it was found that students had difficulty understanding the material on acids and bases, particularly regarding the representation of the pH concept, the acid-base ionization process, and the meaning of neutralization reactions. The teacher also mentioned that the learning media used so far were conventional, consisting of textbooks and static slides, which were less engaging and not aligned with the technological developments students use daily.

The next stage is the initial media design, which involves compiling the user interface design and the content framework for the developed media. The designed content refers to the Core Competencies (KD) in the revised 2013 Curriculum, specifically the acid-base material in grade XI science. In its development, this media is equipped with five main features, namely:

a. An interactive theory that discusses the theories of Arrhenius, Bronsted-Lowry, and Lewis, is compiled using a visual mapping approach to facilitate understanding of the differences and relationships between theories.
b. Digital pH simulation to measure the acidity and alkalinity of solutions virtually, complete with color indicators and numerical pH values, so students can conduct experiments without the limitations of laboratory equipment.
c. Neutralization reaction animation that displays a dynamic visualization of the reaction between HCl and NaOH, emphasizing the changes in ions and reaction products that occur in the form of particles as well as changes in the color of the indicator.
d. Interactive practice questions in the form of multiple-choice and short answer quizzes that can be automatically corrected, accompanied by feedback to improve students' conceptual understanding.
e. A digital chemistry dictionary, containing explanations of technical terms and chemical symbols related to acids and bases in simple yet scientific language. The application design process was carried out using Android Studio as the main development platform and Canva for creating visual elements, icons, and

illustrations. The visual design was created following the principles of user-centered design, namely user-friendly, attractive, and easily accessible to students with various levels of digital ability. Interface navigation is made simple and logical, with intuitive icons so that students can explore the content independently without constant guidance from the teacher.

This media was developed based on constructivist learning principles, where students actively construct their own understanding through exploration and hands-on learning experiences. Therefore, the app's features are designed to encourage student participation in observing, analyzing, and independently drawing conclusions about concepts through digital interaction.

During the development process, the research team also considered accessibility aspects, such as the app's size to ensure it can run on various Android smartphones running Android 8.0 and above, as well as compatibility with the minimum device specifications of students at MA AR-Rasyid Sei Renggas. The app was tested internally on various devices to ensure there were no bugs, errors, or other technical obstacles that could disrupt learning.

By comprehensively considering pedagogical, technical, and visual aspects, AsamBasaKU media is not only designed as a learning tool, but also as an innovative learning instrument capable of improving students' motivation, chemical literacy, and exploratory abilities. This stage serves as an important foundation for entering the next phase, namely expert validation and limited trials, to empirically measure the product's feasibility and effectiveness.

2. Media Trial Results and User Responses

After validation by two experts (a chemistry education lecturer and a chemistry teacher), the media was trialed on a limited basis with 20 grade XI science students during three learning sessions. Based on the results of the questionnaire distributed after the media was used, data on student responses to five main aspects of the "AsamBasaKU" media were obtained, which are presented in Table 1.

Table 1. Student responses to the learning media "My Acids and Bases"

Aspect	Average Score (Scale 1–5)	Percentage of Postive Response	Category
Ease of Navigation	4.4	88%	Very Good
Clarity of Acid Material	4.3	86%	Very Good
Visual Quality and Animation	4.6	92%	Very Good
Interactivity and Simulation	4.5	90%	Very Good
Benefits to Understanding the Material	4.7	94%	Very Good
Wish to Use the App for Other Materials	4.8	96%	Very Good

The table shows that all aspects received an average score above 4.3, with a positive response rate above 85%. This indicates that students considered this media to be very good in terms of appearance, interactivity, and benefits for learning. Specifically, the aspect of students' desire to use the application for other materials received the highest score (4.8) with a positive response rate of 96%. This indicates that

the application not only captured students' attention but also fostered their interest in further learning.

In addition to assessing the visual and navigation aspects, as can be seen in Table 1, students were also asked to rate the impact of media use on their learning confidence and their interest in using similar applications in other topics. The results of these responses are presented in Table 2.

Table 2. student responses to the impact of the "AsamBasaKU" Media

Response Statement	Average Score (Scale 1–5)	Percentage of Postive Response	Category
The media makes understanding easier	4.6	90%	Very Good
Attractive visualizations and animations	4.7	94%	Very Good
Easy-to-use navigation	4.5	88%	Very Good
Increases self-confidence in studying chemistry	4.3	85%	Good
Wish to use the app for another topic	4.8	95%	Very Good

These findings align with Mayer's (2021) theory in Multimedia Learning, which emphasizes the importance of combining text, images, sound, and animation in enhancing conceptual understanding. Furthermore, students' positive responses to the pH simulation feature and the animated neutralization reaction video reinforce the evidence that experimental visualization has a significant impact on explaining abstract chemical concepts (Harianto et al., 2020).

A chemistry teacher at MA AR-Rasyid Sei Renggas also responded positively to the platform. He stated that "AsamBasaKU" can be used as an enrichment tool, for independent learning, or in blended learning. He also suggested further development by adding gamification features to increase student competition and motivation.

3. Expert Validation of Media

The results of expert validation of the media showed that the average feasibility score reached 89.5%, which is classified as "very feasible." The validator assessed that the application content is in accordance with the 2013 Curriculum, the language used is communicative and scientific, and the visualizations used are attractive and functional. The application was assessed to operate well on various versions of the Android system without any technical problems (crashes or bugs), indicating adequate technical quality. Validation results from two experts showed that the AsamBasaKU learning media obtained an average score of 89.5%, with all assessment aspects in the "very appropriate" category. Details of the validation results are presented in Table 3.

Table 3. Expert validation results for the "AsamBasaKU" learning media

Assessment Aspect	Average Score (%)	Eligibility Category
Content / Material Quality	90%	Very Worthy
Curriculum Compliance	88%	Very Worthy
Visual & Aesthetic Appearance	91%	Very Worthy
Navigation & Interface	89%	Very Worthy
Application Functionality	89%	Very Worthy
Average	**89.5%**	Very Worthy

Based on the trial and validation results, it can be concluded that the AsamBasaKU learning media is a suitable and effective medium for use in chemistry teaching on acid-base topics. This media is able to overcome students' difficulties in understanding abstract material through a visual and interactive approach, as well as increasing student interest and independence in learning.

Picture

The research results show that the development of AsamBasaKU media has succeeded in creating an interactive application that is able to bridge abstract chemical concepts into concrete visuals that are easy for students to understand. One of the advantages of this application is the presentation of illustrations of molecular structures, as shown in Figure 1, which allows students to understand the relationships between atoms and the structure of molecules in acid and base materials.

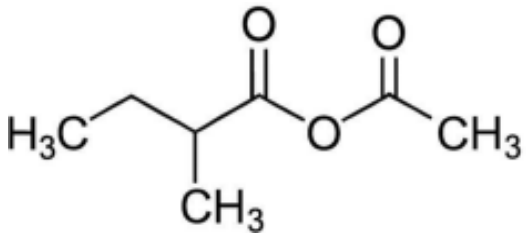

Figure 1. The molecular structure of an ester as a visual representation of acid-base matter

This image is a form of microscopic representation that is very important in chemistry learning. Johnstone's theory (2006) states that a complete understanding of chemistry must encompass three levels of representation: macroscopic (real-world observations), microscopic (particle structure), and symbolic (reaction equations). With three-dimensional visualizations like this, students can visualize chemical reactions in greater depth, such as how H atoms^{+} from acids interacting with OH ions^{-} from alkali to forming water. This media has also demonstrated its effectiveness through very positive student responses. This is consistent with the findings of Rahmawati and Partana (2019), who stated that visual and interactive learning media can improve students' self-efficacy and conceptual understanding of chemistry.

Compared to previous research by Maulana (2021), which also developed Android media for acid-base materials, AsamBasaKU's innovation lies in its comprehensive features and visual integration, such as the use of pH simulations and neutralization reaction animations. These advantages demonstrate that this media not only conveys information but also encourages students to actively explore and construct their own understanding through digital simulations, as emphasized in the constructivist approach (Sugiyono, 2020).

However, this study has several limitations. The testing was conducted on a relatively small scale and has not yet been evaluated over an extended period. In addition, the developed medium focused only on a single topic, namely acids and bases. Therefore, further development is recommended to include other chemistry topics and to conduct longitudinal testing in order to examine its long-term impact on improving learning outcomes in a more sustainable manner.

The implications of this research are highly relevant in the context of 21st-century learning, which emphasizes the importance of ICT integration in education.

Media like AsamBasaKU can be an alternative solution to improve the quality of chemistry learning, which has been considered difficult and uninteresting. Furthermore, this media development approach can be replicated by other teachers or researchers in different contexts, both in terms of material and educational level.

CONCLUSION

Based on the results of the research that has been conducted, it can be concluded that the Android-based chemistry learning media developed under the name AsamBasaKU is very suitable for use as a learning medium for acid-base material in class XI IPA Madrasah Aliyah AR-Rasyid Sei Renggas. This media successfully bridges students' understanding of abstract chemical concepts through a visual and interactive approach. The validation results from experts show a feasibility percentage of 89.5% with a very suitable category, while the results of trials on students show that more than 85% gave a positive response to the media's features. This application not only facilitates students' understanding of the concept of pH, neutralization reactions, and acid-base theory, but also increases their interest in learning and engagement in learning. Therefore, the AsamBasaKU media can be an effective alternative in technology-based learning, both for independent learning and blended learning. For further research, it is recommended that similar media be developed for other complex chemistry topics and trials be conducted on a wider population to see their impact on long-term learning outcomes.

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