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Development of Android-Based Applications With an Inquiry Approach on Solubility Material and Solubility Products as a Source of Independent Learning for High School Students

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ABSTRACT

This study aims to develop an Android-based application that uses an inquiry approach on solubility material and solubility products, and assesses its feasibility as an alternative source of independent learning for high school students. The approach used is the development research method, by choosing a development design using the ADDIE model. The result of this study is in the form of an Android-based application. The evaluation of the results of this development is based on the assessment of validators who show very good categories, with ideality reaching 86% according to the assessment of media experts, and 84.75% according to the assessment of material experts. Student responses to Android-based applications with an inquiry approach to solubility material and solubility results obtained a percentage of 93.22%. Based on the expert assessment and student responses, it can be concluded that the Android-based application that has been developed is worthy of being used as an independent learning resource for high school students.

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1. Introduction

Education is not just a process of distributing information, but also an effort to build skills, values, and a deep understanding of the surrounding environment. It is a series of complex and multidimensional processes that aim to facilitate student growth in various aspects of life [1]. Education is not limited to the formal period in school but rather lasts throughout the life span. Every individual should be allowed to continue learning, improving skills, and gaining new knowledge throughout life [2]. The entry of students into the era of 21st-century education marks a significant shift in the learning paradigm. This era not only brings new challenges but also opens up vast opportunities to form individuals who can face constant changes in today's world. In the era of 21st-century education, educators are required to be more creative and innovative in delivering material [3]. The development of technology, communication, and information facilities has a great influence on the progress of education in the 21st century and causes changes that create new challenges and expectations for teachers and schools today [4].

The special characteristics of the 21st century are the use of computing-based equipment, information that is available quickly, and ease of access in the use of communication tools without time and place restrictions. The use of information technology carried out in the learning process can be applied to choose the type of media and learning resources that can be chosen to support the ease of the learning process. Learning in the 21st century is carried out by integrating technology into the learning process, thus requiring prospective teachers or teachers to master technology well. Based on the results of recent research, it is known that 21st-century learning can occur successfully if it involves the use of information technology, understanding of the material, and teaching strategies that are carried out synergistically [5]. The implementation of learning activities needs to integrate or synergize technological knowledge, materials, and pedagogy that are integrated to support the process of teaching and learning activities [6]. Therefore, much more precise learning is needed to improve some of the weaknesses that occur in schools, one of which is through habituation to technology integration combined with the right learning strategy. The use of appropriate learning strategies has a significant impact on student learning outcomes [7]. One of the things that requires the right learning strategy in the process is Chemistry learning. Chemistry itself is a part of natural science that explains a lot about the structure of substances, changes in substances, properties of substances, laws, principles theories, and concepts that describe the process of changing substances [8]. More simply, chemistry is a basic field of knowledge that examines everything down to the level of molecular particles and atoms. Most of the chemical concepts are abstract, which makes understanding them difficult, especially when students have to understand something that cannot be seen directly [9]. This is in line with what was revealed by [10] that special characteristics in chemistry involve abstract aspects, understanding simplification of chemical concepts, progression in subject matter from simple to complex, as well as an emphasis on problem-solving. Several factors such as the involvement of mathematics in understanding chemistry, the use of various chemical terms, the complexity of the material that is often abstract, and chemistry education that requires more than just learning in the classroom are contributors to why studying Chemistry is considered difficult. The study of chemistry can be well understood if one can describe three levels of representation which include macroscopic, microscopic, and symbolic [11]. Macroscopic representation is a representation at the concrete level that can be observed on a laboratory scale, while microscopic representation is a representation at the abstract level that requires explanation at the particulate level and includes interactions between atoms, ions, and molecules. Symbolic representation is a representation that involves the use of chemical symbols, formulas, equations, molecular structure drawings, diagrams, models, and computer animation to symbolize abstract objects [12].

Understanding chemistry cannot be best understood using only one of the three levels of representation. Therefore, if students have difficulty at one level of representation, it can affect students' understanding of other representations [13]. One chemical material that requires an understanding of the three levels of representation is solubility and solubility product. Solubility material and solubility product are chemicals taught in high school grade XI. The material discusses concepts that include the concept of solutions (saturated and through saturated), solubility, solubility products, factors that affect solubility (temperature, namesake ions, and pH), and precipitation reactions. Examples of macroscopic representations of solubility matter and solubility products are shown through the process of precipitation of AgCl in water solvents. When AgCl is dissolved in water, the macroscopic representation that can be observed is the formation of AgCl deposits at the base of the solution. Microscopic representation of this material can be known through equilibrium events in saturated solutions which can be explained that when AgCl deposits form, it does not mean that the dissolving process has stopped but in the solution, there is an equilibrium process between insoluble AgCl crystals and AgCl solutions. The representation is a picture at an abstract level that can be visualized to explain a macroscopic phenomenon. As for the symbolic representation, an example is the equilibrium constant for dissolving AgCl which can be written as $Ksp = [Ag^+] [Cl^-]$. The abstract nature of the solubility material and the product of solubility, resulted in this material being difficult for students to understand. Therefore, a more meaningful approach to chemistry learning is needed, which aims to enable students to think critically, logically, creatively, and innovatively so that they can overcome problems in the context of chemistry learning. Meaningful learning is applied to replace teaching patterns with traditional approaches that focus on memorizing concepts only [14]. An educator needs to know content related to their understanding of the subject matter taught, as well as pedagogical knowledge related to their understanding of the learning process and teaching on a particular subject matter. Chemistry plays a very important role in the development of basic concepts as well as the production of diverse goods and technologies, such as detergents, cleaning agents, beverages, and food products, as well as nanotechnologies that are developing rapidly today [15]. In the field of chemistry, scientists have emphasized how important it is to connect chemical knowledge with everyday phenomena so that abstract chemical concepts can become more concrete [16]. Unfortunately, many people, including students, have not realized that these products and technologies rely on chemical knowledge [17]. So it can be known that problems in chemistry learning can occur because teachers focus more on understanding concepts without showing how these concepts can be applied in everyday life [18].

The process of learning chemistry should be carried out by the characteristics possessed by chemistry, to increase student learning motivation. The characteristics possessed by chemistry require students to think at a higher level to understand chemistry well. Through learning Chemistry students can have the opportunity to better understand, explore knowledge, and gain a significant understanding of phenomena that occur in the world around them [19]. Learning that is done by considering the nature of chemistry as a process, will be done by focusing on developing the skills that students have as researchers or giving students opportunities to learn chemistry in a similar way to how chemists study it. This can be done if students are supported by the availability of quality learning media, easy to understand and can be used by students and make it easier for students to understand concepts. One alternative that can be done is through the use of Android-based learning media using an inquiry approach. Android is an operating system on mobile devices to create an application by providing an open platform making it easier for developers to create an application, especially in the teaching and learning process, how to operate it is easy, making Android widely used in the current era. According to [20] the advantage of android in learning is to increase learners' learning motivation because the delivery of subject matter becomes more interesting with the broad prospect of applications and design. The integration of technology in Android-based learning will be effective if combined with the right learning strategies, one of which is inquiry. Inquiry learning can place learners as learning subjects who not only receive knowledge from educators verbally, but are active in discovering for themselves the core of the knowledge being taught [21]. All forms of scientific activities in learning are carried out to find and search, therefore educators act as facilitators with the ability to ask questions as the main requirement in carrying out inquiry strategies. This is in line with what was expressed by [22] that inquiry is a series of scientific activities that occur by presenting to the maximum all the learners' abilities to identify critically, systematically, analytically, and logically so that they can confidently formulate their findings. The inquiry was chosen as an approach combined with Android-based learning media because it has several advantages, one of which can improve scientific thinking skills, and the ability to argue [23], increase learning achievement, and reduce the anxiety of learners who assume chemistry is a difficult lesson [24]. Through this application, it is expected to increase students' interest in chemical materials, especially in the concept of solubility and solubility products. In addition, the app is expected to be an easily accessible self-study resource, allowing students to learn flexibly outside the classroom environment. A much greater contribution is expected in changing the learning paradigm to be more interactive, independent, and engaging. Thus, the development of Android-based applications with an inquiry approach to solubility material and solubility products aims to provide innovative solutions in chemistry learning for high school students, arouse their interest in learning, and deepen their understanding of chemistry concepts thoroughly.

2. Research Method

The research conducted is included in the category of research and development, which is a method used to develop and test the validity of educational products. The model applied in this development is the procedural model, which describes the steps or procedures that must be followed to create a particular product [25]. The development model chosen in this study uses the ADDIE development model. The development steps are as follows. (1) analysis, (2) design, (3) development, at this stage expert reviews are carried out which is the first evaluation stage to revise the product, (4) implementation, at this stage field tests are carried out (5) evaluation.Data regarding the feasibility of Android-based application products with an inquiry approach to solubility material and solubility results are obtained from expert reviews and assessments of student responses or responses and then made in the form of scores. Data in the form of input is summarized and used as a basis for product revisions until the final product is obtained. Here are the percentages of ideality criteria that can be seen in Table 1.

Table 1. Percentage Ideal Criteria

Score	Category	Score Range	Description
5	Excellent	$X > 80\ \%$	Worth using without revision
4	Good	$66{,}67\% < X \leq 80\%$	Worth using without revision
3	Medium	$55{,}3\% < X \leq 66{,}67\%$	Worth using with minor revisions
2	Less	$40\% < X \leq 53{,}5\%$	Worth using with multiple revisions
1	Very Less	$X \leq 40\ \%$	Not worth using

(Source : Sudjono, 2010)

3. Result and Discussion

This research is a research on the development of a product in the form of an Android-based application with an inquiry approach to solubility material and solubility products. This development uses a procedural development model, which is a descriptive model that outlines the steps that must be followed to produce the final product of the study. In development research, the first thing to do is a needs analysis to find out what problems are faced and what needs are needed to overcome these problems so that the resulting products will be as needed or Based on need. After the application has been developed, it is continued with expert testing. This expert test stage is carried out to test the feasibility of the application that has been developed. This stage involves media experts and material experts. Trials are carried out as a basis for improving the quality of the products produced in terms of material suitability to the tools made. Media validation is carried out by 1 media expert. Validation is carried out as a basis for improving the quality of the products produced. The rating scale used in media expert validation is a Likert measurement scale with a score range per item 1-5. Based on the results of media expert opinions, the final results are averaged and categorized as eligibility according to Table 2.

Table 2 Tabulation of Media Experts' assessment of Development Products

No	Assessment Aspect	% Ideality	Category
A	User Interaction Aspect	86,67	Excellent
B.	Content Design Media	83,33	Excellent
C.	Aspects of Media Appearance	88	Excellent
Number of Scores		86	Excellent

Furthermore, an assessment by material experts was carried out as a basis for improving the quality of the products produced in terms of material suitability to the development of android-based applications with an inquiry approach to the solubility material and solubility results developed. The following is the material expert's assessment of the developed product which can be seen in Table 3.

Table 3 Tabulation of Material Expert Assessment of Development Products

No	Assessment Aspect	% Ideality	Category
A	Content Eligibility Aspect	84	Excellent
B	Feasibility Aspects of Presentation	85	Excellent
C	Aspects of linguistic eligibility	80	Excellent
D	Usability Aspect	90	Excellent
	Number of Scores	84,75	Excellent

Figure

The next step at the implementation stage is a field test for students to measure the feasibility of the product being developed. With this trial, it is hoped that it will be known which parts have been considered good by students and which parts require improvement because the purpose of this development research is to produce learning media products that are suitable for use to help the teaching and learning process. The trial results showed a very good category with an ideal percentage of 93.22%. The following are the results of developing an android-based application with an inquiry approach on solubility material and solubility results as a source of independent learning for high school students which can be seen from 3.1, Figure 3.2, Figure 3.3, Figure 3.4.

Figure 3.1 App initial view

Figure 3.1 shows the initial appearance of the application, designed with an attractive, simple, and easy-to-use design for students. Visual elements such as colors, layouts, and icons are arranged harmoniously to create an interface that is both aesthetic and intuitive. Users can easily recognize the available menus or features thanks to the use of clear and consistent icons and text. The initial display also contains responsive navigation elements, allowing students to directly access learning materials or other features without confusion. This design aims to create a positive user experience so that students are more motivated to use the application as an independent learning medium. In the center of the screen, there is a round "Play" button with a cheerful design, decorated with decorative elements, which provides a visual contrast between technological elements and natural aesthetics. This button functions as the main navigation for users to start the application. Around the "Play" button, there are various supporting visual elements, such as molecular diagrams, illustrations of electrolyte experiments (weak, strong, and nonelectrolyte), and the crystal structure of salt (NaCl). These elements are designed to represent chemistry learning material visually so that users can immediately associate the application with educational content.

Figure 3.2 Application menu display

The application homepage in Figure 3.2 displays six main features that can be accessed directly via interactive buttons: Developer Profile, Instructions for Use, Basic Competencies, Learning Objectives, Materials, and Competency Achievement Indicators. Each button has a neat, easily recognizable hexagonal icon design, making it easy for users to navigate the app as needed. These buttons can be clicked to open the page corresponding to that feature. For example, a Developer Profile provides information about the team or individual who developed the application, while a User Guide provides guidance on how to optimally use the application. Basic Competencies and Competency Achievement Indicators help users understand the learning objectives they want to achieve, and Materials allow direct access to learning content. This design creates an organized, intuitive, and user-friendly experience.

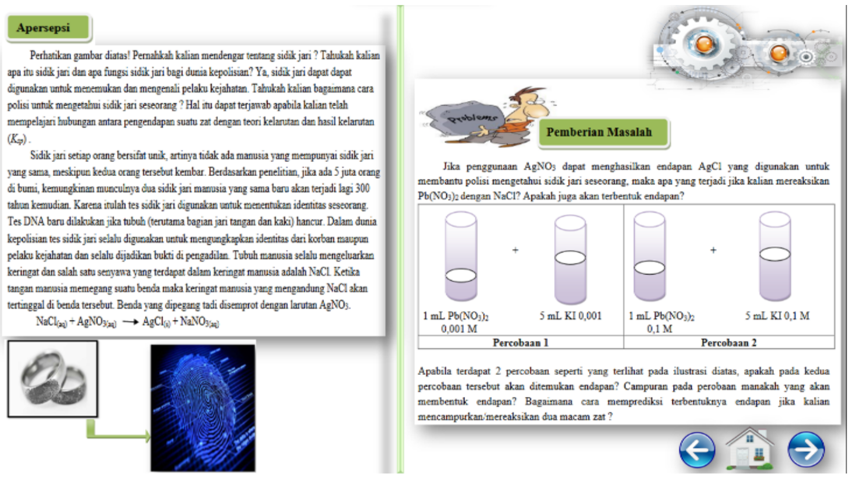

Figure 3.3 Integration of one of the Sintax Inquiry (Problem Giving Phase)

Figure 3.3 shows the integration of one of the inquiry learning syntaxes, namely in the problem-posing phase. In this phase, students are exposed to real situations that are relevant to arouse their curiosity, such as the case of fingerprints in the world of forensics which is explained in the apperception section. This material provides a practical context that connects chemical concepts to everyday life. Students were given two experiments to analyze, where they were asked to predict the formation of a precipitate based on the reaction between $Pb(NO_3)_2$ and KI solutions. This approach is designed to hone critical thinking and problem-solving skills, which are the core of the inquiry syntax in this phase. Informative and structured visuals support students in understanding the material more easily.

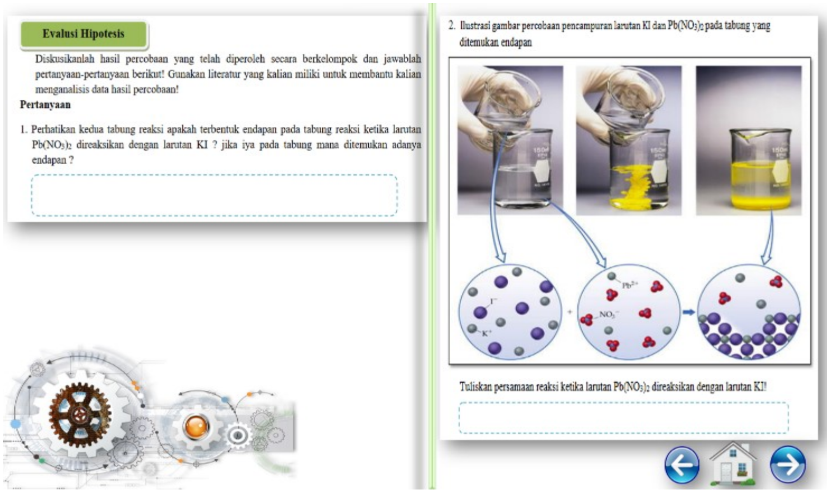

Figure 3.4 Integration of one of the inquiry syntax (hypothesis evaluation phase)

Figure 3.4 is a very effective visual representation in guiding students through the hypothesis evaluation stage in a chemistry experiment. This image presents a simple but relevant experimental scenario, where students are asked to observe and analyze the results of the reaction between $Pb(NO_3)_2$ and KI solutions. With clear test tube illustrations and structured questions, students are invited to think critically, connect theory with practice, and communicate the results of their analysis in the form of chemical reaction equations. The visual and text elements in these images work synergistically to support active and meaningful learning while fostering important skills such as observation, data analysis, and problem-solving.

4. Conclusion

Based on the results of research and discussions that have been carried out, it can be concluded that:

1. An android-based application with an inquiry approach to solubility material and solubility results as an independent learning resource for high school students has been successfully developed through the ADDIE development model, namely (1) analysis, (2) design, (3) development, (4) implementation (5) evaluation.
2. The feasibility of an android-based application with an inquiry approach to solubility material and solubility results as an independent learning resource for high school students based on the assessment of material experts, media experts, and respondents of high school students has a excellent category. The percentage of the ideality of material experts is 84.75%, the percentage of the ideality of media experts is 86% and the percentage of student respondents is 93.22%. Based on some of these assessment results, it can be concluded that the development of Android-based applications with an inquiry approach to solubility material and solubility products is feasible to be used as an independent learning resource for high school students.

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