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Development of Handout Android-Based Application on Buffer Solution using Discovery Learning Model

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Abstract: *Research and development aims to produce Handout Buffer Solution on a quality Android Application. Quality is seen based on the validity, practicality, and effectiveness. Based Buffer Solution Handout Refers to the ADDIE (Analysis, Design, Development, Implementation, and Evaluate) development model. The instruments used for validity are validation sheets by theory experts and media experts, practicality teacher response questionnaires and students, and the effectiveness of the learning outcomes test. The results of the research show: 1) the validity of the Handout from the theory expert 3.65 and the media expert 3.58 with a very valid category, 2) the average percentage of practicality of the handout based on the teacher's response questionnaire equal to 91% and 87.58% of students in the very practical category, 3) the valid handouts that fulfill the effective criteria (≥ 85%) based on the achievement of class completeness with a percentage of 86.1 %. Thus, it can be concluded that the Handout Buffer solution based on Android Application development with the ADDIE Model is very valid, very practical, and effective for use in the learning process.*

Keywords: *Android Application; Handouts; Buffer Solutions*

INTRODUCTION

Changing the learning process from being teacher-centered, or one that is focused on the educator, to being student-centered is one of the things educators may do to improve student learning outcomes (Mujahida, 2019). Based on this, an effort is needed through a learning approach that is able to bring changes to a better direction. One of the learning environments that plays a very important role in facilitating students' mastery of competence is the application of technology in the use of learning media (Arsyad, 2011). However, in reality many educators do not use instructional media or educators are less creative in utilizing instructional media. Using learning media can help teachers convey concepts to students more clearly. On the other hand, learners may easily retain knowledge from the media that teachers employ.

Chemistry is part of the natural sciences that studies the structure and properties of matter, changes in matter and the

energy that accompanies these changes. The application of chemistry is very closely related to everyday life. All matter found in nature is part and result of chemistry. One material that is quite difficult to understand is buffer solution. Students' learning difficulties in understanding buffer solution material were reinforced by research by Yunitasari et al. (2013) who stated that buffer solution is a complex concept, so students experience many difficulties in understanding the material. Buffer solution which includes sub-materials: the definition, components, principle, pH, and the role of buffer solution in everyday life, requires an understanding of the concept. Students should be able to use a structured, systematic mentality through the appropriate problem-solving stages, be directly involved in understanding concepts, and be able to enhance student learning outcomes.

According to the findings of teacher interviews for Chemistry XI MIPA SMA Negeri 7 Takalar, many students still do not comprehend the KKM for the buffer solution material. KKM for chemistry is 75. One way to improve learning outcomes is by using media so that students can be more active and easier to understand the material. One of the media that has been used so far is textbooks and worksheets. The learning process is less engaging, less interactive, and unable to express ideas through pictures and movies with either of these media (Nana, 2022), so students become bored and monotonous. By looking at these conditions, learning media should be designed as attractive as possible so that the expected learning objectives can be achieved.

Interesting learning media can be obtained from the development of science and technology, namely handouts. One solution to create meaningful learning is to provide handouts before the start of the learning process. Typically, handouts are produced for educational objectives. Handouts make learning portable and enduring and can be used to reload knowledge that students have already learned or to create assessments for them (Muliawati, 2016).

The first draft of Handouts was written by hand. The goal of creating buffer solution handouts for android-based applications is to help students comprehend the information offered by teachers and enable them to learn at any time, anywhere (Prastowo, 2011). By compiling a handout for chemistry learning as a learning resource in class and independently for class XI students, it is hoped that students will gain more knowledge about the buffer solution material. Distribute materials that can be used in the teaching and learning process and have appropriate criteria and standards. The effectiveness of a lesson is determined by the chosen learning model or method. media collateral and a model The character of the learning model known as Discovery Learning is comparable to that of the development handouts buffer solution. Discovery learning is a framework for creating active learning techniques through introspective self-reflection and exploration, ensuring that the outcomes are retained in memory (Susanto & Akmal, 2018).

In order to come to a conclusion, the discovery learning model guides students to grasp concepts, meanings, and relationships through a discovery process (Meliawati, 2019). Students are encouraged to identify what they want to know, search for knowledge on their own, and then organize or construct what they know and comprehend in a final form. The discovery of concepts is not presented in its final form. By switching from the expository model, in which students only get knowledge from teachers, to the discovery model, in which students obtain information on their own, the discovery learning approach seeks to promote dynamic and innovative learning environments (Nugrahaeni et al., 2017).

Based on the description on then one way to improve student learning outcomes is needed handouts as learning media. The learning media that will be developed in this study is the handout android-based

application on buffer solution with discovery learning model.

LITERATURE REVIEW

According to Borg & Gall (in Saputro, 2011), development research, also referred to as research and development (R&D), is a procedure used to create and validate educational materials. The method of creating and developing learning media through a research process enables it to create learning materials that are reliable and thought to be practicable for use in the learning process. It can be carried out using a combined research approach, where the research data consists of quantitative and qualitative data (Batubara, 2020). Students can benefit from studying from home and from media development research that follows the ADDIE approach, which stands for Analysis, Design, Development, Implementation, and Evaluation. The media that has been developed in this study is valid, practical, effective and suitable for use as learning media (Arief et al., 2021). The definition of development research presented above leads to the conclusion that it is educational research that creates products intended to make the learning experience more engaging and pleasurable in order to accomplish learning objectives.

The discovery learning paradigm includes students in problem-solving for the advancement of knowledge and abilities. Teachers must be able to direct and guide student learning activities in accordance with learning objectives while using the discovery learning model since they act as mentors by giving students opportunities to learn actively (Kurniasih et al., 2014). Discovery learning is a framework for creating active learning techniques through self-reflection and inquiry, ensuring that the learning outcomes are retained in memory (Susanto, 2018).

It is essential that media be used in classroom instruction and cannot be disregarded. One of them is how to set up a learning environment where students can experience the learning process by utilizing all available learning materials and productive and efficient learning techniques. In this case, learning media-based Android applicationisan effective supporter in helping the learning process occur.

Android is an operating system for tablets and touch-screen mobile devices. Android has capabilities with the use and functionality of providing advanced features such as electronic mail, internet, e-books and Handouts. In order for users to engage with the device and use the programs that are available on it, the operating system can be seen as a bridge between the device and its users (Satyaputra & Aritonang, 2014).

Handouts is a teaching material for students. This handout serves to help students in the learning process. Handouts are written teaching materials prepared by teachers to enrich students' knowledge. The function of the handout is to help listeners not to take notes and as a companion to the teacher's explanation (Prastowo, 2011). Typically, handouts are produced for educational objectives. In addition to reloading knowledge that students have learned and developing student tests, handouts make learning portable and enduring. Initially, handouts were created by hand. Teachers utilize handouts to supplement lectures with discussion material and to provide information that is not included in the lectures (Mohammed Nazrul Islam, 2005 in Muliawati 2016). Based on understanding handouts above it can be concluded that handouts are teaching material that combines various audio-visual media designed to make the learning process more interesting and enjoyable in achieving learning goals.

The evolution of the Android operating system includes the creation of touch-screen tablets, mobile phones, and software that runs on other Android operating systems. Obviously it can benefit students who own and use Android in daily life. One of them involves creating effective and efficient giveaway Android applications. Students can access independently anytime and anywhere. The appropriate learning model or strategy

determines the success of a lesson. Media handouts and models discovery learning is a learning model whose character is similar to development handouts on buffer solution. To apply the discovery learning model by using learning media and using applications Android assumes the role of the instructor to help learners through the learning process. The discovery learning paradigm, which gives students the chance to actively learn by solving issues for the advancement of information and abilities, is anticipated to increase students' capacity for critical and creative thought.

METHODS

This research is directed at efforts to produce a product in the form of a handout android-based application on buffer solution using the discovery learning model. The ADDIE model of development was employed in this study. For high school students, research and development of a free Android app employing the discovery learning method will take place during the even semester. This research was conducted at SMA Negeri 7 Takalar which is located at Cikoang, Mangara Bombang, Takalar. The intent of this study is a handout android-based application on buffer solution using discovery learning model developed. For a practicality test, this study's participants were chemistry instructors and students. The effectiveness test of the products produced was carried out on students at SMA Negeri 7 Takalar class XI MIPA 3 in the 2021/2022 academic year.

The research tool used included validation sheets from media and material experts for the validity test, chemistry teacher and student response questionnaires for the practical instrument, and learning achievement tests for the practical instrument to assess the efficacy of handouts. The practicality of the handout Android-based application was assessed by processing and analyzing data from student and teacher response questionnaires, and handout effectiveness data was quantitatively analyzed based on student learning outcomes. This study's data analysis method was quantitative descriptive analysis.

RESULT AND DISCUSSION

As part of this research and development, a handout Android application based on the buffer solution and the discovery learning model was created as learning media. The ADDIE Model, which has five stages, Analysis, Design, Development, Implementation, and Evaluation, was used to create this material. The development approach for the handout Android application on buffer solution utilizing the discovery learning paradigm is described here, along with the outcomes attained at each stage.

The initial phase is the analysis stage where at this stage the researcher conducts a performance analysis and needs analysis as a basis for developing. Performance analysis shows that if the teacher has used textbook media in the learning process, however, the media has not attracted the attention of students and the textbook media that has been used so far has not been able to make chemistry subjects more attractive to students. The needs analysis resulted that learning media which is a problem felt by teachers can be overcome by presenting more innovative learning media. To increase the enthusiasm for learning and attract the attention of students in learning, the media being used needs to innovate with audio-visual and appealing designs.

The second stage is the design stage. For this stage, several steps were carried out, namely designing research instruments and designing handout android-based application are designed using many applications such as canva, microsoft word, and WPS Office. The conceptual framework is turned into a product during the development stage after being validated by media and material experts. Two lecturers from the Chemistry Department at Universitas Negeri Makasar validated the material's expert status. The applicability of learning objectives, the content's quality, and how the content is presented are the three components of validation by material

specialists. Table 1 displays the findings of the material experts' data validation.

Table 1. Material Expert Assessment Data

Aspect	V1	V2	Mean	Category
Learning Objectives	3.67	3.67	3.67	Very Valid
Material	3.67	3.67	3.67	Very Valid
Presentation	3.75	3.5	3.62	Very Valid
Average			**3.65**	**Very Valid**

At this stage, handouts revised based on suggestions given by material experts. One media fix handouts based on the material expert's advice is to divide the buffer solution material for each meeting. Then Handouts validated media experts conducted by 2 lecturers of the Department of Chemistry, Universitas Negeri Makasar. Validation by material experts includes two aspects, namely aspects of media design and aspects of media operation. Table 2 displays the findings of the media experts' data validation.

Table 2. Media Expert Assessment Data

Aspect	V1	V2	Mean	Category
Design	3.67	3.67	3.67	Very Valid
Operation	3.33	3.67	3.5	Very Valid
Average			**3.58**	**Very Valid**

One media fix handouts based on the advice of media experts is varying the colors of each page in the handout so it is not monotonous and boring. The implementation phase is carried out when the handout media has been validated for use in learning, at this stage initial field trials and main field trials are carried out. Five students from class XI MIPA 3 SMA Negeri 7 Takalar participated in the first field trial. After the validator declares the handout practical, the next step is to conduct main field trials so that the handout can be used in the learning process. This stage is carried out at SMA Negeri 7 Takalar in the even semester 2021/2022 academic year. The handout was implemented in class XI MIPA 3 as many as 36 students who would become respondents to find out the practicality and effectiveness of this handout android-based application on buffer solution using the discovery learning model.

Table 3. Recapitulation of Student Responses to Handouts per Aspect

Assessment Aspects	Percentage	Category
Operation	88%	Very Practical
Appearance	90.43%	Very Practical
Benefits	90.43%	Very practical
Average	**87.58%**	**Very Practical**

Table 4. Recapitulation of Teacher Responses to Handouts per Aspect

Assessment Aspects	Percentage	Category
Operation	93.33%	Very Practical
Appearance	91.43%	Very Practical
Benefits	92.5%	Very Practical
Content	100%	Very Practical
Average	**91%**	**Very Practical**

The effectiveness assessment was carried out on 36 students in class XI MIPA 3 SMA Negeri 7 Takalar. The learning outcome data was obtained from the learning outcomes test which was filled out by the students after carrying out the learning. The results of the student learning outcomes test are presented in Table 5.

Table 5. Results of Descriptive Analysis of Student Learning Outcomes Tests

Variable	Descriptive Value
	XI MIPA 3
Assessment Subject	36
Ideal Value	100
KKM	75
Average	82,89
Maximum Score	96
Minimum Score	68
Number of Completed Students	31
Number of Students who did not complete	5
Class Completeness Percentage	86.1%

The evaluation stage in this study was implemented at each ADDIE stage. At this stage the researcher revises the shortcomings of the Handout that was developed if there are still deficiencies when implemented in the learning process. The handout profile will be created once the handout preparation process is finished. The handout's product profile,

which was developed, matches the qualities of the handout in the manner described below:

1. Handouts the buffer solution was developed to facilitate and motivate class XI students in learning the buffer solution material in which there is an interesting Handout Cover.
2. There are basic competencies, indicators, and learning objectives.
3. The buffer solution material starts from concept maps, apperceptions, material descriptions, LKPD, examples of questions and exercises.
4. Presentation of interesting content in the form of learning videos for readers.
5. Handout salso includes a bibliography

The purpose of this study is to identify the handout's profile and create learning materials that are reliable, usable, and useful for the teaching and learning process. Handout android-based application on buffer solution using the discovery learning model which was developed using the ADDIE Model which was modified according to research needs.

a. Analysis Stage

The analysis was done on the class XI chemistry learning materials for the buffer solutions material. Based on the background of the problems obtained, namely learning media that are designed according to the needs of students, one of which is by providing interesting learning media to students so that students' learning interest increases. According to the 2013 curriculum, the study of the buffer solution material taught in class XI MIPA has Core Competencies (KI), Basic Competencies (KD), and indicators of competency in buffer solution materials.

Considering the content standards outlined in Minister of Education Regulation No. 22 of 2006, chemistry subjects in SMA emphasize mastery of abstract concepts, therefore students are given learning media that increase students' interest in independent learning. Learning media is categorized as good if it fulfills three functions, namely: 1) the stimulus function that creates interest in the media, 2) the mediation function which is an intermediary for communication between the teacher and students, and 3) the information function which can make it easier for students to capture the explanation conveyed by teacher.

A handout Android-based application on buffer solution utilizing the discovery learning paradigm has never been employed in the chemistry learning process, according to the findings of observations and conversations with teachers of chemistry class XI MIPA SMA Negeri 7 Takalar. The media that have been used so far are textbooks and worksheets. Educators also realize that learning using media that has never been obtained by students besides being able to attract students' attention, learning using handouts can also provide innovation in learning activities so that students do not get bored quickly. By incorporating information and communication technology into their lessons through a variety of media, including electronic media and online learning, teachers must innovate in the classroom (Sunarti, 2020). Students need interesting learning media that can stimulate and arouse students' enthusiasm for learning as well as a learning resource that can be used independently or in groups, where skills for independent learning are a characteristic of learning whenever and wherever it can be done (Hasanah, 2020).

b. Design stage

After identifying the problem, the researcher analyzes the solution to solve the problem. In this second stage the researcher first designed the instruments used in the form of a validation width and a questionnaire compiled to evaluate the handout that had been made. The preparation of the instruments was carried out based on aspects that were adjusted to the objectives of each instrument. Furthermore, the researchers designed a learning tool, namely the lesson plan. The preparation of lesson plans is based on the syllabus for the chemistry subject in the 2013 curriculum on buffer solutions.

The design of handout framework consisting of four handouts to be used at each meeting. The designed handout framework consists of covers, KD, indicators, learning objectives, concept maps, apperceptions, material descriptions, sample questions, exercises, and bibliography. After that the researcher carried out the process of collecting buffer solution material, pictures, and making learning videos obtained from various learning sources such as textbooks, articles, papers, and youtube which can be used as a reference. Handout android-based application on buffer solution using the discovery learning model was designed using the Canva. As for the preparation of material using Microsoft Word and WPS Office.

c. Development Stage

At this stage, expert validation is carried out on the handout product to identify deficiencies and improvements that need to be made before the handout is tried out. Validation was carried out by 2 lecturers from the Department of Chemistry as material experts and media experts. This is consistent with research done by biological et al. (2015), who found that data from the evaluation of pertinent and experienced material experts and media specialists was used to determine the legitimacy of the generated media.

1) Material Expert Validation

The results of the handout android-based application on buffer solution using the discovery learning model in table 1 assessment by two material experts show that for the aspect of suitability of learning objectives by material experts, an average score of 3.67 is obtained with a very valid category. This demonstrates that the information in the handout complies with the KD in the buffer solution package. This is in accordance with Kasmadi's statement in Harjanto (2008) that the selection of learning materials needs to consider the content in the curriculum and clear objectives. In addition, according to Chee and Wong (2003) good material has pictures, animations and videos, which can provide illustrations of concepts in real life and can provide direct examples of the use and application of a science being studied.

A very valid category has an average score of 3.67 for material quality factors. This demonstrates that the information in the handout has a clear source and has been organized and presented in an orderly manner. Facilitating the students' understanding of the supplied buffer solution information. Nevertheless, the aspect of how the information was presented received a highly valid category average score of 3.62. This demonstrates that the communicative handout's wording is clear and acceptable for student who will use learning media at their developmental stage. This is in accordance with Walker and Hess's statement in Arsyad (2015) which explains that material must have technical quality which includes; readability, quality of handling student responses, quality of program management, and quality of documentation.

Based on these three aspects, an average score of 3.65 is obtained. Then, when converted based on the validity criteria table according to Arikunto (2016), The handout Android application's validity assessment utilizing the discovery learning paradigm yielded results that fall into the “very valid” category.

2) Media Expert Validation

The handout Android application's validity assessment utilizing the discovery learning paradigm yielded results that fall into the “very valid” category. This demonstrates how user-friendly, appealing, and instructive the produced handout Android-based application on buffer solution employing the discovery learning model media is during the learning process. This is in line with what Thorn said in Munir (2009) which argues that one of the assessment criteria for good media must have ease of operation. So that students can understand it without having in-depth media knowledge, interactive media should be made as easy as feasible.

Based on these two aspects, an average score of 3.58 is obtained. Then, when converted based on the validity criteria table

according to Arikunto (2016), results from the validity evaluation of the Android-based handout application's buffer solution utilizing the discovery learning model can be classified into the very valid category.

d. Implementation Stage

At this stage the handout android-based application on buffer solution using the discovery learning model which has been declared valid by the material expert validator and media expert is implemented in the learning process in class XI MIPA 3 SMA Negeri 7 Takalar. This is done to evaluate the usefulness and efficacy of the created Handout. From the instructor and student feedback surveys, the handout's usefulness was evaluated. The survey findings from both teachers and students' replies collectively demonstrate how useful the handout Android application on buffer solution using the discovery learning approach is for the learning process.

Based on student responses in table 3 and teacher responses in table 4 as for the aspect of operating the media, the percentage of student responses was obtained by 88%, the display aspect was obtained by the percentage of student responses by 90.43%, and the media benefit aspect was obtained by the percentage student response was 90.43%. The average student response rate for all components was then calculated and came out to 87.58% in the extremely practical category. The teacher's response to the topic of using the media received a percentage of 93.33% in the meantime. The percentages for the display aspect, the media benefits aspect, and the content aspect were 91.43%, 92.5%, and 80% respectively. Then, the average percentage of teacher responses for all aspects assessed at 91% was obtained in the very practical category (Akbar, 2013).

This demonstrates that using the created handout to aid in the learning process has an advantageous effect on the students. The handout's inclusion of images and videos facilitates students' understanding of the concepts in the buffer solution material and enhances their conceptual understanding. According to research by Hutahaean et al. (2019), information is more likely to be recalled and understood when it is received by a variety of senses. Aspects of media benefits and content both received percentages of 92.5% and 80%, respectively. Then, the average percentage of teacher responses for all aspects assessed at 91% was obtained in the very practical category (Akbar, 2013).

Overall positive responses to the handout were found in the analysis of the teacher and student response questionnaires, therefore it can be deduced that the handout being prepared was deemed practicable in terms of its practicality. This is in keeping with Akker's assertion in Mustaming et al. (2015) that "practicality" refers to the extent to which consumers find learning media entertaining and usable in any situation. Therefore, a handout is considered practical if media experts, subject matter experts, and practitioners affirm that it may theoretically be utilized in the field and that its level of execution is “good”.

A two-way relationship between the handout and the user that involves the senses of sight and hearing may result from the usage of the handout Android-based application on buffer solution employing the discovery learning model in learning, so that they are inspired to learn actively, creatively, and independently. The developed handout Android-based application on buffer solution using the discovery learning model has many benefits, including having an appealing appearance, being simple to use on laptops and smartphones, being affordable, and being available to students anytime, anywhere to study independently.

The student learning outcomes test, which is used to assess students' level of cognitive development in relation to the buffer solution material being taught, provides evidence of the usefulness of the created handout. The developed handout is declared effective if the class completeness reaches 80% based on the KKM that applies in the school, namely 75. From the test the learning outcomes obtained by the students were good

with the acquisition of the percentage of class completeness in class XI MIPA 3 SMA Negeri 7 Takalar reaching 86.1% with a KKM score of 75 for individual completeness can be seen in Table 5. This shows that the Handout developed effectively for use in Offline and Online learning processes. This is in line with the class completeness category used as a national standard, namely a class is declared complete if it has a minimum class completion percentage of 85% (Depdikbud, 2001). So if the class mastery reaches or is more than 85% then the handout used is categorized as effective.

The developed handout Android-based application on buffer solution, which was created using the discovery learning model, meets the requirements for being appropriate for use in the learning process, according to the findings of the analysis of the validity, viability, and effectiveness of the developed learning media.

e. Evaluation Stage

This stage was carried out by revising the deficiencies of the handout which were developed based on the input and suggestions given in revising the handout. This stage is carried out at each stage in the handout development process. Thus, producing a handout android-based application on buffer solution using the discovery learning model that is practical to use.

CONCLUSION

The Handout's validity was rated as 3.65 by theory experts and 3.58 by media experts, with a very valid category. According to the teacher's response form, the handout's average practicality rating was 91%, with 87.58% of learners falling into the highly practical group. The eligible handouts that achieve class completion with a percentage of 86.1% and meet the effective requirements (85%). Thus, it can be said that the handout Android-based application on buffer solution using the construction of the discovery learning model with the ADDIE Model is highly valid, extremely useful, and effective for use in the learning process.

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