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Development of Android-based statistics learning simulation media to support student achievement

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Abstract
This study aims to (1) produce valid and practical android-based learning media and (2) determine the potential effects on learning outcomes and positive attitudes of students from the development of android-based learning media. The type of research used is research and development using a development model adapted from Plomp. The subjects tested in the research are students who have studied basic statistical material, especially on the size of data centering. Data collection techniques in this study consisted of questionnaires, tests, and interviews. The results of this study include (1) producing valid and practical android-based learning media and (2) having a potential effect on learning outcomes and students' positive attitudes.

Keywords: development; Android-based learning simulation media; statistics; student learning outcomes

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I. Introduction

Mathematics has an important role in life and education (Amalia and Surya, 2017), including one of its branches, namely statistics (J. Deal and G. Wismer, 2010). Important statistical skills are not only used in education but also in the decision-making process (Steel et al., 2019), representing and disseminating information accurately (Tong, 2019), and even numeracy skills (Bailey et al., 2020; Tiro, 2017). However, the statistical abilities of students in Indonesia still need to improve (Lukman and Wahyudin, 2020; Tiro, 2018). One way to help students improve their statistical learning outcomes is with the help of technology (Tiro, 2018; Tsubaki, 2008).

Technology is now developing very rapidly to facilitate human activities and interests in all areas of life (Sole and Anggraeni, 2018; Tutiasri et al., 2020), including education. Technology can increase learning opportunities and the learning process (Casanova et al., 2020). Thus, teachers must be skilled at developing and utilizing technology in their learning activities (Bernacki et al., 2020; Novaliendry et al., 2020; Suryani et al., 2021). With the ability to master technology and information, teachers can increase learning effectiveness according to student needs (Geng et al., 2019).

One form of utilizing technological advances in learning is the Virtual Laboratory

(drylab). Drylab has the advantage that it can be used to explain abstract concepts that cannot be explained verbally (Gunawan et al., 2018). Using drylab also does not require long preparation because teachers do not need to prepare the tools and materials needed for the experiment (Dak et al., 2017). One form of drylab in the learning process is Android-based learning media. Using Android-based virtual laboratory media has many advantages, including: 1). easy to operate, 2). attractive design and easy to understand, 3). There are practice questions in accordance with KD/KI and indicators .4). There is a virtual laboratory that can be used equipped with tools and materials to carry out simulation activities; 5). can be operated anywhere at any time; 6). It is independent of a data network because it can be operated offline (Kuswanto and Radiansah, 2018; Sunarto et al., 2020; Zulfiani et al., 2021). Android Studio is an application that can be used to develop Android-based drylab media. Android Studio's advantages include a flexible Gradle-based build system, a fast and feature-rich emulator, and a unified environment where you can develop applications for all Android devices (Hagos, 2018).

Several studies on the development of Android-based teaching materials have been carried out in the fields of algebra (Liang et al., 2022; Nissa et al., 2021; Rahmat et al., 2019), geometry (Afni et al., 2021; Astriawati et al., 2020; Mambu et al., 2020), calculus (Affriyenni et al., 2021; Tetralian et al., 2020; Wahyu and Pradhana, 2020), and subjects other than mathematics (Fitriyana et al., 2020; Mudjid et al., 2022; Watrianthos et al., 2022). However, only a few media have developed statistical material. Therefore, in this research, an Android-based application will be developed for statistical material to support student achievement.

II. Research Method

The method in this study is research and development. The subjects in this study are students who have received basic statistical material, such as the size of data concentration, so that statistical material centred on distribution can be predicted to run smoothly because it has taken the prerequisite material. In this study, learning simulation media will be developed on statistical material and then implemented to support student learning outcomes. The research procedure consists of 4 phases, which are as follows.

Phase I: Exploration

The main activity in this phase is a literature review from books, journals, and the latest news regarding statistical learning, android-based learning media, and other problems related to this research. This phase aims to analyze the needs and curriculum used.

Phase II: Development

In this phase, researchers will begin to develop by applying a development model adapted from Plomp & Nieveen (2013). The stages of development consist of preliminary research and prototyping stage. The preliminary research stage will produce flowcharts and storyboards to be used as a reference for developing Android-based learning media. The learning media will be constructed through Visual Code Studio (VsCode). After the program is constructed, it is converted into an application form through Website 2 APK Builder. At the same time, the prototyping stage will produce valid Android learning media through the implementation of validation by experts and one-to-one implementation.

Phase III: Assessment

The assessment phase is a semi-summative evaluation to conclude whether the solution or intervention conforms to predetermined specifications. This phase will produce practical android-based learning media through the implementation of small groups.

Phase IV: Implementation

After obtaining teaching materials in accordance with valid and practical criteria, the teaching materials will be applied to the implementation of field tests. At this stage, the potential effects of learning media on learning outcomes and students' positive attitudes will be seen.

The instrument to be used to perform validation is a validation sheet. The validation sheet covers aspects of content as well as constructs and language. The sub-aspects of content validation assessment include the suitability of learning objectives, material quality, simulation presentation, and question presentation. Construct and language validation assessment sub-aspects include media benefits, word and language selection, media design, and media operation. Each statement on the validation sheet has 4 assessment categories: excellent, good, sufficient, and lacking. Then, to obtain the percentage of validity, the formula used is:

$$Percentage = \frac{number\ of\ validation\ result\ scores}{total\ scores} \times 100\%$$

The results of these calculations are then categorized based on Table 1 (Natasya and Izzati 2020).

Table 1. Validated category of learning media

Percentage	Category
0%-20%	Invalid
21%-40%	Not Valid Enough
41%-60%	Sufficient
61%-80%	Valid
81%-100%	Very Valid

Then, researchers will also conduct data collection techniques in the form of tests, questionnaires, and interviews to see the potential effects of learning outcomes and students' positive attitudes. Data obtained from tests, questionnaires, and interviews will be analyzed descriptively. The data was analyzed based on scoring guidelines, and the questionnaire results were analyzed using the Likert scale.

III. Results and Discussion

The results of the development carried out by researchers produced Android-based learning simulation media in the form of applications on statistical material under the name Stimulation. This research and development is carried out through a research procedure consisting of 4 phases, namely Phase I (Exploration), Phase II (Development), Phase III (Assessment), and Phase IV (Application).

Phase I: Exploration

The main activity in this phase is a literature review from books, journals, and the latest news regarding statistical learning, android-based learning media, and other problems related to this research. From the literature review results, an analysis related to student needs was carried out by describing the problems in learning activities. Based on research conducted by Awaludin (2017), students still need to understand how to use the formula's mean, median, mode, and meaning of the variables. Then there is also research from Sa'adah & Sumartini (2021), which states that there are still students who need help understanding statistical concepts well, causing errors and difficulties in solving the given problems. Then, an analysis of the curriculum was also carried out. Based on the results of the curriculum analysis, it was found that android-based learning media in accordance with the 2013 curriculum still needs to be found (Batubara, 2018).

Phase II: Development

In this phase, researchers will begin to develop by applying a development model adapted from Plomp T. et al. (2013). This phase results in flowcharts and storyboards for Android-based simulation media to be developed. Figure 1 presents an Android-based learning media flowchart.

Figure 1. Android-based learning media flowchart

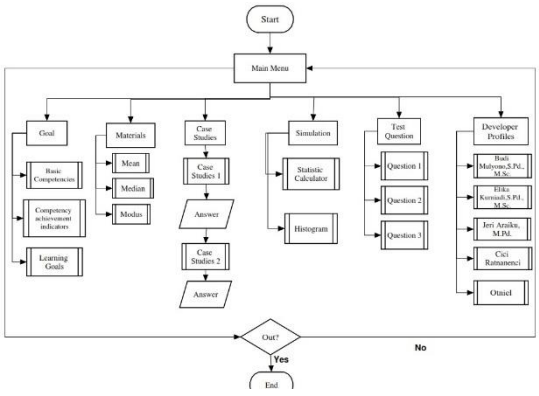

Table 2 presents Android-based learning media storyboards.

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Table 2. Android-based learning media storyboard

Menu *Home*

Menu *Tujuan Pembelajaran*

Menu *Materi*

Menu Contoh Kasus

Menu *Simulasi Statistik*

Menu *Latihan Soal*

Menu *Profil Pengembang*

After conducting preliminary research, researchers proceed to the prototype stage. Android-based simulation media will be developed at this stage with flowcharts and storyboard references made in the previous phase. Android-based learning media that has been developed is called Stamulation (Statisic Simulation). Stamulation is constructed through Visual Code Studio (VSCode). Visual Code Studio (VSCode) is software for source code editors that can be used for various programming languages such as HTML, CSS, Java, JavaScript, Go, Node js, Python, PHP, and C ++. VSCode supports many programming languages and a different set of features of each programming language. When creating Stamulation programs, developers use HTML, CSS+Bootstrap, PHP, and JavaScript. After the program is constructed, it is converted into an application form through Website 2 APK Builder. Prototype development will be piloted and revised based on formative evaluation through expert assessment. Table 3 presents the identity of experts who validate content, constructs, and languages on Android-based simulation media developed.

Table 3. Content, construct and language expert validators

Name/Position/Agency	Validation Aspect
Jeri Ariku, M.Pd. Lecturer of Mathematics Education Sriwijaya University	Content
Dr. Meryansumayeka, M.Sc. Lecturer of Mathematics Education Sriwijaya University	Constructs and Languages

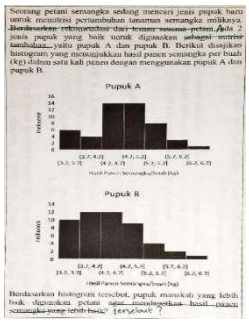
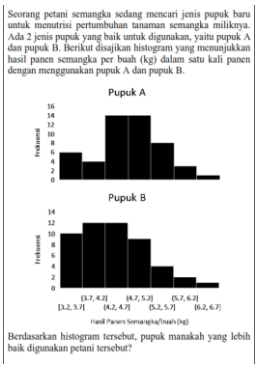
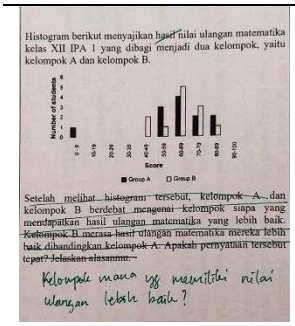
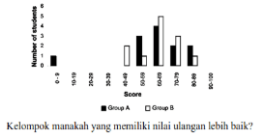
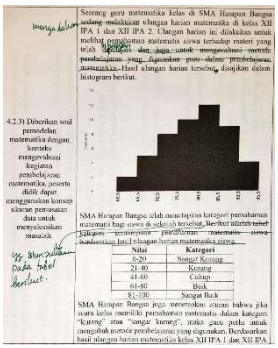
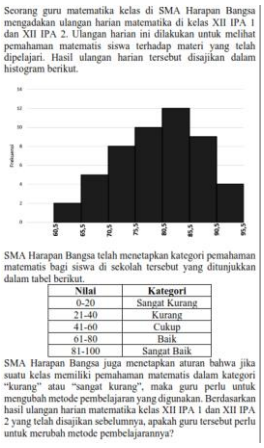
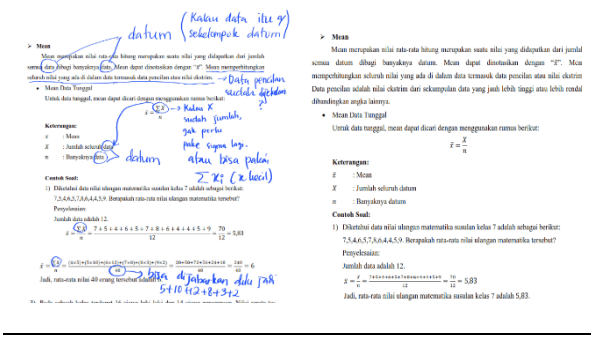
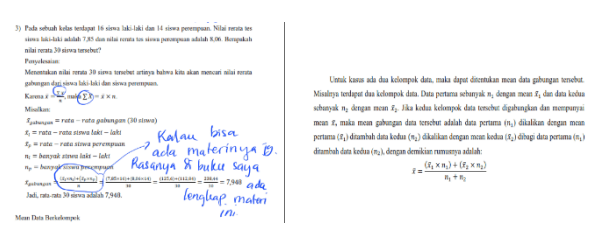
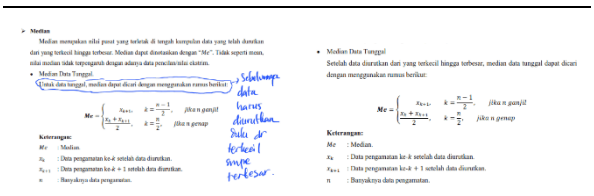
Table 4 presents validation results from experts.

Table 4. Validation results by expert validators

Assessment Aspects	Percentage
Content Validation by Content Experts	81,25%
Construct and Language Validation by Construct and Language Experts	87,5%
Average Percentage	84,375%

Based on Table 4, the overall validation results were obtained at 84.375%, with the validity category being very valid. However, there are still some comments and advice given by experts. Table 5 presents comments and suggestions on the content and the results of revisions.

Table 5. Content expert validator comments and revisions

Commentary	Revision
 There are some words wasted.	
 There are some words wasted.	
 This question was replaced with another question.	
	
	
	

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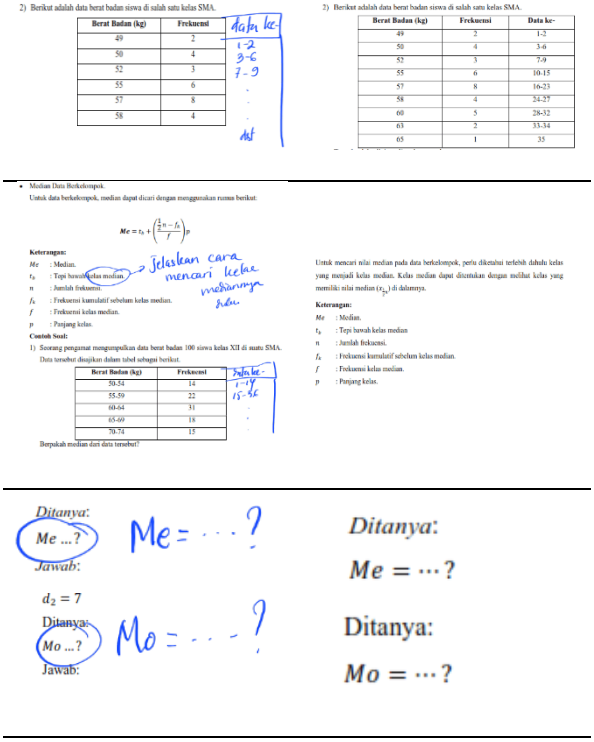


Table 6 presents comments and suggestions on constructs and language and the results of revisions.

Table 6. Construct and language expert validator comments and revision results

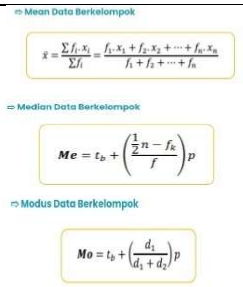
Commentary	Revision
 Revision In learning activities, there is no place for students to enter completions, but in the test section, there is	In the learning activity in the Case Example menu, only enter the final answer to check the correctness of the answer. For the solution carried out, it is written on the answer sheet provided and then presented and discussed together. Meanwhile, for practice questions, a column is given to enter the solution because the teacher himself will correct it.
Commentary	**Revision**

Which learning objectives can this menu support? Because the answer place only contains the final answer, you need to learn to learn how to solve the question. While on the test, students can enter the work result file.

The menu supports learning objectives according to those displayed on the Learning Objectives menu. Learning is carried out in groups where students have discussions to solve these problems, and at the end, a presentation of the results of their discussions will be made. Thus, there is no need to upload the completion they wrote.

After the validation stage by experts, proceed to the one-to-one stage. This one-to-one activity was carried out to test subjects as many as 4 semester 1 mathematics education students. Table 7 presents the results of one-to-one activities through comments and revisions.

Table 7. One-to-one stage comments and revisions

Commentary	Revision Results
On the Material menu, boxes are given for each formula and definition so that readers can be more aware of the formula and its important definition.	
Add learning videos as well to make the material clearer and easier to understand.	

In the Material menu, it is better if the material is presented per point so that the reader can more clearly read the material presented.

Valid learning media are obtained based on the results of the expert and one-to-one validation stages. Then, the valid learning media is continued to the small group stage.

Phase III: Assessment

The assessment phase is a (semi-) summative evaluation to conclude whether the solution or intervention conforms to predetermined specifications. This stage is carried out in small groups or small groups. This small group activity was conducted to test subjects as many as 6 mathematics education students divided into 2 groups. Table 8 presents the results of small group activities in the form of comments, suggestions, and revision results.

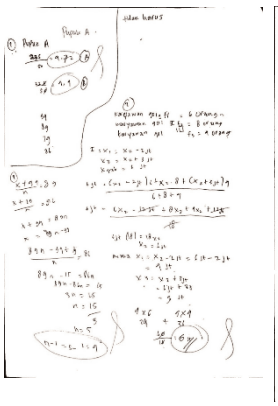
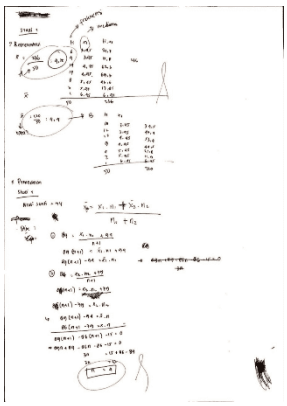
Table 8. Comments and suggestions for small group stage

Commentary	Revision Results
The questions on the Case Example menu should be displayed directly on one page to make it more practical.	

On the Case Example menu, in the column, enter the answer, preferably when the column has been filled in with the correct answer. Then the answer is immediately saved so that when moving to another menu and returning to the Case Example menu, the answer still appears without having to fill in the answer column again.

After the small group stage, valid and practical learning media results are obtained. The practicality of this media can be seen from the results of small groups, where students can use learning media well and easily. Students can listen and understand the explanation of the material provided in the material features along with the learning videos. Students can also work on the case studies presented, along with the practice questions. This can be seen from the results of students' answers, which are quite satisfactory. Table 9 presents the results of the answers of 2 groups at the small group stage.

Table 9. Answers to small group stage questions

Kelompok 1	Kelompok 2
	

Then, the statistical simulation feature provided in the media makes students more interested in using learning media. Therefore, this

android-based learning media is acceptable for school learning.

The next stage is the field test. Researchers piloted valid and practical android-based learning media for 30 students in class XII Science 2 SMAN 01 Palembang. This stage is carried out to see the potential effects on student learning outcomes. Researchers conducted an analysis of student test results after the implementation of Android-based learning media-assisted learning. The analysis results found that as many as 22 students (73%) scored ≥ 75, while 8 other students still scored < 75. This shows that Android-based learning media that have been developed have a potential effect on student learning outcomes because the test scores of students who obtain a ≥ score of 75 are more than 73%.

Students' positive attitudes towards learning media can be seen in questionnaires and student interviews. After the results of the questionnaire that students had filled out were analyzed using the Likert scale, it was found that all indicators showed a percentage of ≥ 61%. This shows that the android-based learning media given students shows a positive attitude. In addition, in interviews, students said that they felt the learning media was very flexible and practical and had an attractive visual appearance so that the material taught became easier to understand and could increase their learning motivation. This is in line with the results of research by Mahuda, Meilisa, and Nasrullah (2021), which shows that Android-based learning media can increase motivation and attract students' attention because the process of delivering material is not monotonous.

IV. Conclusion

Based on the results and discussion, it was obtained that the Android-based learning media developed was valid and practical. The validity of learning media based on content constructs and language is in the very valid category, with a value of 84.375%. Then, the practicality of this media can be seen from the results of small groups, where students can use learning media well and easily. Students can listen and understand the explanation of the material provided in the material features along with the learning videos. Students can also work on the case studies presented, along with the practice questions. This can be seen from the results of students' answers, which are quite satisfactory.

In addition, the learning media developed also has a potential effect on student learning outcomes. This can be seen from the assessment results of the test questions, where as many as 22 students (73%) scored ≥ 75. This android-based learning media also potentially affects positive student attitudes towards android-based learning media.

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