

## INSTRUCTIONAL MEDIA APPLICATION BASED ON ANDROID SMARTPHONES ON DNA STRUCTURE MATERIAL

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### Abstract

The education system uses more technology-based visualization in the 4.0 industrial revolution era which is used as a tool in learning that is more effective, and efficient, interactive. Lecturers can arrange more interesting learning materials by adding digital instructional media, such as instructional media based on Android smartphones. Based on the results of observations, generally students who do not understand the material concepts in the Genetics course, especially on the material of DNA structure. DNA structure material is very difficult to understand, and abstract, and student learning activities and outcomes are still low on the DNA structure material. So, it requires instructional media that can visualize these materials so that it is easy for students to understand. This study aims to produce instructional media applications based on Android smartphones on DNA structure material. The type of research is research and development using a 4-D model, namely define, design, and develop. Furthermore, the data obtained were analysed descriptively. Instructional media application based on Android smartphones on DNA structure material shows that the developed instructional media are valid (96%), practical (94%), effective increase student activity and learning outcomes, and the disseminate stage was carried out through the Play Store.

**Keywords:** Android, DNA Structure, Instructional Media, Learning Outcome

### 1. INTRODUCTION

The world of education continues to grow and improve to the needs of life and technological developments. In the 21<sup>st</sup> century technology and information affect every aspect of human life so there is a transformation from an industrial society to a knowledge society (Sulaiman & Shahrill, 2015). In the 21<sup>st</sup> century, technology has been able to provide proactive, accessible, and comprehensive learning as a learning environment (Anjarini, 2022). This transformation is known as the industrial revolution 4.0 era which touches all aspects of human life, such as trade, industry, agriculture, banking, and education. In the industrial revolution 4.0 era, the education system makes more use of technology-based visualization which is used as a tool in learning that is more effective, efficient, interactive, and attractive (Zhong et al., 2017); (Witkowski, 2017); (Thoben et al., 2017). Industrial revolution 4.0 is growing rapidly, progressively, and has spread in all fields so that everything becomes automatic and digital (Setiawan et al., 2021). Therefore, lecturers must be able to increase knowledge and create instructional media so that it is easy to transfer knowledge (Abidah et al., 2020). In improving skills, lecturers can arrange more interesting learning materials by adding technology to learning and creating digital learning media (Yuniani et al., 2019). The world of education in

Indonesia has tried to improve the competence of the Indonesian people by increasing teacher abilities or skills in preparation for facing global competition today, such as proclaiming the quality of education and management of international standards (Syamsurrijal et al., 2021). Digital learning media created by lecturers must be adapted to the needs and characteristics of students.

Digital learning media are learning media that use digital technology to carry messages or information that can be used for learning purposes. Digital learning media presents various innovations that aim to facilitate, streamline and streamline the learning process (Christensen et al., 2018). Various forms of digital learning media continue to develop, such as interactive multimedia, digital video, animation, podcasts, augmented reality, virtual reality, game-based learning, gamification, and instructional media based on Android smartphones. Instructional media based on android smartphones utilize mobile devices in learning (Wijaya et al., 2019). Android is a smartphone working system that uses the Linux 2.6 Kernel, including an operating system, middleware, and applications (Kirthika et al., 2018). Android growth in Indonesia reached 89%, this is because the Android operating system allows users to get various applications and have various benefits (Paridawati et al., 2021). the development of android-based information technology is increasing rapidly which is marked by the widespread use of mobile devices for the community. Android-based smartphone technology which is a new class of cellular phone technology that can facilitate significant access to various uses (Mansyur et al., 2021). Instructional media based on Android smartphones has become a new paradigm in the learning and teaching process and solving problems in learning, such as in the Biology Education Study Program, Universitas PGRI Sumatera Barat, Padang, West Sumatra, Indonesia. Based on the results of observations, generally students who do not understand the material concepts in the Genetics course, especially on the material of DNA structure. In the material of DNA structure, students are required to master the concept of genes, DNA structure, DNA replication, stages of protein synthesis, and apply the role of genetics in life. The DNA structure material is a material that is difficult to understand and abstract. It requires learning media that can visualize these materials so that it is easy for students to understand. According to (Prihantini et al., 2021) the urgency of instructional media as one of the main components learning because it can clarify abstract learning experiences into concrete, such as interactive power points and animated videos.

In addition, students are less motivated in reading lecture books and other references. Students prefer to open Android mobile smartphones compared to reading lecture books because almost all students have an Android mobile smartphone. There are no available instructional media based on Android smartphones. As a result, student learning activities and outcomes are still low on the DNA structure material. This study aims to produce instructional media application based on Android smartphones on DNA structure material. Instructional media based on Android smartphones can help students master lecture materials, especially for students who are less motivated in reading lecture books. Android smartphone is an alternative learning supplement that can make students learn independently. Through instructional media based on android smartphones, students can easily browse lecture materials according to their wishes. Instructional media based on android smartphones is produced as a positive impact and

breakthrough from technological progress and development in the world. The use of technology in education is very supportive of improving the quality of education. Especially in the development of instructional media to increase the spirit of learning, activity, and success in learning, especially in the Biology Education Study Program, Universitas Sumatera Barat, Padang, West Sumatra, Indonesia.

## **2. METHODOLOGY**

This research was carried out in a class that took the Genetics course at the Biology Education Study Program, Universitas PGRI Sumatera Barat, Padang, West Sumatra, Indonesia. The type of research is research and development using a 4-D model, namely define, design, develop, and disseminate. Furthermore, the data obtained were analyzed descriptively. The stages of the research carried out were defined, designed, and developed (Mulyatiningsih, 2013).

### **2. 1. Define stage**

The purpose of the define stage is to determine product development needs. The define stage is carried out through curriculum analysis, analysis of student characteristics, material analysis, and formulating the objectives of providing learning materials on the material of DNA structure.

### **2. 2. Design stage**

At the design stage, an Android smartphone-based instructional media prototype was made using Adobe Photoshop and Adobe Flash CS. Made prototyping consists of several stages, namely:

1. Layout draft planning
2. Design the basic display using Adobe Photoshop and Adobe Flash
3. Designing the text and its aesthetics
4. Designing navigation buttons
5. Design and enter identity text
6. Design and enter descriptive text
7. Designing and entering material text
8. Design and insert source text
9. Design and enter evaluation text
10. Design and enter Help text
11. Insert background
12. Beautify the display with animations and add notifications when the application is closed
13. Test and evaluate running the product.

### **2. 3. Develop stage**

The objectives of the development stage are to produce instructional media based on Android smartphones that have been revised by several validators. This development stage consists of several tests, namely:

#### **a. Validity test**

The validity test is the prototype assessment stage by the validator to check the validity of the product by the validator followed by revision. The validity test is performed by 3 validators and includes three validation aspects. The data is then processed to obtain the average score of validity.

#### **b. Practicality test**

Several aspects were measured in the practicality test, such as ease of use of instructional media, the time required for implementation, Student interest in learning media based on an android mobile smartphone on DNA structure material, and Ease in interpreting.

#### **c. Effectiveness test**

The effectiveness test aims to determine the effectiveness of android-based instructional media during the teaching and learning process. The students' activities observed were active in completing exercises, working together in groups, and presenting the results of group work. The effectiveness of android smartphone-based instructional media was carried out in one class that took the Genetics course totaling 30 students. Student learning outcomes are taken from the final exam conducted after the lecture. Furthermore, the value is processed following the assessment standards of the Biology Education Study Program, Universitas PGRI Sumatera Barat, Padang, West Sumatra, Indonesia.

### **2. 4. Disseminate stage**

At the dissemination stage, instructional media based on Android smartphones has been disseminated through the Play Store.

## **3. RESULTS**

The instructional media innovations based on Android smartphones have been successfully developed. Instructional media development based on Android smartphones uses 4-D models, namely define, design, develop, and disseminate.

### **3. 1. Define stage**

In the define stage, the result obtains from curriculum analysis, analysis of student characteristics, material analysis, and formulation of the objectives of providing learning materials on the material of DNA structure.

### **a. Curriculum analysis**

The curriculum analysis carried out is an analysis of competency standards, basic competencies, indicators, and materials in the Genetics course syllabus. The competency standard for DNA structure material is that students can master the concept of genes, DNA structure, DNA replication, stages of protein synthesis, and apply the role of genetics in life. Competency standards are translated into several basic competencies and indicators. The results of the curriculum analysis are used to determine the concepts needed in designing instructional media based on android smartphones in the Genetics subject.

### **b. Student characteristics analysis**

Interviews were conducted with several lecturers and students of the Biology Education Study Program Universitas PGRI Sumatera Barat to determine the characteristics of the students. The results of the interview show that students are interested in using learning media because it can help them understand increasing motivation in learning.

### **c. Material analysis**

Genetics subjects have limitations and scope, such as Mendel's Laws I and II, DNA Structure, Epistasis, and gene interaction, Probability theory, Multiple alleles, Sex determination, Sex-linked genes, Sex links, and crossover. The purpose of this subject is for Biology education study program students to have understood classical genetic theories, and modern genetics, and apply genetics theories in their lives. The results of the analysis of the material show that the structure of DNA is a material that is difficult to understand and abstract so instructional media is needed that can visualize these materials so that it is easy for students to understand. The instructional media that will be made is instructional media based on android smartphones as a supplement to the DNA structure material.

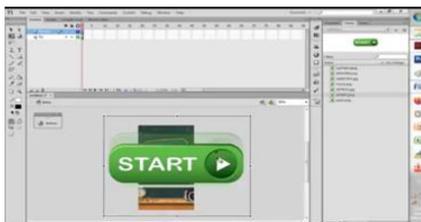
### **d. Formulating learning objectives on the material of DNA Structure**

The purpose of learning the material of DNA structure is that students can explain the meaning of genes, describe the structure of DNA, and chromosomes, and describe DNA replication.

## **3. 2. Design stage**

At the design stage, a prototype learning media based on an Android smartphone is made (Figure 1).

**Figure 1: Screenshot of Prototypes of Instructional Media Based on Android Smartphones on DNA Structure Material**



a) Navigation buttons



b) Identity text



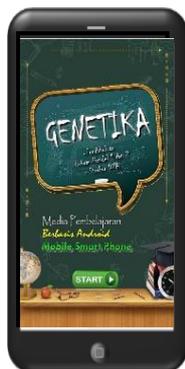
c) Description text



d) Main menu

Furthermore, the prototype was refined into instructional media based on Android smartphones. The display of instructional media based on an Android mobile smartphone can be seen in Figure 2.

**Figure 2: Screenshot of the display of instructional media based on android smartphones on DNA structure material**



a) Navigation buttons



b) The main menu



c) Exit the app

The appearance of the Android smartphone consists of navigation buttons, the main menu, and the exit of the app. After the Android smartphone-based instructional media has been created, it is continued with the development stage of the developed instructional media based on Android smartphones on DNA structure material.

### 3. 3. Develop stage

At the development stage, the results of the validity, practicality, and effectiveness tests are obtained:

#### a. Validity test results

Testing the validity of learning media based on Android mobile smartphones on DNA structure material is carried out by 3 validators, namely information technology experts, Indonesian language experts, and geneticists. Instructional media validation was revised 2 times by the validator. The results of the test of the validity of the instructional media based on an Android smartphone on the DNA structure material show that the instructional media developed is declared very valid with a validity value of 96% (Table 1).

**Table 1: The results of the validation of android-based instructional media on the dna structure material**

Assessment standards	Validity value (%)	Criterion
Construct Aspect	95	Very Valid
Material Aspect	98	Very Valid
Graphic Aspect	96	Very Valid
Language Aspect	95	Very Valid
Average	96	Very Valid

In Table 1, it can be seen that there are 4 standards of assessment carried out on the development of instructional media based on android smartphones on DNA structure material, namely aspects of constructs, materials, graphics, and language. The results of the validity test on the constructs aspect are classified as very valid criteria with a validation value of 95%. This 95% validation value is obtained from the validation carried out by the validator with 2 times validations. The revision suggested by the validator is the addition of animation to the developed learning media. Revisions have been made to the constructs aspect so that the android-based instructional media on the DNA structure material developed is very valid.

The results of the validity test on the material aspect are classified as very valid criteria with a validation value of 98%. The revision suggested by the validator is the addition of practice questions to increase students' skills in solving practice questions. Generally, the DNA structure material contained in instructional media based on Android smartphones is by the curriculum and learning objectives contained in the syllabus. Based on the curriculum analysis carried out, the elaboration of the DNA structure material is following competency standards and basic competencies. The learning process that will be delivered through learning media to students has been adjusted to the applicable curriculum, such as material content, material structure, and material area in DNA structure.

Graphical aspects of learning media based on Android mobile smartphones on DNA structure material are classified as very valid criteria with a validation value of 96%. The graphic aspect of instructional media based on android mobile smartphones on the DNA structure material has followed the revision suggested by the validator. The revision made is that the pictures on the developed learning media are made to attract the attention of students so that they can foster learning motivation, the meaning of learning materials will be clearer, and learning objectives can be achieved. The results of the validity test on the language aspect are classified as very valid criteria with a validation value of 95%. The revision suggested by the validator is that the language used in the developed learning media should use standard and effective language. Revision on Android-based instructional media on very valid DNA structure material so that it is easy for students to understand.

### b. Practical test result

The result of a practical test by the lecturer and students shows that instructional media based on Android smartphones on DNA structure material is very practical criteria (Tables 2 and 3).

**Table 2: Practical test results of instructional media based on an android mobile smartphone on DNA structure material by the lecturer**

Aspects	Practical test results (%)	Criterion
Ease of use of instructional media	92	Very Practical
The times required in the implementation	95	Very practical
Student interest in learning media based on an android mobile smartphone on DNA structure material	96,2	Very Practical
Ease in interpreting	94,7	Very Practical
Average	94,5	Very Practical

**Table 3: Practical test results of learning media based on android mobile smartphones on DNA structure material by students**

Aspects	Practical test results (%)	Criterion
Ease of use of instructional media	91,7	Very Practical
The times required in the implementation	94,3	Very practical
Student interest in learning media based on an android mobile smartphone on DNA structure material	95,8	Very Practical
Ease in interpreting	92,2	Very Practical
Average	93,5	Very Practical

Aspects of the ease of use of instructional media by lecturers and students in the practicality test were 92% and 91.7%, respectively. This means that the instructional media based on android smartphones on DNA structure material can be used because it has navigation buttons that are easy to use and understand. This convenience causes lecturers and students to easily understand the learning media developed. The aspect of the time required for its implementation is classified into very practical criteria with practicality values of 95% and

94.3%. This indicates the learning media based on Android mobile smartphones. This shows that android smartphone-based instructional media can reduce lecturer time in providing DNA structure material. Students like instructional media based on an android smartphone on DNA structure material classified as very practical with practicality values of 96.2% and 95.8%. Students are very interested in the instructional media developed because in the instructional media images and animations are easy to understand. In addition, the size, font, font style, and color used in the instructional media used are very popular with students. Ease of interpreting belongs to very practical criteria with practicality values of 94.7% and 92.2%. This shows that the DNA structural material contained in the developed instructional media is easy to interpret because it is systematically arranged and displayed with pictures and animations that are easily understood by lecturers and students.

### c. Effectiveness test result

The aspects measured in the instructional effectiveness test of Android smartphone-based instructional media on the DNA structure material, namely activities and learning outcomes. The results of observing the activities of 30 students who participated in the learning and learning process using instructional media based on android smartphones on DNA structure material were in the very good category (Table 4).

**Table 4: Student Activity Observation Result**

Aspects of student activity	Percentage (%)	Category
Completing the exercises	97,6	Very good
Cooperate in teams	93,5	Very good
Present group results	95,7	Very Good

Based on the data in Table 4 shows that the aspect of completing the exercise is classified as a very good criterion with a value of 97.6%. The aspect of cooperation in the team is classified as very good with a score of 93.5%. While the aspect of the presentation of learning includes good criteria with a value of 95.7%. The conclusion obtained from the activity test is that instructional learning media based on Android smartphones on DNA structure material can increase student activity. Students are more enthusiastic about doing the exercises, discussing with friends, and can present the learning materials that have been studied. Student scores were obtained from tests carried out on the DNA structure material which were attended by 30 students. There are 48.9% of students who get an A grade, 22.2% of students who get a B grade, 17.7% of students who get a C grade, and 11.2% of students who get a D grade. This shows that the instructional media developed is effective in improving the value of student learning on the material structure of DNA. Variations in student learning scores are influenced by various factors, such as student abilities, instructional media used, learning methods, and student motivation. Analysis of learning outcomes was carried out to determine the interest and increase in the value of student learning while using learning media based on Android smartphones.

## **4. DISCUSSION**

### **4. 1. Define stage**

The Define stage or the needs analysis stage is the initial stage in the 4D model and is a mandatory requirement carried out in development research. In product development, the developer needs to refer to the development requirements and analyze and collect information on the extent to which development needs to be carried out. The stage of defining or analyzing needs can be done through analysis of previous research and literature studies (Thiagarajan, 1974). The define stage aims to determine the requirements of the product being developed. The defined stage is also known as the product requirements analysis stage, this stage will vary for each product developed. At the defining stage generally carried out needs analysis, development requirements research, and development of products and models suitable for product development (Mulyatiningsih, 2013).

### **4. 2. Design stage**

Based on Figure 1, showed the prototype navigation buttons, identity text, description text, and main menu. Prototyping is an important part of the initial design of product development and is developed into a usable product (Elverum et al., 2016; Luff et al., 2018). The appearance of the Android smartphone consists of navigation buttons, the main menu, and the exit of the app. All navigation buttons act as instructions in the use of instructional media when used by students or users. Students or users are free to choose the menus available in the instructional media. Several researchers have developed mobile applications based on an Android prototype to improve the learning process (Dollah et al., 2017; El-Sofany et al., 2014; Eppard et al., 2019). Android mobile smartphone is used as a learning medium through mobile technology to facilitate learning because they can access learning materials and information as desired (Said et al., 2018). Through instructional media based on Android mobile smartphones, students can access relevant information even though far from their physical location. Instructional media based on Android mobile smartphone smartphones become personal learning that connects students with cloud computing using mobile devices (Azamovna, 2021). Learning systems that use Android are flexible, scalable, accessible, preferred, and cheaper (Kirthika et al., 2018). The Android operating system is a system that works using a modified version of the Linux Kernel 2.6 for mobile phones.

### **4. 3. Development stage**

Overall, it shows that the android-based instructional media on the DNA structure material developed is very valid with a validity value of 96%. This means that the developed learning media is suitable for use by students and lecturers in the learning dan teaching process of DNA structure material. Testing the validity of Android-based instructional media has been carried out by several researchers (Mayefis et al., 2019; Eliza et al., 2019; Pujiasih et al., 2021; Permana et al., 2021). The validity of the developed instructional media can be used to measure what should be measured. The results of the practicality test of Android-based instructional media for graphic design courses conducted by Huda et al., (2020) are classified as very practical with a practicality value of 85%. Likewise, research by Yona et al., (2021) shows that

Android-based instructional media in chemistry subjects is classified as very practical with a practicality value of 86.5%.

Learning scores are obtained from tests conducted after students participate in learning activities (Trianto, 2010). The development of instructional media based on Android mobile smartphones on DNA structure material can increase student activity and learning outcomes on DNA structure material. Students can learn independently and master the concepts of DNA structure material. According to Wijaya et al., (2019); Mufidah et al., (2019); Adrizal et al., (2021) the use of instructional media based on android was effective in learning. The development of instructional media based on Android mobile smartphones on DNA structure material is an innovation in the subject of Genetics, especially on the material structure of DNA. So far, no Android smartphone-based instructional media has been found or developed on DNA structure material. Researchers have developed android-based instructional media in addition to material DNA structure in genetics subjects, among others Husna and Ahda (2020); Talwar et al., (2019); Maryuningsih et al., (2019); Cotillon et al., (2019). Instructional media based on Android smartphones on DNA structure material can improve students' understanding of abstract DNA structure material. Students can study independently anytime and anywhere not only learning in the environment of school but also learning outside of school. The use of instructional media based on Android smartphones on DNA structure material can increase student motivation, activity, and learning outcomes. According to Murdiono et al., (2020) use an Android-based application to assist the teaching-learning process. Skills and experience in mobile technology have improved students' skills in using mobile learning and the use of technology for education. Instructional media based on Android smartphones has become a new paradigm in the learning and teaching process and solving problems in learning. The use of digital technology is needed in the world of education in order to educate the nation's life, for example through the use of smart phones or smart phones. Digital learning is growing along with the development of technology (Ikaningrum et al., 2022).

#### **4. 4. Disseminate stage**

In this study, the Disseminate stage was carried out through the Play Store. The disseminate stage is the last stage in the development of instructional media based on Android mobile smartphones. According to Thiagarajan et al, 1974, it was explained that in the Disseminate stage, final packaging, diffusion, and adoption were carried out. The dissemination stage aims to promote media instructional products that have been developed to be accepted by users by individuals, groups, or systems (Marín-González et al., 2017). Packaging materials must be selective to produce the right shape and can be used.

## **CONCLUSION**

Instructional media application based on Android smartphones on DNA structure material shows that the developed instructional media are valid (96%), practical (94%), effective increase student activity and learning outcomes, and the disseminate stage was carried out through the Play Store.

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