

How kidneys work? Developing of Android-based Adobe animate media for senior high school students

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Abstract: Media is one of the determining factors for learning success which can accommodate student critical thinking. Moreover, during the COVID-19 pandemic, learning media became crucial in online learning. This study aims to produce and test the feasibility of android-based media on kidney material developed through Adobe Animate CC software. In addition, it also to find the effectiveness of the media in improving the critical thinking skills of eleventh graders students when used in online learning. Borg & Gall's model was used in this research and development but was limited to the seventh stage. Data collection techniques used interviews, validation (media and material experts), and test. The instruments used are interview sheets, validation sheets, response questionnaires, and essays (five critical thinking questions). The test subjects were 15 senior high school students in Bantur, East Java, Indonesia. The validation results from media and material experts show that the media is "very feasible" to use. Teachers and students stated that the media was "very practical" in online learning. There is a significant difference between students' critical thinking skills before and after using the media, $t(14) = 5.65$, $p < 0.001$. The study finding becomes the basis for continuing the process of media dissemination.

Keywords: Adobe animate; android; kidney; learning media; urinary system

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1. Introduction

Learning in the disruption era must provide critical thinking for students. Students who think critically can analyze how a phenomenon or problem is around them (Bielik & Krüger, 2022; Miharja et al., 2019; Permana et al., 2019). These skills will use not only in learning but also in everyday life. Thus, teachers have a role in creating effective learning to accommodate students' critical thinking skills (Cargas et al., 2017; Permana et al., 2019; Sahamid, 2016; Uiterwijk-Luijk et al., 2019). Moreover, during the COVID-19 pandemic, cause the learning activities had to be online. Then, teachers had to try harder to conduct meaningful learning. One of the many efforts made is to vary the learning media. Learning media not only acts as a communication tool to deliver material but also can foster student interest and motivation (Liao et al., 2019; Maemunawati & Alif, 2020; Samsudin et al., 2019; Widiensyah et al., 2018). Learning media is effective if it can facilitate both offline and online learning.

Learning media must also be relevant to the content of teaching materials. Some materials require visualization of abstract substances, such as biology subjects (Astatin & Nurcahyo, 2016; Syah & Yustina, 2021; Syamsurizal et al., 2021), especially regarding the mechanism of body systems (Agustini et al., 2021; Muninda et al., 2021; Nuraini et al., 2021). Students must understand the anatomy and its function in human body. As in the urinary system material, concepts related to its working mechanism become abstract for students. The urinary system will remove the remains of food metabolism produced by the body, especially nitrogen compounds such as urea and creatinine, foreign materials, and waste products. The organs of the urinary system include the kidneys, renal pelvis,

ureters, bladder, and urethra. In this material, students have to explain how their body produces urine. Given the complexity of the process that students need to understand, this material is one of the abstract materials that require media assistance (Arifin et al., 2021; Saniyyah et al., 2021; Syawalinda et al., 2021).

The results of the need assessment also show the same fact that online learning of urinary system materials requires relevant media. The results of interviews with biology teachers at SMAN 1 Bantur (*Sekolah Menengah Atas Negeri* - State Senior High School) stated that they only used power points and student worksheets linked to Google Classroom as media for online learning. The media is considered less effective in accommodating students' critical thinking skills. Students often copy answers from blogs or other students. Online learning tends to require students to find learning resources from the internet. The weakness is when they cannot distinguish sources considered valid references. Using material videos on YouTube has also been done as an effort for teachers to increase the effectiveness of online learning. However, the limitations of students in accessing the internet are an obstacle for them.

Therefore, it is necessary to develop appropriate, effective, and practical learning media related to the urinary system for online learning. The learning media must be able to accommodate students' critical thinking skills. Students can use it anywhere and anytime, offline and online. Learning media must be relevant to students' learning styles (Malik et al., 2018). According to Priyatna (2013), children's learning styles consist of three types, namely visual (seeing and reading), auditory (hearing, hearing while seeing), and kinesthetic (learning by doing). Effective media can facilitate all these student learning styles. In addition, the existence of abstract concepts will be easier to understand if explained through pictures or animations (Saniyyah et al., 2021; Syawalinda et al., 2021). In connection with this, it needs software to create images and animations, one of which is Adobe Animate CC.

Adobe Animate CC is a multimedia authoring-computer animation program developed by Adobe Inc. Animate is used to design vector graphics and animations for television series, websites, web applications, rich web applications, game development, advertisements, and other interactive projects. Media development that utilizes Adobe Animate CC can facilitate visual and auditory learning styles (Afifah, 2013). Adobe Animate CC can also be developed as an educational game (Abdullah & Yuniarta, 2018), making it suitable for kinesthetic learning styles. Adobe Animate CC can construct a mobile application with offline access anywhere and anytime (Samsudin et al., 2019; Saniriati et al., 2021; Sari et al., 2019). Adobe Animate is more advance than Adobe Flash because it is easier and faster to develop and is more compatible with all smartphone devices. However, this software can only run on 64-bit OS and is poor at managing large amounts of audio.

The learning media developed from Adobe Animate CC 2021 has three main features: (1) illustrated e-books, (2) animated videos, and (3) educational games. The illustrated e-book contains material (texts and images) that summarize as simply as possible, then it easy for students with visual learning styles to understand (Setianingrum, 2017). The second feature is an animated video that contains audio-visual material that is suitable for auditory and visual learning styles (Mas'udah & Suwanda, 2018). The third feature is an educational game to guess and match pictures relevant to students with kinesthetic learning styles (Borman & Idayanti, 2018). Some researchers state that Adobe Animate can improve learning outcomes (Afifah, 2013; Silvia & Bukhori, 2021) and increase motivation (Afifah, 2013; Samsudin et al., 2019; Silvia & Bukhori, 2021). Some researchers use the software to produce interactive multimedia (Pratama & Fitriani, 2020; Samsudin et al., 2019; Wirawan & Sulistiyo, 2020).

The results of previous studies show that Adobe Animate is an effective software to be developed as a learning medium in various subjects and courses. Therefore, it's also can be utilized for developing urinary system media. The designed media can facilitate the three student learning styles. The developed application has a small size, so it is compatible with any android smartphone type. The developed material comes from reliable

sources, such as international books written by experts and materials that access offline. In previous studies, Adobe Animate CC media was designed to improve students' understanding. However, it has not developed to affect students' critical thinking skills. Thus, it is necessary to develop effective learning media to improve students' critical thinking skills during online learning, which can access both online and offline. Thus, this research and development aim to produce and test the feasibility of android-based media on kidney material developed through Adobe Animate CC software. In addition, it also to find the effectiveness of the media in improving the critical thinking skills of eleventh graders students when used in online learning.

2. Materials and Methods

This research and development use the Borg and Gall (1983) model (Borg & Gall, 1983), which is limited to stages 1-7 (Figure 1). The types of data in this study are qualitative and quantitative data. Data collection techniques used interviews, validation (media and material experts), and test. The instruments used are interview sheets, validation sheets, response questionnaires, and essays (five critical thinking questions). The timeline for the study starts in February-November 2021 at SMAN 1 Bantu. The research procedure to describe the steps taken to develop learning media products is shown in Figure 1.

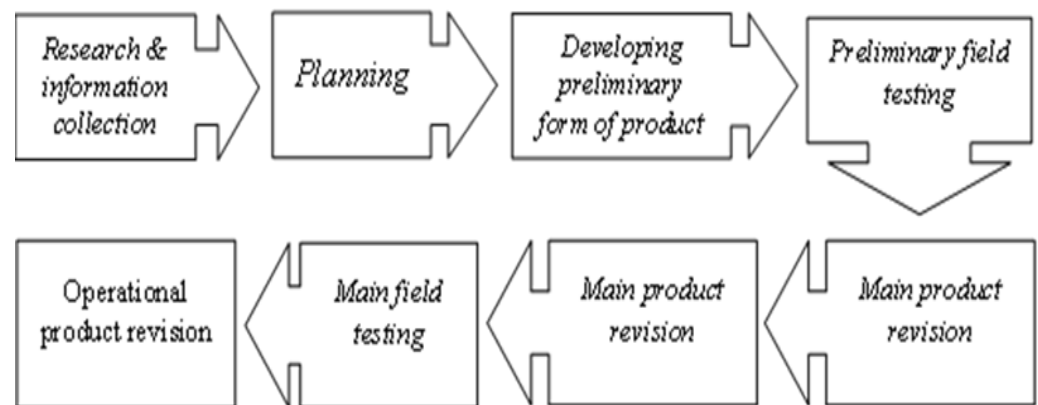


Figure 1. The stage of Borg and Gall R&D model.

2.1. Research and information collecting

The first stage is collecting data through interviews with teachers and students for using learning media. The lesson plans and syllabus analysis were carried out to determine the indicators of learning achievement in urinary system material. It's also adjusted to Indonesian education curriculum. An analysis of the suitability of the material with the indicator and learning objectives was also carried out.

2.2. Planning

In this second stage, the researcher selects the basic competencies, then determines the indicators and materials. Next, prepare the required software, namely Adobe Animate CC 2021. In addition, prepare the images, videos, and animations needed for media preparation.

2.3. Developing preliminary form of product

In this stage, the researcher makes a flowchart that will be a reference for making the initial product. It adjusts to the suitability of concepts and materials for product completion. The results of this stage are the initial product of Android-based media on urinary system material developed through Adobe Animate CC software. The initial media was then measured for its validity by material experts and media experts. The validity results are analyzed using a Likert scale consisting of four categories, shown in Table 1.

Table 1. The categorization of the validation sheet and response questionnaire

Score	Description
4	Strongly agree – very clear – excellent
3	Agree – clear – good
2	Fairly agree – fairly clear – fair
1	Disagree – unclear – poor

The validation results of material and media experts are analyzed using percentage. The percentage score will be categorized in each aspect of the questionnaire using the categorization shown in [Table 2](#).

Table 2. The categorization of the validation results

Percentage (%)	Qualification	Description
81 – 100	Very valid	Very feasible, no need to revise
61 – 80	Valid	Feasible, need a little revision
41 – 60	Medium valid	Feasible enough, needs to be revised
21 – 40	Reasonably valid	Not feasible, needs to be revised some parts
0 – 20	Invalid	Very not feasible, need a lot of revision

2.4. Preliminary field testing

At this stage, preliminary field testing on a small scale was conducted. The trial subjects consist of high, medium, and low academic abilities. The sample subject chooses using purposive random sampling to gain five students with these criteria. Preliminary field testing is conducted to assess the effectiveness and practicality of learning media products on a small scale. Product effectiveness tests were carried out by giving pre-test and post-test using five essay critical thinking questions. The experimental design uses one group pretest-posttest experimental design. The practicality test was obtained from the teacher and student response results. The data of teacher and student responses are analyzed using a Likert scale consisting of four categories ([Table 1](#)).

2.5. Main product revision

In the fifth stage, main product revisions are made based on input and suggestions from experts (media and material), teacher responses, and student responses. The product improvement process is carried out more than once to implement at the next stage (main field testing). The revised product is called a hypothetical product.

2.6. Main field testing

Main field testing is carried out to determine the effectiveness and practicality of learning media on a larger scale. This trial involved 15 students of class eleventh graders in SMAN 1 Bantur. Experimental subjects are selected based on academic ability from low to high in addition to 5 students in the small-scale trial. The experimental design used one group pretest-posttest to determine the effectiveness of learning media in improving critical thinking skills. The data obtained were then analyzed using the Shapiro-Wilk normality test to define the data distribution. Furthermore, if the data are normally distributed, the paired t-test is conducted. If the t-test score reaches a significance value ($p < 0.001$), there is a difference in the mean values of the pre-test and post-test.

2.7. Operational product revision

The next stage is improving the product following the results of main field testing. The revision conducts based on the effectiveness test of critical thinking skills and students' responses at the previous stage. The results of the product revision at this stage will be the final result of this development research.

3. Results

The result of this study is an Android-based Adobe Animate media in urinary system material that can improve students' critical thinking skills. The learning media is also practical for use in online learning. A more detailed explanation for each stage of R&D is as follows.

3.1. Research and information collecting

The findings at this stage reveal that the urinary system material requires learning media. It is also confirmed that PowerPoint slides, students' worksheets, and online reference sources are still not effectively used in learning. The absence of learning media in the urinary system makes it difficult for teachers to convey concepts, especially in online learning. When giving assignments, students tend to only copy answers from the internet or friends, so that students' critical thinking skills are still not visible.

3.2. Planning

The planning stage includes the selection of basic competencies, indicators, and essential materials based on the needs assessment results. The chosen basic competence is: "Analyzing the relationship between the tissue structure of the excretory system organs concerning its bioprocesses and functional disorders". The essential materials include: (1) the kidney structure and function; (2) the process of formation and excretion of urine; (3) factors that affect urine production; (4) impaired kidney function; and (5) efforts to maintain healthy kidney function.

While the indicators that need to achieve are: (1) Analyzing the process of urine formation & excretion in the kidneys, (2) Identifying the substance content in normal urine, and (3) Validating the physical activity factors affecting urine quality through existing research data, (4) Concluding the effect of the type of drink we consume on the quality of urine (5) Deciding on the type of drink that is suitable for reducing dehydration, (6) Correlating of coffee drinking habits with large urine output, (7) Determining the efforts to maintain kidney health. Then, prepare the required software, namely Adobe Animate CC 2021. Researchers also prepare flowchart as a guide in developing the learning media (Figure 2).

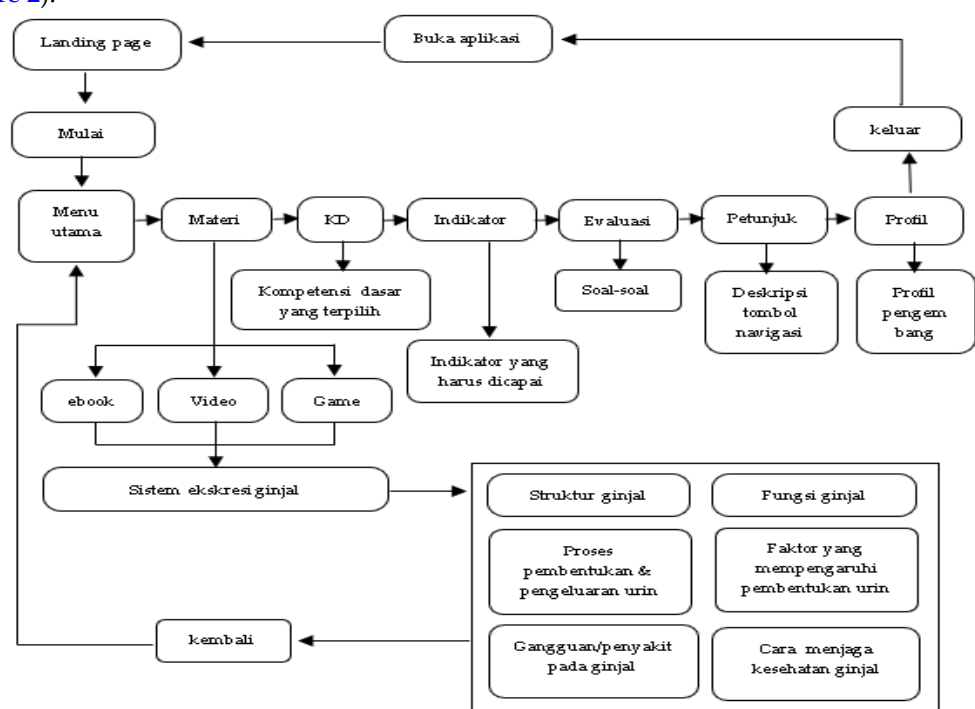


Figure 2. The flowchart of urinary system media.

3.3. Developing preliminary form of product

In this stage, the learning media is developing according to the flowchart illustrated in Figure 2. The initial product of Android-based media on urinary system material developed through Adobe Animate CC software is presented in some figures. Figure 3 shows the landing page, main menu, and developer profile view.

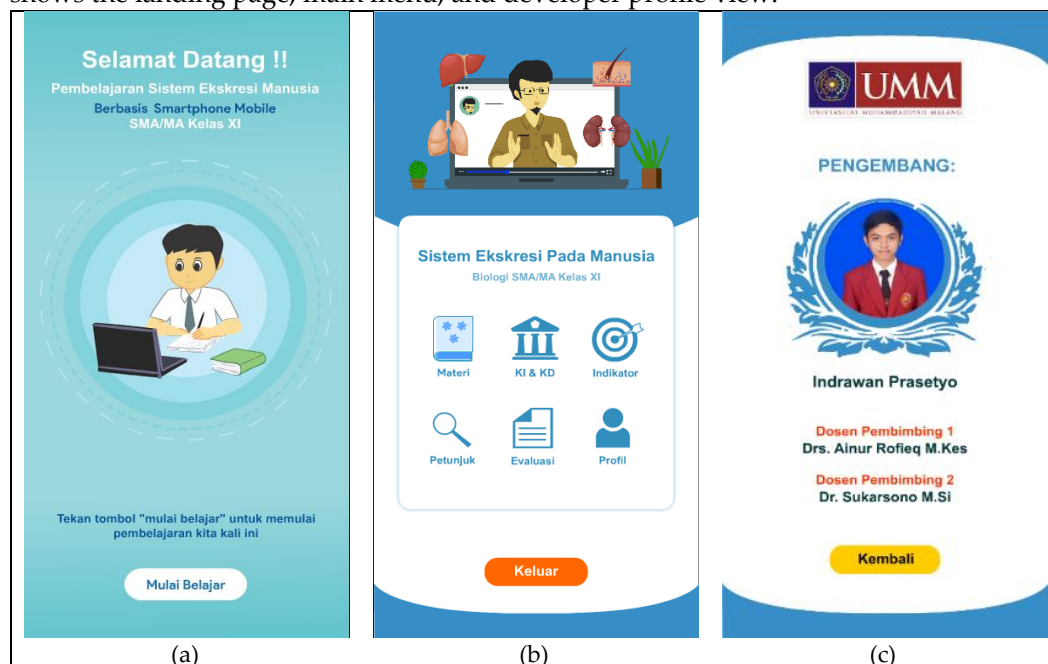


Figure 3. Display of landing page (a), main menu (b), and developer profile (c).

Then, Figure 4 shows a menu of instructions, core competencies, basic competencies and learning indicators. The e-book menu and an explanation of the material in the e-book for is shown in Figure 5. Furthermore, Figure 6 shows the animated video menu. Examples of evaluation questions are presented in Figure 7. Finally, Figure 8 shows a menu of educational games.



Figure 4. Display of instructions (a), competencies (b), and indicators (c).

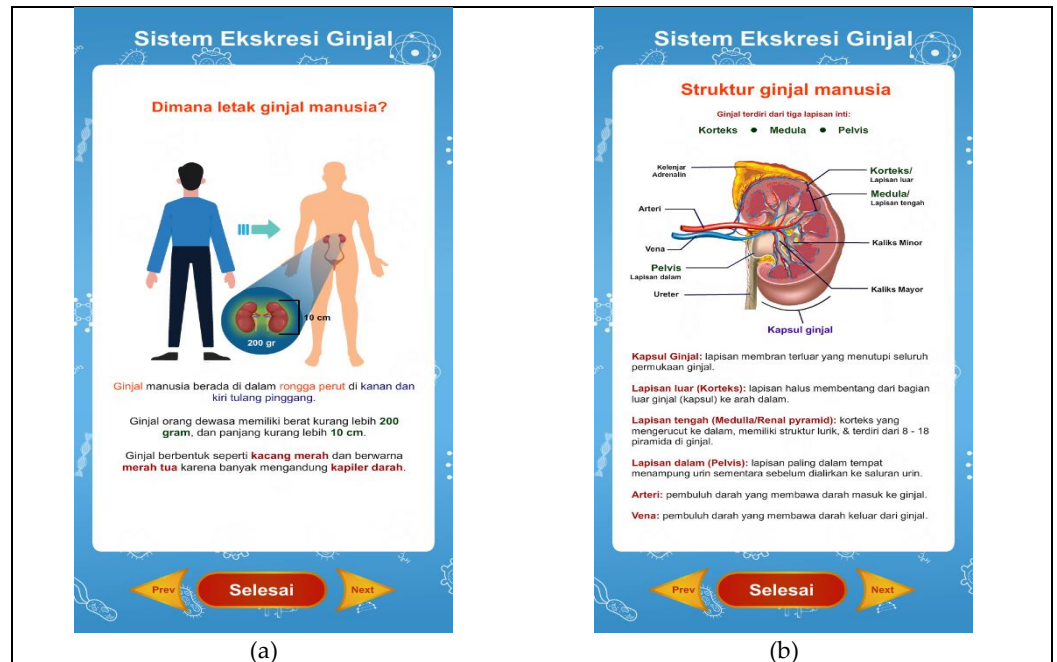


Figure 5. Display of the e-book (a) and the explanation materials (b).

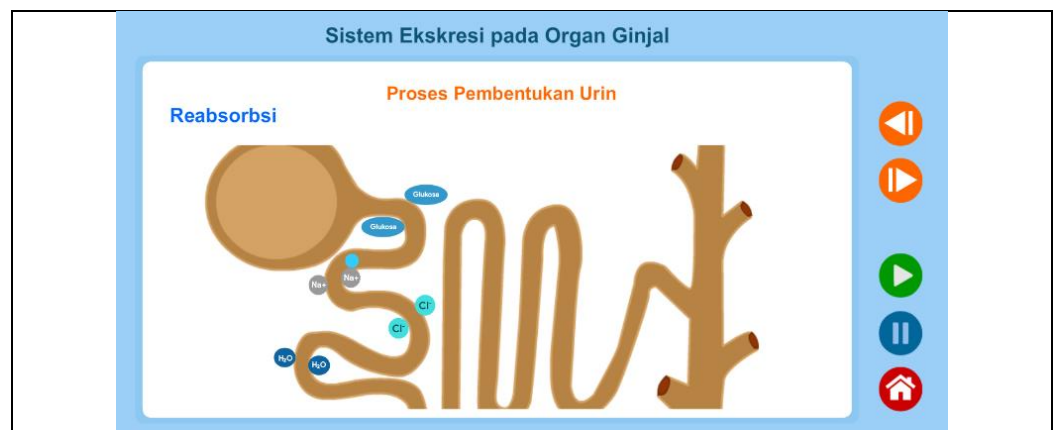


Figure 6. Display of the animated video menu



Figure 7. Display of evaluation menu (a) and test question (b, c).

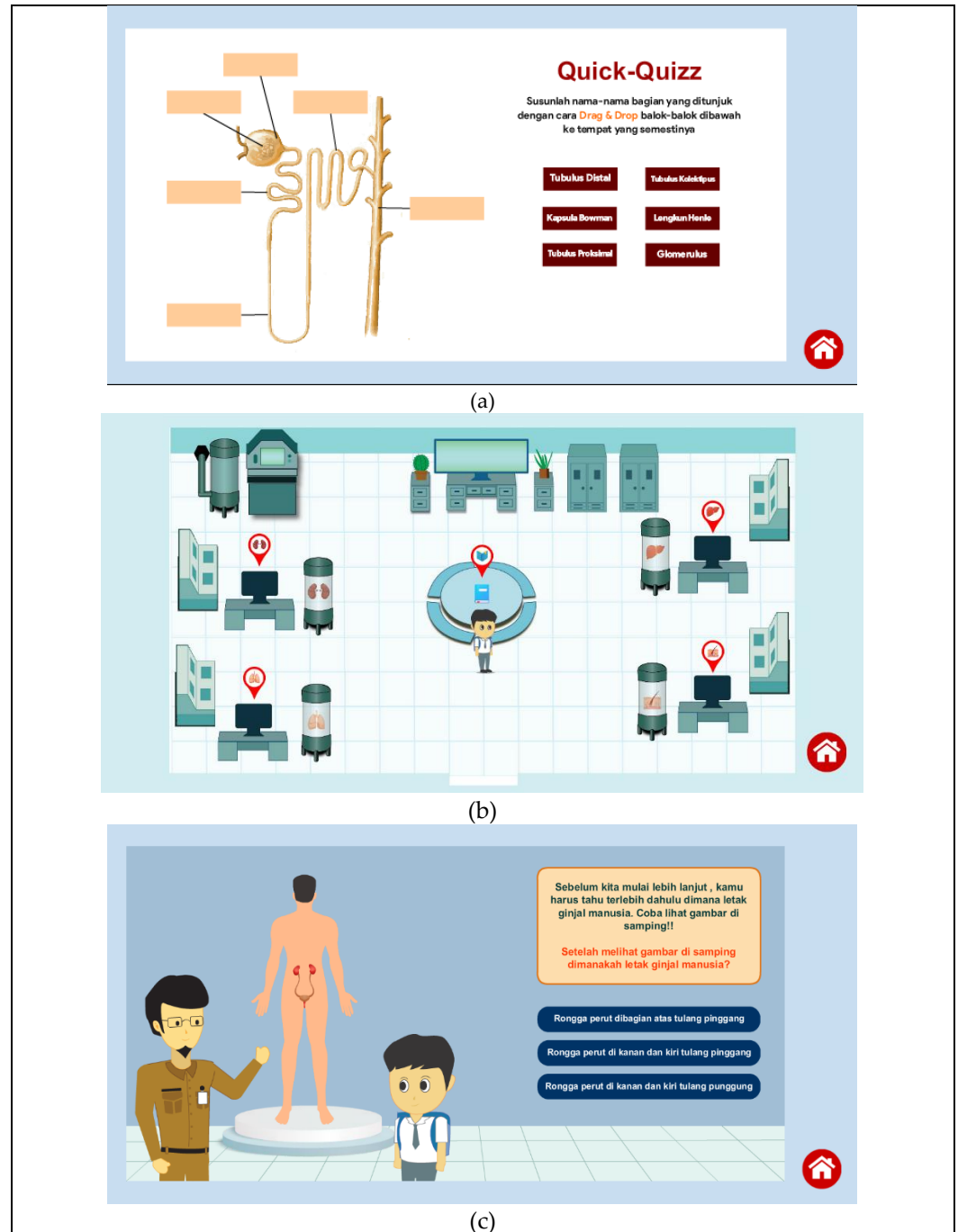


Figure 8. Display of quizzes (a) and educational games (b, c).

Furthermore, the learning media was validated by two validators of material expert and a learning media expert. The validator for material experts is Dr. Nurul Mahmudati, M.Kes, lecturer in a physiology course. The validation was conducted on January 20, 2022. Three aspects measure content material, namely: (1) the suitability of the material with competencies, (2) the accuracy and validity of the material, and (3) the existence of learning support materials. The validation results of the material expert reach 100% for the first aspect (the suitability of the material with competencies), 95% for the material accuracy aspect, and 100% for the existence of the supporting material aspect. The validator of media experts is a lecturer in biology education. The validation was carried out on December 8, 2021. The measuring aspect of media validation includes (1) material presentation, (2) display, and (3) programming. The validation results of the media expert obtained 100% for all three aspects. The validation results from media and material experts show that the media is "very feasible" to use.

3.4. Preliminary field testing

The preliminary field testing on a small scale involved five eleventh graders as subjects. This stage is carried out to measure the effectiveness and practicality of learning media products. The effectiveness test to determine whether the Android-based learning media on urinary system material was effective in improving students' critical thinking skills. The data were then analyzed using a paired sample t-test. The paired sample t-test result is shown in Table 3.

Table 3. The paired sample t-test result in the preliminary field testing

	Paired Differences					T	df	Sig. (2-tailed)
	Mean	Std.Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pretest-Posttest	-39.332	25.970	11.614	-71.578	-7.086	-3.387	4	.028

The paired sample t-test stated a value of sig < 0.05 ($p < 0.05$), so there was a significant difference between the mean of pretest and posttest scores. There was a significant effect of using Android-based learning media on urinary system material on students' critical thinking skills. At this stage, a practicality test was also conducted with response questionnaires distributed to the students and the teacher. The results of the practicality test from the teacher are stated in Table 4, while the student responses explain in Table 5.

Table 4. The results of the teacher's response to the developed learning media

No.	Assessed Aspect	Score (%)	Category
1.	Content presentation	88.46	Very practical
2.	Display and program	91.67	Very practical

The teacher's response toward the Android-based media on urinary system material is categorized as very practical in all aspects. The contents presenting of media reach 88.46%, while the display and program obtain 91.67%. Student responses also show the same results that the media is in the very practical category. Students responded with an understanding level of 88.33% and 84.17% on the aspect of student interest (Table 5).

Table 5. The results of the teacher's response to the developed learning media

No.	Assessed Aspect	Score (%)	Category
1.	Students' understanding	88.33	Very practical
2.	Students' interest	84.17	Very practical

3.5. Main product revision

In this stage, main product revisions are made based on input and suggestions from experts (media and material), teacher responses, and student responses. The product revisions include: fixing some bugs, enlarging the used font, simplifying the material, and adding animation effects. The revision product is used for the next test stage in the main field testing.

3.6. Main field testing

The main field testing involved 15 students of class eleventh graders in SMAN 1 Bantur as research subjects. This stage measures the effectiveness and practice of learning media products on a large scale. The results of the paired sample t-test in the main field testing are presented in Table 6. From the results of the paired t-test analysis, it was stated that the value of sig < 0.05 ($t(14) = 5.65, p < 0.001$), so there was a significant difference between the mean pretest and post-test scores. There is a significant effect of using

Android-based learning media on urinary system material toward students' critical thinking skills in main field testing.

Table 6. The paired sample t-test result in the main field testing

	Paired Differences					T	df	Sig. (2-tailed)
	Mean	Std.Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pretest-Posttest	-36.223	24.815	6.407	-49.965	-22.481	-5.654	14	.000

At this stage, teachers and students also give the respond. The results of teacher responses are presented in [Table 7](#), while the student responses are shown in [Table 8](#).

Table 7. The results of the teacher's response to the developed learning media (main field testing)

No.	Assessed Aspect	Score (%)	Category
1.	Content presentation	94.23	Very practical
2.	Display and program	94.44	Very practical

Both teacher and student state that revised media is very practical. The teacher's response is categorized as very practical in all aspects. The contents presenting of media reach 94.23%, while the display and program obtain 94.44% ([Table 7](#)). Students' response in the understanding aspect reaches 90.56% and 87.50% on the aspect of student interest ([Table 8](#)).

Table 8. The results of the teacher's response to the developed learning media (main field testing)

No.	Assessed Aspect	Score (%)	Category
1.	Students' understanding	90.56	Very practical
2.	Students' interest	87.50	Very practical

3.7. Operational product revision

At this last stage, the learning media product has to make an improvement based on teachers' and students' responses. The media is only compatible with Android devices. However, it should be compatible with iOS devices. So, it can be used for all smartphones OS.

4. Discussion

The results of developing Android-based learning media on urinary system material using the Borg and Gall model are feasible. The validation results from media and material experts show that the media is "very feasible" to use. The validation results of the material expert reach 100% for the first aspect (the suitability of the material with competencies), 95% for the material accuracy aspect, and 100% for the existence of the supporting material aspect. The validation results of the media expert obtained 100% for all three aspects (material presentation, display, and programming). Several researchers state that Adobe Animate software will produce learning media adapting to the various subject matter ([Prakasiwi et al., 2021](#); [Samsudin et al., 2019](#); [Saniriati et al., 2021](#); [Sanusi & Haq, 2021](#); [Silvia & Bukhori, 2021](#); [Wirawan & Sulistiyo, 2020](#)). Adobe Animate can support the creation of interactive and innovative media ([Sanusi & Haq, 2021](#)). It allows the learning process to be optimal.

The learning media has practicality for use in online learning. Both teacher and student state that revised media is very practical. The teacher's response is categorized as very practical in all aspects. The contents presenting of media reach 94.23%, while the display and program obtain 94.44% ([Table 7](#)). Students' response in the understanding

aspect reaches 90.56% and 87.50% on the aspect of student interest (Table 8). Learning media in the form of smartphone applications makes it easier for students to obtain alternative learning resources anywhere and anytime (Basak et al., 2018; Samsudin et al., 2019; Saniriati et al., 2021). Learning media through smartphone devices is very practical when used for online learning because of its flexibility (Chandrasiri & Weerakoon, 2021; Lindner et al., 2019; Widodo & Nursaptini, 2020). Android-based learning media on urinary system materials can accommodate all student learning styles. The illustrated e-books (Figure 5) are suitable for visual learning styles. Animated videos (Figure 6) can facilitate visual and auditory learning styles. The existence of educational games (Figure 7 & Figure 8) is fit for students with kinesthetic learning styles. It gives students to choose the material according to their learning style. The media facilities make students interested and can use them flexibly.

Media effect on students' critical thinking skills significantly based on main field testing. According to the validator's response, Android-based learning media on urinary system materials can train students' critical thinking skills during online learning. Various activities for students while using the media can affect their thinking skills (Astuti et al., 2018; Budhiman et al., 2021; Muninda et al., 2021). The existence of evaluations, quizzes, and educational games can attract students' attention (Casanoves et al., 2017; Chen et al., 2019; Firdausi et al., 2017; Liao et al., 2019). It is a way to promote their critical thinking skills. The results of teacher and student responses emphasize that the media supports offline access anytime and anywhere according to student needs. When students can use the media flexibly, it makes it easier for them to make more efforts to understand the material (Lindner et al., 2019; Sari et al., 2019). So that students' critical thinking skills are also affected.

However, several things need to be considered in the use of media. Android-based learning media developed through Adobe Animate CC does not have a time slider or progress bar on animation video playback control. So, users can not set to play video at a specific time. In addition, the developed learning media is only compatible with Android smartphone devices. As a follow-up to the lack of media, the researcher provided the previous-skip and next-skip buttons to replace the progress bar. Furthermore, for iOS device users, the researcher directs users to download android emulators such as i-Android, so they can still run-on iOS devices.

5. Conclusions

The results of developing Android-based learning media on urinary system material using the Borg and Gall model are feasible to use. The validation results from media and material experts show that the media is "very feasible" to use. Teachers and students stated that the media was "very practical" in online learning. There is a significant difference between students' critical thinking skills before and after using the media, $t(14) = 5.65$, $p < 0.001$. The study finding becomes the basis for continuing the process of media dissemination.

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Conflicts of Interest: We declare that there is no conflict of interest.

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