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DEVELOPING ANDROID-BASED EDUCATIONAL PUZZLE GAME FOR BIOLOGY TO IMPROVE STUDENTS' COGNITIVE ABILITY

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ARTICLE INFO

ABSTRACT

This research aims to determine the development, feasibility, and effectiveness of an android-based educational puzzle game for biology learning. This research is a research and development (R&D) with Brog and Gall procedure up to the ninth stage. The instruments employed are the media expert validation questionnaire, the language expert validation questionnaire, the material expert validation questionnaire, the student response questionnaire, cognitive ability tests, and documentation. Based on the validation by the experts, the media experts validation percentage was 98.91%, the language expert validation percentage was 92.05%, the material expert validation percentage was 98.5%, and the students' response questionnaire percentage was 85.75%. All the results were categorized as highly feasible. Furthermore, the effectiveness of the product based on the independent sample t-test was $t_{observed}$ (5. 57) was higher than $t_{critical}$ (1.71) with an average N-gain value in the experimental class of 0.64 and the control class of 0.40. Based on the assessment, the Android-based educational puzzle game for biology on virus material can improve students' cognitive abilities.

Pengembangan Media Game Edukasi untuk Puzzle Biologi Berbasis Android untuk Meningkatkan Kemampuan Kognitif

ABSTRAK: *Penelitian ini bertujuan untuk menentukan perkembangan, kelayakan, dan efektivitas game pendidikan puzzle biologis berbasis android. Penelitian ini merupakan penelitian dan pengembangan (R&D) menggunakan prosedur Brog dan Gall hingga tahap 9. Instrumen yang digunakan adalah kuesioner validasi ahli media, kuesioner validasi ahli bahasa, kuesioner validasi ahli materi, kuesioner respons siswa, tes kemampuan kognitif dan dokumentasi. Berdasarkan hasil penilaian yang diperoleh dari beberapa ahli, persentase validasi dari pakar media sebesar 98,91%, validasi ahli bahasa sebesar 92,05%, validasi ahli materiil sebesar 98,5%, dan respon mahasiswa sebesar 85,75% dengan seluruh kriteria "Sangat layak". Kemudian efektivitas media dilihat berdasarkan hasil t-test Independent t count = 5,57> t tabel = 1,71 dengan jumlah*

rata-rata nilai N-Gain di kelas eksperimental 0,64 dan kelas kontrol 0,40. Berdasarkan penilaian ini dapat disimpulkan bahwa media game edukasi berbasis puzzle biologis android pada materi virus dapat meningkatkan kemampuan kognitif.

INTRODUCTION

Computer and technological advancement continue to develop almost all aspects of human life (Himmah & Azisi, 2019; Ngafifi, 2014; Setiawan, 2018; Yasin et al., 2019). Thanks to the advances, nearly all areas, such as work processes, learning, and physical interactions, can be done digitally, including creating learning media (Ardiansyah & Nana, 2020; Y. Huda & Faiza, 2019). Learning media as teaching aids help the teacher to deliver teaching materials to students (Halidi et al., 2015; I. A. Huda, 2020; Mediawati, 2011; Muhammad et al., 2020). One of the learning media that utilizes technology is educational games (Andari, 2020; Citra & Rosy, 2020; Fujiati & Rahayu, 2020; Putra & Nugroho, 2016). Educational games contain the concept of serious games. They have the entertainment element and are displayed as learning or training media (Nurdiana & Suryadi, 2017; Parlika et al., 2019). Besides, they can also increase knowledge and act as attitudes and behaviour training media (Saputra, 2016).

Games create vibrant and fun learning atmospheres (Fauziah et al., 2018; Mulyanti & Lestari, n.d.; Purwoko, 2018). The characteristic of such games is creating a pleasant learning atmosphere (Hanifah, 2017; Saihu & Umar, 2021). This media can help achieve learning objectives effectively and efficiently in an exciting atmosphere despite discussing complex topics (Hartami et al., 2017). Educational games are the link between entertainment and education (Permatasari et al., 2020; Pratama & Haryanto, 2017; Setiyadi, 2016).

The entertainment aspect of games increases motivation and learning experience (Hardian, 2019; Mustaqim, 2016). Therefore, many studies focus on educational games that stimulate thought,

improve concentration, and solve problems (Rahman & Tresnawati, 2016). Educational Puzzle games are puzzles made for players to experience an element of fun when solving problems (Afrian & Arifin, 2018). The biology learning process using the scientific approach combined with puzzles can improve students' competence and make the learning process to be more fun (Lukitaningsih, 2015).

The researchers focused on virus material because viruses have varied shapes and structures so that if they are implemented into games, they become exciting (Hasanah et al., 2021; Mawarni Purnamasari, 2021; Rosyidah et al., 2020). (Hasanah et al., 2021; Mawarni Purnamasari, 2021; Rosyidah et al., 2020). Based on interviews with biology teachers, the teachers use shapes or images that resemble viruses. However, this approach is less effective because many students have a hard time understanding the material. The developed Android-based educational puzzle game is expected to help students to understand virus material effectively.

A study by (Nugroho & Komarudin, 2018) shows that educational puzzle games are feasible and effective to introduce national heroes to students. Research by (Fadhila & Puspitawati, 2018) found that educational puzzle games can improve students' conceptual understanding of biology materials. The observations on three public senior high schools in Bandar Lampung showed that the learning was quite effective. However, some things must be improved at school, namely selecting learning media and smartphones in the learning process.

So far, teachers have never used smartphone-based educational puzzle games, although the games could support the learning process, especially in virus learning

material. The games can help students to recognize and understand viruses. Therefore, the solution was to develop an Android-based educational puzzle game. The created media required a feasibility assessment so that it could be used in the learning process. This research aimed to determine the feasibility and effectiveness of an Android-based educational puzzle game for virus learning material.

METHOD

The research method used referred to the nine stages of Borg and Gall research and development model to develop and validate educational products (Komarudin & Thahir, 2019; Rohmaini et al., 2020).
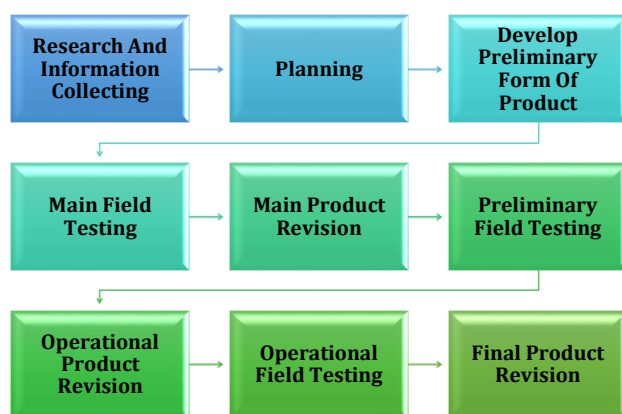
Figure 1. Borg and Gall Development Model

In this research, the researchers only limited the stages to the final product revision stage (the 9th stage). At that stage, the researchers assumed that they had determined the feasibility and effectiveness of the product. The simplification of the stages in this research does not eliminate the value of research and development at all (Haka, 2020). There were seven experts involved in the product assessment. They were three media experts, two material experts, and two language experts. Furthermore, the limited-trial involved ten students and the large-scale trial involved 60 students. The students were divided into two classes, namely 30 students in the

experimental class and 30 students in the control class.

The obtained data were then analyzed quantitatively to determine the feasibility and effectiveness of the product. Furthermore, the students' test results were analyzed to see their interest in the media. The last step was the N-Gain test to see the effectiveness of the product.

RESULTS AND DISCUSSION

The developed product was an Android-based educational puzzle game application. The product development followed Borg and Gall development model, which had been simplified into nine stages. The stages were research and information gathering (preliminary study), planning (research planning), initial product development (design development), initial field testing (initial or limited field trial), main product revision, main field testing (product testing), operational product revision (revision based on the trial results), operational field testing (effectiveness test), and final product revision. The trials were carried out on the tenth-grade students of SMA Negeri 15 Bandar Lampung.

Based on the primary study, it can be concluded that along with the development of information and technology-based learning curriculum, Android-based learning media was needed, especially in the biology subject. The teachers were required to create an interesting and exciting atmosphere (Anggoro, 2015). Educational puzzle game needs to take advantage of the technological tools to be used more positively by students. Therefore, technology and information advances can contribute to the advancement of education.

Virus learning material has very broad and abstract properties. Learning media is expected to make learning more effective and easy to understand (Anggoro et al., 2019). The developed product contains virus learning material that has been adapted to Core Competencies, Basic Competencies, and Indicators. Besides, the product is equipped with learning games and

videos to increase students' knowledge of virus material. The product is also equipped with various detailed video explanations about the virus. Furthermore, other menus include the evaluation menu and application developer profiles. The following is the overview of the product design.
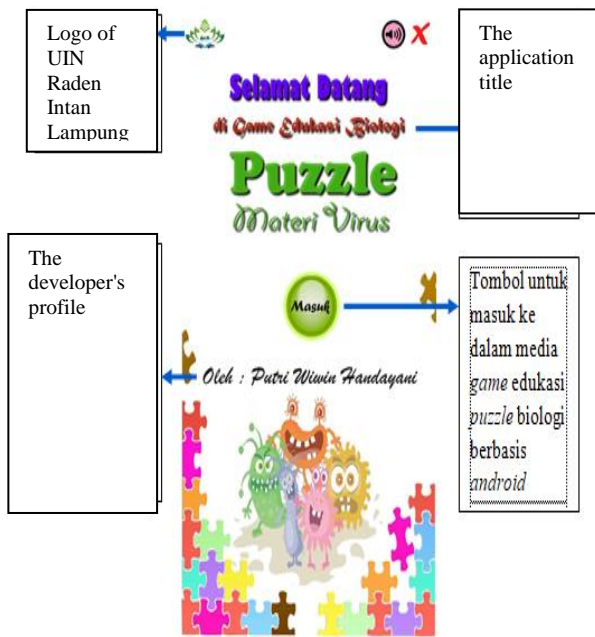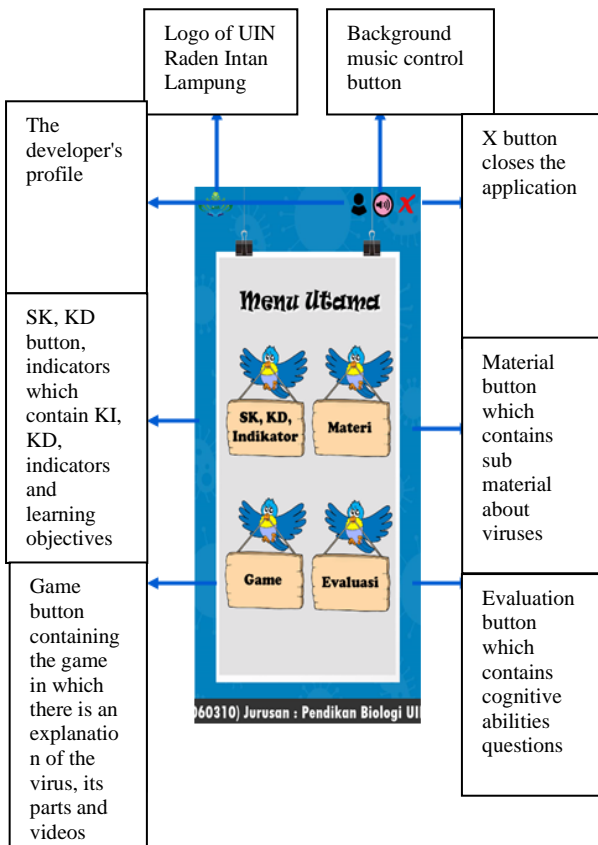

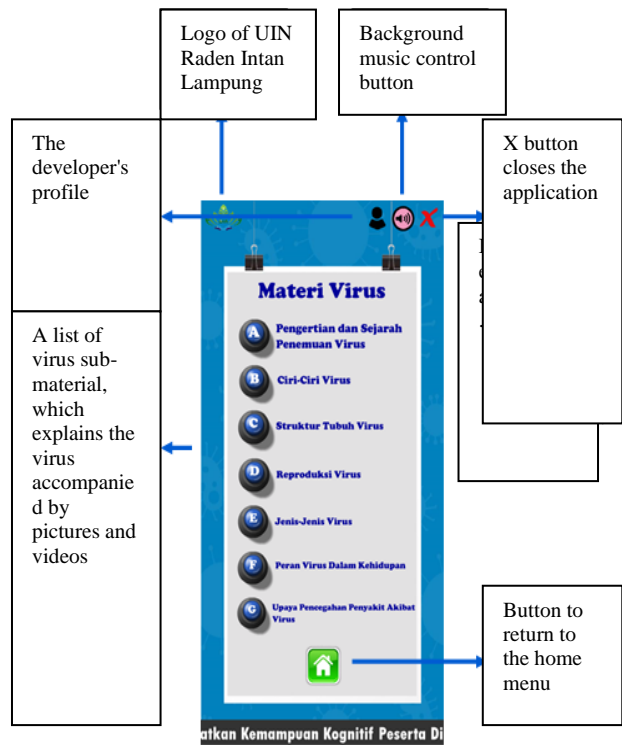**Figure 2.** Media preview

Figure 3. Main Menu Display

Figure 4. Material Page Display
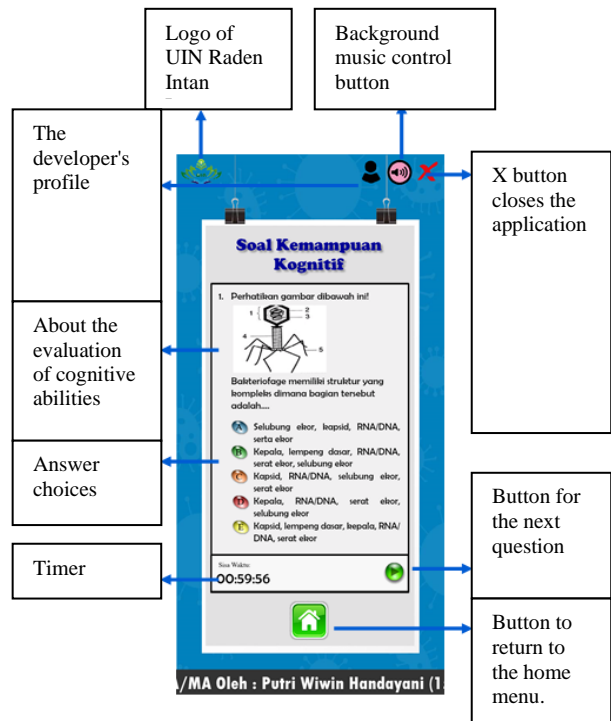
Figure 5. Cognitive Abilities Page Display
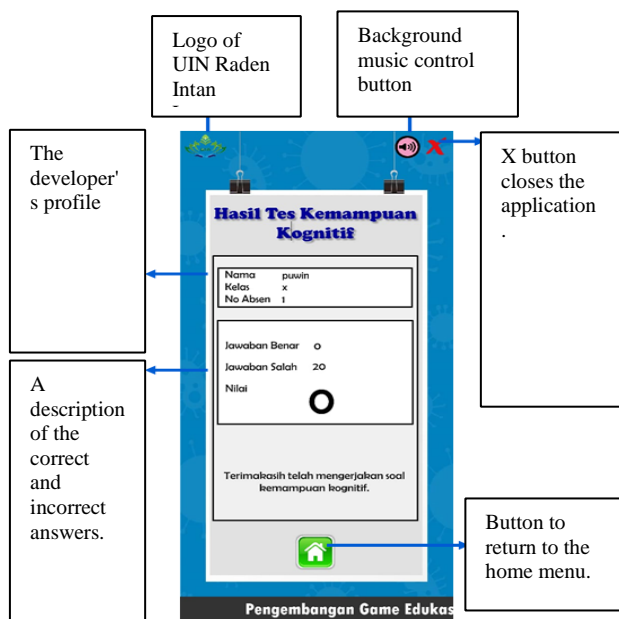
Figure 6. The Evaluation Result Page

After the researcher completed the initial product design, the next step was to validate the product. The validation was performed by three media experts, two material experts, and two language experts. The validation results are described in the descriptions below.
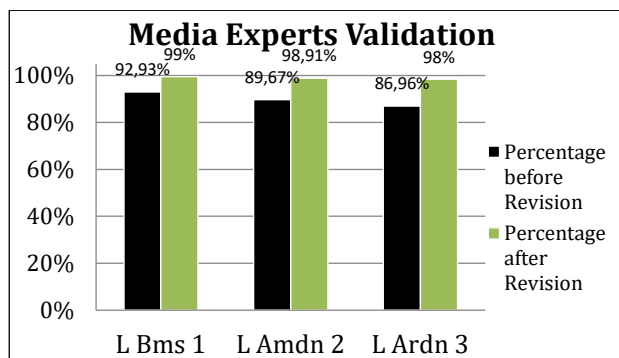

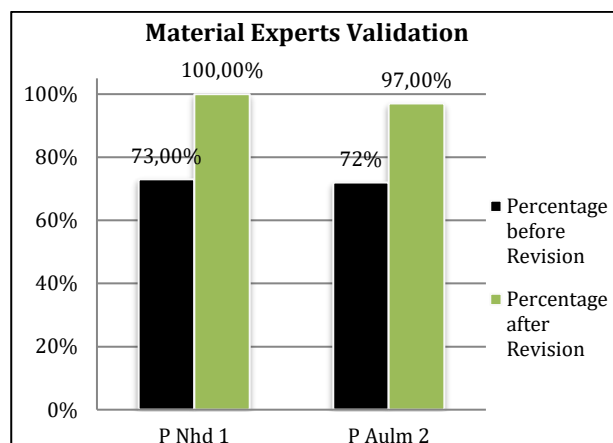**Figure 7.** Media Expert Validation before and after the Revision

Figure 8. Material Expert Validation Results before and after the Revision

Figure 7 displays the results of the media experts validation before and after the revision. There was an increase in the average percentage from each validator. Validator L BMS 1 provided an average percentage of 99%. Validator L Amdn 2 provided an average percentage of 98.91%. Validator L Ardn 3 provided an average percentage of 98%. Therefore, the total average percentage was 98.91% within the highly feasible category.

Furthermore, material expert validation was carried out to assess the content of the product. This validation contained a statement regarding the contents of the virus learning material contained in the developed product.

Furthermore, the language experts validation assessed whether the language follows the rules of PUEBI (General Guidelines for Indonesian Spelling).
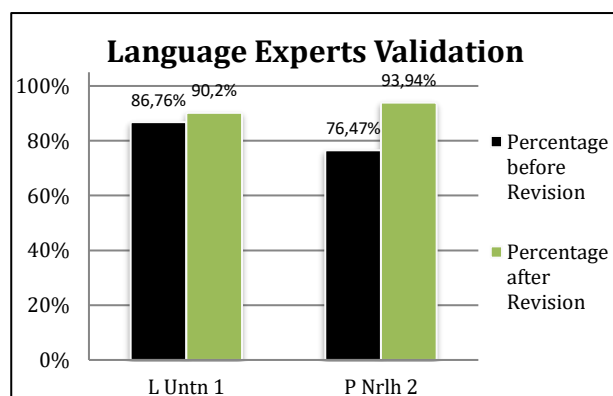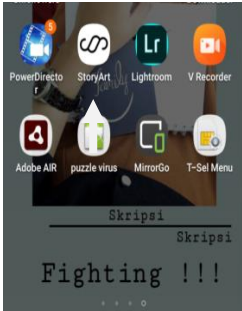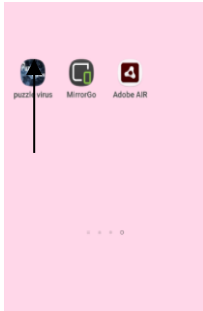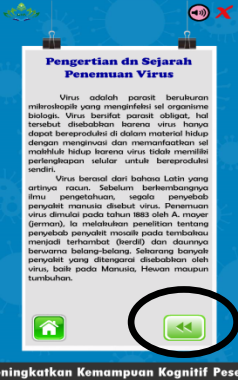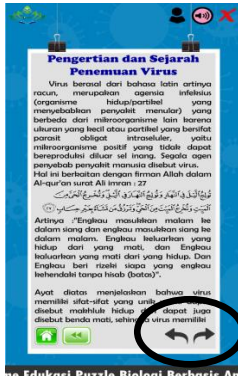

Figure 9. Language Experts Validation before and after the Revision

Based on Figure 9, there was an average percentage increase. Validator L Untn 1 provided an average percentage of 90.15%, and validator P Nrlh 2 provided an average percentage of 93.94%. Therefore, the total average percentage was 92.05% within the highly feasible category. The comparison results before and after the revision can be seen in Table 1.
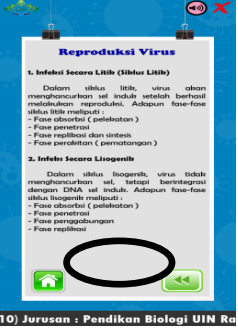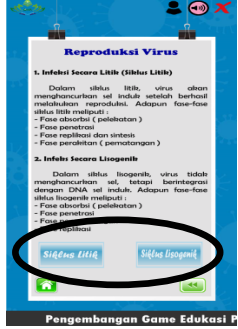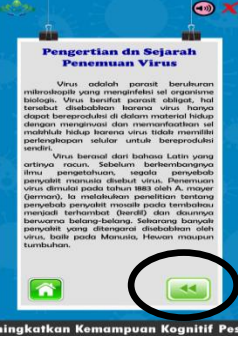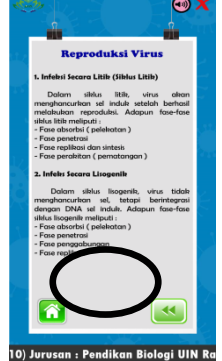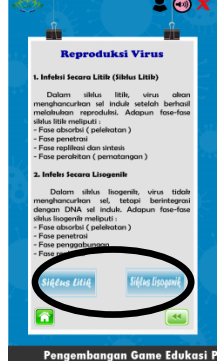
Table 1. The Comparison of before and after the Revision with Media Experts

Validators	Validators' Notes	The Comparison of before and after the Revision with Media Experts	
L Bms 1	There is no significant images in the APK icon.	Description: There is no virus image on the apk icon **Figure 10.** Display Icon before Revision	Description: There is a virus image on the apk icon **Figure 11.** Icon Display after Revision
L Amdn 2	Add media developer profile menu.	Description: Button to view developer profile does not exist. **Figure 12.** Display before Revision	Description: The button to view the developer profile is available. **Figure 13.** Display after Revision

	Add the next menu to the next material at the end of the screen.	Description: There is no button used to go to the next slide. **Figure 14.** Display before Revision	Description: A button to go to the next slide is available. **Figure 15.** Display after Revision
P Ardn 3	Add two buttons to view live videos.	Description: Buttons to display video are not available. **Figure 16. V**ideo Display Button Unavailable	Description: Buttons to display video are available. **Figure 17**. Video Display Buttons Are Available
		Description: There are no next and video buttons on the material. **Figure 18.** No Next and Video Button Available	Description: There are next and video buttons on the material. **Figure 19.** The Next and Video Buttons Are Available
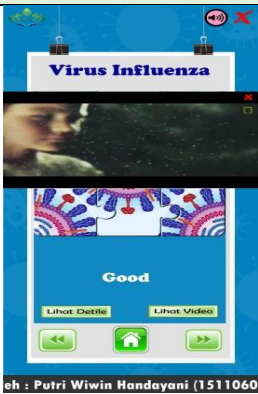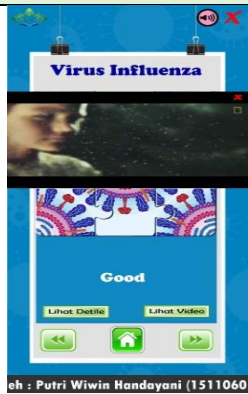
Table 2. The Comparison of before and after the Revision with Material Experts
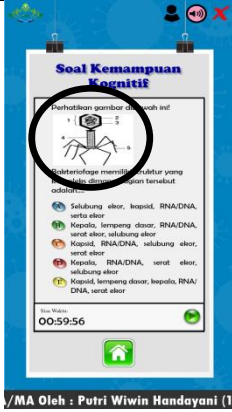
Validators	Validators' notes	The Comparison of before and after the Revision with Material Experts	
P Nhd 1	Add a video about the definition of a virus and the history of the virus.	Description: The menu display does not contain a video explanation. **Figure 20.** Material Page Display before Revision	Description: The menu display contains a video explanation. **Figure 21.** Material Page Display after Revision
P Aulm 2	Elaborate the learning materials on lytic and lysogenic processes.	Description: The written materials on lysogenic and lytic are incomplete and unclear. **Figure 21.** Display before Revision	Description: The written materials on lysogenic and lytic are complete and clear. **Figure 22.** Display after Revision

	Add one game about the coronavirus 19.	Description: The game does not have coronavirus 19. **Figure 23.** The Display of the Virus in the Puzzle Game before the Revision	Description: The game has coronavirus 19. **Figure 24.** The Display of the Virus in the Puzzle Game after the Revision

Table 3. The Comparison of before and after the Revision with Language Experts

Validators	Validators' Notes	The Comparison of before and after the Revision with Language Experts	
L for 1	Correct the use of language in the video.	Description: The video is in English. **Figure 25.** The Language Display before Revision	Description: The video is in Indonesian. **Figure 26.** The Language Display after Revision

P Nrlh 2	Add pictures to clarify the questions.	Description: The questions are incomplete. **Figure 27.** Questions Display before Revision	Description: The questions are complete and easy to understand. **Figure 28.** Questions Display after Revision

After passing the product validation and revision, the next step was the limited product trial stage. At this stage, the product was tested on ten students of SMA Negeri 15 Bandar Lampung as respondents. The data can be seen in Table 3.

Table 3. Limited Trial Results

No	R	Total score	Max score	Percentage	Criteria
1	R1	113	120	94.17%	SM
2	R2	115	120	95.83%	SM
3	R3	99	120	82.5%	SM
4	R4	96	120	80%	M
5	R5	101	120	84.17%	SM
6	R6	103	120	85.83%	SM
7	R7	97	120	80.83%	M
8	R8	109	120	90.83%	SM
9	R9	95	120	79.17%	M
10	R10	101	120	84.17%	SM
Total Score				1029	
Maximum Total Score				1200	
Presentation				85.75%	
Criteria				Very Interesting	

Furthermore, to see the effectiveness of the product, the researchers provided evaluation questions. The effectiveness test results can be seen based on the N-Gain test and the Independent sample t-test contained in Table 4 and Table 5.

Table 4. The Result of the N-Gain Test

	Average Value		N-Gain	Criteria
	Pretest	Posttest		
Experimental Class	51.67	79.83	0.64	High
Control Class	41.50	65.67	0.40	Low

Table 3. The Result of Independent Sample t-test

$t_{observed}$	$t_{critical}$	Conclusion
5.57	1.70	H_1 is accepted

Based on the t-test results, the product was considered effective. Before the t-test, the researchers administered a prerequisite test, namely the normality and homogeneity tests. The normality test was carried out to determine whether the data was normal or not using the Liliefor formula. The control class's normality test results were $L_{observed}$ (0.132) was lower than $L_{critical}$ (0.161). Therefore H_0 was accepted, or the data were normally distributed. The experimental class's normality test results were $L_{observed}$ (0.104) was lower than $L_{critical}$ (0.161). Therefore, H_0 was accepted, and the data were normally distributed.

Furthermore, a homogeneity test was carried out to see whether the data was homogeneous or not. The obtained results were $F_{observed}$ (0.55) was lower than $F_{critical}$ (3.34). Therefore, H_0 was accepted, and the data were homogeneous.

The independent sample t-test calculation obtained that $t_{observed}$ (5.57) was higher than $t_{critical}$ (1.71). Therefore, H_1 was accepted, and H_0 was rejected. It meant that there was a difference between the Android-based education puzzle game and the conventional learning media. The conclusion was derived from the results of the N-Gain test on students' cognitive abilities. Students who applied the developed product obtained an average score of 0.64, while those who applied the conventional media obtained an average of 0.40. it can be concluded that the developed product was more effective than the conventional media in improving students' cognitive abilities.

Furthermore, the questionnaire distributed to experimental class students got 85.69% within the very interesting category. In conclusion, the developed product was feasible and effective to be used as a learning medium to improve tenth-grade students' cognitive abilities.

CONCLUSIONS AND SUGGESTIONS

Based on the discussion, the educational puzzle game (bit.ly/PuzzleVirus) was feasible and effective to be used as a learning medium for the tenth-grade students on virus learning material. The researchers suggest that the educational puzzle game should be continuously developed with different materials and wider scope by adding other interesting features.

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