

# Zappar-Based Augmented Reality Development for Science Learning for Elementary School Students

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**Abstract:** The development of Zappar-based Augmented Reality learning media was carried out because students' understanding of human digestive organs was still lacking. The purpose of this study was to analyze needs, describe development designs, prove feasibility and prove the effectiveness of Zappar-based augmented reality media for fifth-grade elementary school students in Sukolilo District, Pati Regency. This study is a type of development research or Research and Development (R&D) that adopts the Borg and Gall model development method. Qualitative data collection techniques through documentation, interviews and observations, while quantitative data collection techniques through tests and questionnaires. Data analysis included initial data before the study, product development process data, product feasibility data and data on the effectiveness of Zappar-based augmented reality learning media. The results of the study showed that the level of need for Zappar-based augmented reality learning media for science is quite high. Furthermore, designing a Zappar-based augmented reality application using the Zapworks application used seven stages. The average validation results from language, material, and media experts were 3.50, 3.50, and 3.58, respectively, all of which were included in the "Very Eligible" category. This validity was strengthened by the results of the questionnaire which showed that student and teacher responses had an average score of 3.33 and 3.14, with the "Very Good" and "Good" categories. In addition, the results of the analysis using the Paired Sample T-test showed a value  $<0.05$ , namely 0.00 and 0.00, supported by the results of the Independent Sample T-test which were also  $<0.05$ , namely 0.036 and 0.022.

**Keywords:** augmented reality, zappar, human digestion, science learning.

## 1. Introduction

Today, the development of science and technology is growing rapidly. This also happens in the world of education. This phenomenon is certainly beneficial on the one hand, considering the availability of media used to facilitate learning activities in the classroom. The use of good learning media can have the opportunity to improve student concentration and learning outcomes. Use of learning media This learning media is actually used to attract students' interest and curiosity. The use of learning media is intended to pique students' interest and curiosity. It is hoped that this interest in learning will be stimulated, thereby improving their cognitive intelligence. Stimulation is used to stimulate children to acquire new knowledge or skills. This is crucial for improving children's intelligence (Utaminingsih et al., 2023).

The digestive organs are one of the important organs in humans. The digestive organs are in the body, so seeing them directly is a challenge in itself. It is very necessary to provide an understanding of the digestive organs for elementary school students. However, the methods and media used mostly still use books and picture displays. Learning is also still centered on educators, so it does not provide students with a learning experience. This also has an impact on low student learning outcomes in science learning in elementary schools.

Based on the questionnaire obtained by the researcher, it shows that in Sukolilo sub-district only around 14.3% use learning media every day. Even then, it is not used in all subjects. The results of the questionnaire were also reinforced by the results of the interview where they agreed that the science learning they did in class was still dominated by lectures and lacked in the use of learning media. This then made students bored and less interested in science learning because they thought science learning was memorization learning.

In addition, the researcher had the opportunity to conduct observations in class V in one of the classes at Dabin Diponegoro, Sukolilo District when science learning was taking place. The researcher found that teachers did not use learning media during learning. Teachers used teacher books and Student Worksheets (LKS) when teaching. The method used when teaching was dominated by lectures. This made most students seem less enthusiastic about learning activities. The assignments were done by students at the end of science learning, making students seem increasingly bored and unenthusiastic.

## 1.1 Conceptual framework

According to (Fakhriyah & Masfuah, 2021), learning success can be measured by students' mastery of the material and understanding of the concepts. Therefore, researchers are developing augmented reality learning media about the human digestive system to ensure successful classroom learning. According to Mustaqim, (2016) and Nistrina, (2021) Augmented reality is a technology that can combine two-dimensional or three-dimensional virtual objects into the real world and then can be displayed in real time. According to him, this technology allows students to interact with visual objects so that it seems as if the object can be integrated with the real world in real terms and information can be done interactively.

Firdaus, (2021) explains that the use of Augmented Reality media can make students confident with their limitations. Students can also carry out activities in a disciplined manner and work together in learning activities carried out in learning. In addition, this augmented reality media can be a system that makes it easier to deliver material to students so that it is effective in increasing understanding of the subject matter. Meanwhile, according to Ismayanti, (2020) Augmented Reality is a technology that combines three-dimensional or two-dimensional computer-made objects connected to the real world by users. The augmented reality display can make users perceive that the resulting technology can interact with the real world around the user.

Researchers assume that the development of learning media in the form of zappar-based augmented reality in the science learning content can help meet the need for science learning media. According to Andriani and Ramadani, (2022) Augmented reality affects students' critical thinking skills. Learning using augmented reality makes learning fun and memorable for students. Meanwhile, Wibowo et al., (2022) said that augmented reality makes learning more interesting and not boring. Furthermore, Leoni Indahsari & Sumirat, (2023) stated that augmented reality has the benefits of increasing student motivation and increasing student involvement in learning, facilitating adaptive learning, clarifying students' understanding of concepts, and providing learning experiences for students. Thus, the researcher took the research title "Development of Zappar-Based Augmented Reality for Grade V Elementary School Students in Sukolilo District, Pati Regency".

The development of media in the form of zappar-based augmented reality is also supported by research conducted by Sugiarto & Batu, (2022), "Use of zappar augmented reality media to improve understanding of the concept of blood circulation." The results of the application show that the use of 3-dimensional media in blood circulation material using zappar is very helpful in the learning process. Students find it easy to understand the material because the 2-dimensional images that have been in textbooks can feel alive, can move when scanned using zappar. Students who enjoy using cellphones can be creative in learning so that they provide motivation. Based on the background above, the formulation of the problem in this study consists of: 1) How is the analysis of the need for augmented reality development for learning for grade V elementary school students in Sukolilo District?; 2) How is the design of augmented reality development for learning for grade V elementary school students in Sukolilo District?; 3) How is the feasibility of augmented reality media for learning for grade V elementary school students in Sukolilo District? 4) How effective is augmented reality-based media for learning of fifth grade elementary school students in Sukolilo District?.

## 1.2 Research Objectives

Based on the formulation of the problem that has been stated above, the objectives of this study consist of: 1) To analyze the need for Augmented reality media development for fifth grade elementary school students in Sukolilo District; 2) To describe the design of Augmented reality media development based on zappar for fifth grade elementary school students in Sukolilo District; 3) To prove the feasibility of Augmented reality media based on zappar for fifth grade elementary school students in Sukolilo District; 4) To prove the effectiveness of Augmented reality media based on zappar for learning of fifth grade elementary school students in Sukolilo District.

## 2. Methodology

### 2.1 Research design

The development of this zappar-based augmented reality learning media uses the Research and Development (R&D) research method. Research and Development (R&D) or development research according to Winarni, (2018) is a process or steps used to produce new products or improve existing products so that they can be accounted for. In this study, the researcher chose the Borg and Gall model because this research model is more detailed at each stage and can be adjusted to conditions in the field.

The Borg and Gall development model has relatively long stages consisting of: 1) Research and information collecting (research and data collection through surveys); 2) Planning (planning); 3) Develop preliminary form of product (development of initial form of product; 4) Preliminary field testing (initial field testing); 5) Main product revision (product revision); 6) Main field testing (field testing); 7) Operational product revision (operational product revision); 8) Operational field testing; 9) Final product revision; and 10) Dissemination and implementation.

## 2.2 Respondents of the study

The researcher obtained data from teachers and students of grade V of elementary school in the Diponegoro Development Area (Dabin), Sukolilo District, Pati Regency to find out the problems in the field, the needs of teachers and students, the feasibility of the developed product, and data on the effectiveness of the product developed in this study. The qualitative data collection technique used by the researcher was obtained through documentation, interviews and observations, while the quantitative data collection was obtained by the researcher through tests and questionnaires. Data analysis was carried out on initial data before the study, data during the product development process, data on the feasibility of the developed product and data on the effectiveness of zappar-based augmented reality media.

## 3. Findings and Discussions

Based on the results of interviews, questionnaires, and observations conducted in this study, it is known that the level of need for social studies learning media in the form of zappar-based augmented reality is quite high. The needs analysis shows that there needs to be learning media by considering the following matters. 1) Content of the lesson material: delivery of the content of social studies learning for grade V elementary school on the material of the human digestive system; 2) Access to obtain the necessary media: Augmented learning media is easy to obtain, easy to reproduce and easy to use in learning. Students simply install the application on their smartphone/cellphone and then use it to scan the barcode to observe 3D images and read and understand the contents of the modules provided; 3) Educator competence to use it: All teachers have smartphones/cellphones so that teachers can easily use Augmented reality media; 4) Learning time: Augmented reality learning media is used in learning with a time allocation of 3 x 35 minutes in 1 meeting (including explanation and media experiments); 5) Augmented reality learning media contains a three-dimensional image of the human digestive system of grade V elementary school students.

In the activity of designing zappar-based augmented reality through the zapwork web application, there are several stages carried out. The stages of creating a zappar-based augmented reality design are as follows. 1) Create a three-dimensional image in the paint 3D application; 2) Enter the zapwork web application; 2) Create and design augmented reality with the help of the zapwork application, enter the 3D image that has been created; 3) Enter the digestion video which is also made using the powerpoint application; 4) Design a module containing an augmented reality barcode using canva; 5) Zappar-based augmented reality in the form of a module is downloaded in pdf format; 6) Zappar-based augmented reality is printed so that it can be used with a google lens scan on a smartphone/mobile phone.

After completing the creation of the zappar-based Augmented Reality media, validation was carried out by experts, namely validation by language experts, material experts and media experts. This activity is to improve the media which is carried out in the form of providing input and assessment in the form of criticism and suggestions for the media. Based on the assessment, suggestions and input from the validator regarding the learning media, the researcher revised the zappar-based augmented reality product that had been made. The results of the validator's assessment showed that language experts and material experts both gave an overall average score of 3.50 with the criteria of "very feasible", while media experts gave an overall average score of 3.58 with the criteria of "very feasible" as well. The validator's results are supported by the results of the student response questionnaire which got an average score in the main trial (expanded) of 3.33 with the criteria of "very good" and the results of the teacher response questionnaire which got an average score in the main trial (expanded) of 3.14 with the criteria of "good". Based on the assessment results by expert validators and supported by the results of student response questionnaires and teacher response questionnaires, it can be concluded that the developed zappar-based augmented reality learning media is "very feasible" to be used in learning as an effort to help students understand the concept of human digestive organs for fifth grade elementary school students in Sukolilo District, Pati Regency. The following is a recapitulation of the assessment results of expert validators and the results of student response questionnaires and teacher response questionnaires on the development and use of zappar-based augmented reality.

**Table 1.** Recapitulation of Expert Validator Assessment Results

Validator Type	Overaal Average Score	Criteria
Linguist	3.50	Very Worthy
Material Expert	3.50	Very Worthy
Media Expert	3.58	Very Worthy

**Table 2.** Summary of Student Response Questionnaire Results

Trial Type	Overall Average Score	Criteria
Initial Trial (limited)	2.88	Well
Main Trial (expanded)	3.3	Very good

**Table 3.** Recapitulation of Teacher Response Questionnaire Results

Trial Type	Overall Average Score	Criteria
Initial Trial (limited)	2.46	Not good
Main Trial (expanded)	3.14	Well

Therefore, based on the overall explanation above, it can be stated that the development of zappar-based augmented reality that is developed is very feasible to help students understand the concept of human digestive organs in grade V Elementary School students in Pati District. The results of this study are supported by the results of this study are supported by research conducted by Khoirina & Adriyani, (2024) which in its journal states that augmented reality is feasible to use because it has been validated with very feasible criteria by media experts by 90% and material experts by 92% and the results of trials have been carried out on students and obtained student questionnaire responses of 82% with very good criteria.

The results of data processing using SPSS on the paired t-test from the pretest and posttest data on understanding the concept of the role of human digestive organs in the experimental class show a significance of <0.05, namely 0.000 for experimental class A and 0.000 also for experimental class B.

If the sig. value (2 tailed) <0.05 then H0 is rejected and Ha is accepted, conversely if the sig. value. (2 tailed) > 0.05 then H0 is accepted and Ha is rejected (Pramesti, 2018). Based on the results above, it can be decided that H0 is rejected and Ha is accepted, which means that there is a difference in understanding the concept of human digestive organs in students before and after participating in learning using zappar-based augmented reality. This proves that zappar-based augmented reality is effective in helping students understand the concept of human digestive organs in grade V Elementary School students in Sukolilo District, Pati Regency. The following is a table of the results of the paired t-test in this study.

**Table 4.** Paired T-Test Results for Understanding the Concept of Experimental Class A

		Paired Samples Test									
		Paired Differences							t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference						
Pair 1	Pretest Eksperimen A - Posttest Eksperimen A	-16,667	4,924	1,421	Lower	Upper					
					-19,795	-13,538	-11,726	11	,000		

**Table 5.** Results of Paired T-Test of Concept Understanding of Experimental Class B

		Paired Samples Test									
		Paired Differences							t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference						
Pair 1	Pretest Eksperimen A - Posttest Eksperimen A	-16,667	4,924	1,421	Lower	Upper					
					-19,795	-13,538	-11,726	11	,000		

Furthermore, the results of the statistical data processing of the independent t-test of the data on the understanding of the concept of human digestive organs with the SPSS program showed a significance of <0.05, namely 0.036 for experimental class A with the control class and 0.022 for experimental class B with the control class.

If the sig. (2 tailed) value > 0.05 H0 is accepted and Ha is rejected, while if the sig. (2 tailed) value <0.05 H0 is rejected and Ha is accepted. So based on the data above, the decision H0 is rejected and Ha is accepted, meaning that there is a difference in the understanding of the concept of human digestive organs in students who take part in learning using zappar-based augmented reality with students who do not use zappar-based augmented reality. This proves that the use of zappar-based augmented reality is effective in helping students understand the concept of human digestive organs for grade V Elementary School students in Sukolilo District, Pati Regency. The following is a table of the results of the independent t-test in this study.

All data obtained in this study were analyzed according to established data analysis procedures. Analytical representation of the data results demonstrates the need, feasibility, and effectiveness of Zappar-based augmented reality in helping fifth-grade elementary school students in Pati Regency understand the concept of the human digestive system.

The results of the needs analysis indicate that Zappar-based augmented reality media is essential for supporting fifth-grade elementary school students in Pati District in understanding the concept of the human digestive system. The analysis also revealed that technological devices, such as mobile devices, play a crucial role in helping students understand learning materials. This aligns with the view expressed by Prasetya et al., (2024), who found that students demonstrated more positive motivation towards learning than those not involved in augmented reality-based learning.

These research findings are further supported by (Radu et al., 2023), who showed that students guided by AR content performed better and stimulated students to think about various scientific ideas, as well as encouraging students to adopt a more active learning style.

Augmented reality is also considered to increase the likelihood of an effective, enjoyable, and interactive learning experience. This is in line with Rahman et al., (2023), who stated that if the technology is implemented, it can make student learning more effective, fun, and interactive because of the 3D visuals that can be seen from the students' smartphones. This is in line with the opinion of (Ardianti & Raida, 2022) which states that learning for elementary school students is expected to be more interesting and enjoyable.

Based on the results of the needs analysis, the researcher developed a Zappar-based augmented reality with the aim of supporting the understanding of fifth grade elementary school students in Pati District regarding the concept of human digestive organs.

In the development phase, researchers began by designing a simple design aligned with the desired objectives. Before proceeding to creating a Zappar-based augmented reality design, researchers first compiled ideas into a storyline to ensure the flow of the augmented reality media was clear and aligned with the identified needs. Creating a Zappar-based augmented reality using the Zappwork application involved several steps. The following are the steps for creating a Zappar-based augmented reality design: 1) Select an image; search on Google, in a book, or create your own image to create a 3D image using the Paint 3D application; 2) Log in to the Zappwork augmented reality website to insert the 3D image and download the barcode/marker used for scanning; 3) Design a module using Canva and insert a 3D barcode scanner and add material on digestive organs; 4) Download the module containing the material and a barcode containing a link to the 3D image; 5) Use a mobile phone with Google Lens to test the barcode you created.

Therefore, a barcode/marker image is needed to run the augmented reality application, which is used on the Zapwork website. According to Muktiani et al., (2022) research, augmented reality has the ability to combine virtual and real-world objects, thereby creating high-quality learning and teaching activities. The products developed in this research are markers and augmented reality applications.

A further stage of improvement is required once the Zappar-based augmented reality media is complete. This next stage is validation, conducted by validators—linguists, material experts, and media experts—to provide assessments and input in the form of criticism and suggestions for the media being developed. Product revisions are also made based on the assessment results, suggestions, and input from the validators regarding the Zappar-based augmented reality learning media being developed.

After the Zappar-based augmented reality media design was completed, the next step was validation by experts to assess its feasibility. In this development process, the validators consisted of a linguist, a material expert, and a media expert, each with their own areas of expertise. The linguist was a language lecturer at UPN Veteran East Java. The material expert was an education practitioner who served as a teacher at Gajahkumpul Elementary School, Pati, and the media expert was a Technology Ambassador for the Ministry of National Education. Therefore, the validators were aligned with the product being developed.

The questionnaire assessment scores provided by the experts generated quantitative data for validation. Meanwhile, qualitative data was obtained through comments and suggestions from the experts. Based on the questionnaire scores completed by the validators, the media was deemed to meet the criteria of being very feasible. The input, suggestions, and comments from the validators were used as the basis for revising the media under development. Revisions to the Zappar-based augmented reality media were carried out solely based on the suggestions provided by the validators, resulting in improved results.

Questionnaire responses from students and teachers regarding the use of Zappar-based augmented reality media indicated that the media met the minimum criteria of "Good." These findings further support the expert validator's assessment, which stated that the Zappar-based augmented reality developed was "Very Feasible" for use in helping fifth-grade elementary school students understand the concept of the human digestive system. Furthermore, interviews with teachers and students revealed that the use of Zappar-based augmented reality facilitated teacher delivery and helped students understand the subject matter more effectively.

From the explanation above, it can be concluded that the development of Zappar-based augmented reality media is highly feasible for helping fifth-grade elementary school students in Sukolilo District understand the concept of the

human digestive system. These findings are supported by research conducted by Khoirina & Adriyani, (2024), which stated that augmented reality is feasible for use because it has been validated by media experts and material experts, has been tested, and has received feedback from teachers and students. Hapizd & Safitri, (2023) also stated in their journal that their augmented reality development overall received an average score of "very valid" based on the validation criteria. Nabila et al., (2024) also stated in their journal that the development of AR had received very good assessments from media experts, language experts and material experts and student responses were also very good.

The effectiveness of a product in learning is measured by the improvement in student learning outcomes, both before and after using the developed product. Learning outcomes were analyzed using paired t-tests in SPSS. Therefore, after conducting a limited trial, a broader trial was conducted in two fifth-grade classes as experiments: Experimental Class A and Experimental Class B. For comparison, the study was also conducted in a fifth-grade class as a control class.

The effectiveness and differences in learning outcomes before and after use can be determined by analyzing the significance value. If the sig. (2-tailed) value is  $<0.05$ ,  $H_0$  is rejected and  $H_a$  is accepted. Conversely, if the sig. (2-tailed) value is  $>0.05$ ,  $H_0$  is accepted and  $H_a$  is rejected (Pramesti, 2018).

Based on the results of the pretest and posttest data analysis on the understanding of the concept of human digestive organs in the experimental class, a significance value of  $<0.05$  was obtained, namely 0.000 in experimental class A and 0.000 in experimental class B. Thus, it can be concluded that the null hypothesis ( $H_0$ ) is rejected and the alternative hypothesis ( $H_a$ ) is accepted. This indicates a difference in students' understanding of the concept of human digestive organs before and after learning using Zappar-based augmented reality media. This conclusion proves that Zappar-based augmented reality is effective in improving the understanding of fifth-grade elementary school students in Sukolilo District regarding the concept of human digestive organs.

The results of the independent t-test statistical analysis of the data on the understanding of the concept of human digestive organs using the SPSS program showed a significance value of  $<0.05$ , namely 0.036 for the comparison between experimental class A and the control class, and 0.022 for the comparison between experimental class B and the control class. Based on the provisions, if the sig. value (2-tailed)  $> 0.05$ , then the null hypothesis ( $H_0$ ) is accepted and the alternative hypothesis ( $H_a$ ) is rejected. Conversely, if the sig. value (2-tailed)  $< 0.05$ , therefore, the null hypothesis ( $H_0$ ) is rejected and the alternative hypothesis ( $H_a$ ) is accepted.

Based on the data obtained, the null hypothesis ( $H_0$ ) is rejected and the alternative hypothesis ( $H_a$ ) is accepted. This indicates a difference in understanding of the concept of the human digestive system between students who participated in learning using Zappar-based augmented reality media and students who did not use it. This conclusion proves that Zappar-based augmented reality media is effective in supporting the understanding of the concept of the human digestive system among fifth-grade elementary school students in Sukolilo District, Pati Regency.

This is in line with research by Hernanda and Aji, (2024), which explains that the use of AR applications increases students' interest and understanding of human anatomy. Students demonstrated a high level of engagement and responded positively to the use of AR technology in their learning. The application of augmented reality learning to human organs in elementary schools can increase learning effectiveness and motivate students to be more active in the learning process. This can improve student learning outcomes, as stated by Hadi et al. (2024), who stated that Augmented Reality learning media has the potential to improve fifth-grade science learning outcomes. This is because Augmented Reality can make science teaching more interactive and engaging, and help students understand difficult science concepts.

#### 4. Conclusions

The results of the needs analysis provide an overview that zappar-based augmented reality is needed to help students understand the concept of human digestive organs for grade V Elementary School students. In addition, the development of zappar-based augmented reality media is also very feasible to help students understand the concept of human digestive organs based on expert validation and teacher and student responses. In line with the opinion of Zahro et al., (2024) who stated that augmented reality is suitable for use in classroom learning activities. Because this media can be used by teachers in classroom learning activities as a means given to students to make it easier to understand the material given by the teacher. Even students are enthusiastic and interested in the augmented reality that they have developed. And based on the analysis of the Paired T-Test and Independent T-Test, it can be seen that this zappar-based augmented reality media is effective in learning to help students understand the concept of human digestive organs. In accordance with the opinion of Suryaning et al., (2022), who stated that Augmented Reality media is very suitable and effective to be applied as a science learning media in elementary schools. This is also in accordance with Putra et al., (2024) who obtained research results that augmented reality is very practical, makes learning easier and is effective for improving learning outcomes.

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## Conflict of Interest

The authors declare there is no conflict of interest

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