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Development of Interactive Science Problem Solver Media Based on PBL to Improve Collaboration Skills of Elementary School Students

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Abstract: This study aims to develop interactive science problem solver media based on PBL for elementary school students to improve elementary school students' collaboration skills. The research method used is Research & Development (R&D) with the Sugiyono model. The subjects of the trial were students of class 5A phase C of SD Inpres Perumnas Palu City, Central Sulawesi. Data collection instruments used questionnaires, observations and interviews. Data analysis techniques used qualitative and quantitative analysis. The average validation results of media experts were 73.34% with a valid category, material experts 87.97% with a very valid category, language experts 92.98% with a very valid category, and content experts 100% with a very valid category. The results of the practicality test through student responses were 97.8% with a very practical category and teacher responses 97.5% with a very practical category. These results indicate that interactive multimedia is included in the very valid and very practical categories. The results of the interactive multimedia effectiveness test on students' collaboration skills using the Wilcoxon Signed test obtained a significance value of 0.005 <0.05, then accepting the Ha hypothesis and rejecting Ho. So it can be concluded that the interactive science problem solver media meets the criteria of being valid, practical, and effective in improving students' collaboration skills.

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Introduction

The development of technology in the 21st century has made it possible for it to be used in the field of education to support the learning process both as an information tool and as a learning tool that can be used by students and requires teacher skills in implementing it. (Manongga, 2021; Mulyani, 2021; Marisa, 2021). This good learning process will undoubtedly support the function of education, namely guiding students towards a goal that we uphold, namely to enlighten the nation's life and develop the Indonesian people as a whole. (Masitah et al., 2024). The learning process certainly has many differences; for example, some students can digest the lesson material, and some students are slow to digest the lesson material (Tussa'diah et al., 2024). Teachers should be able to utilize technological developments through media in the learning process as a guide to information about learning materials, create an active, creative, interactive, modern learning atmosphere, and encourage students to understand, communicate, and apply the knowledge they have acquired.(Adiyanti *et al.,* 2022; Putri *et al.,* 2018).

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Learning media helps complement, maintain, and even improve the quality and continuity of the learning process. Media use in learning will improve learning outcomes, increase student activity, increase student learning motivation, improve understanding, present data interestingly and reliably, facilitate data interpretation, and condense information.(Ramadhani et al., 2024). Today, teachers can use many types of technology-based learning media, one of which is interactive multimedia. (Wulandari *et al.,* 2022). Interactive multimedia is a media that combines text, images, graphics, audio, animation, and video packaged into a digital file so that users can control the media and can be used to convey information to the public. (Wulandari *et al.,* 2022; Ridwan *et al.,* 2023). Interactive multimedia was developed according to the demands of learning in the 21st century.

Learning in the 21st century leads students to have 21st-century skills, which consist of critical thinking, creative thinking, collaboration, and communication skills, better known as the 4C skills. (Suharyat *et al.,* 2022; Rosnaeni, 2021). One of the learning activities that improves these skills is science learning. ('Adiilah & Haryanti, 2023). IPAS is a science that studies the interactions between inanimate objects and living things in the universe and how individuals socialize and interact with their environment.(Nurfadillah, 2024; Susilowati, 2023). So collaboration skills are also very much needed for students to have in the science learning process.

Collaboration skills are working together effectively and respectfully on diverse teams and exercising the fluid decision-making necessary to complete tasks and reach shared agreements. (Fitriana *et al.,* 2023; Nur *et al.,* 2023). Collaboration skills can be improved by using appropriate learning models. One of the learning models that provides students with the opportunity to improve collaboration skills is the Problem Based Learning (PBL) learning model.Rahmawati *et al.,* 2023).

The Problem-based Learning (PBL) learning model is a student-centered learning model that places students in real problems around them, allowing students to think critically about solving problems and discovering new concepts. (Wulan 2020; Ardianti *et al.,*2021; Sari, 2019). The use of the Articulate Storyline application can accompany the implementation of the Problem-Based Learning learning model. Articulate Storyline is software that can create interactive learning media that is interesting and easy for beginners. Like PowerPoint, Articulate Storyline has the advantage that beginners find it easier to create interactive learning media. This software can combine text, graphics, images, animations, sound, and video. In addition, Articulate Storyline can produce web-based publications (HTML5) in the form of application files installed on various electronic devices, such as tablets, smartphones, and computers. (Sapitri & Alwen 2020; Saski & Tri 2021; Amiroh (dalam Muzdalifah, 2022).

Based on the existing background, the researcher tried to conduct initial observations in class VA SD Inpres Perumnas. From the results of observations and interviews by homeroom teachers and students, it was found that the problem was that teachers were not optimal in implementing innovative and creative learning; teachers still used media in the form of videos and images. One of the subjects that used this media was the subject of Social Sciences. Then, during the learning process, some students were less focused, and when dividing groups, the teacher had difficulty because students were choosing friends when dividing groups.

Based on the problems above, this study aims to develop interactive multimedia based on PBL (Interactive Science Problem Solver) to strengthen the collaboration skills of elementary school students. An interactive science problem solver is a technology-based

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learning media that combines the concept of Problem-Based Learning with interactive multimedia developed using Articulate Storyline software, including text, images, sound, animation, and video to make it interesting by presenting material to the human digestive system. This is supported by research conducted by Prianggi et al. (2022), explaining that interactive multimedia is defined as a combination of various elements such as text, sound, images, video, and animation, where the five elements are combined and merged into one interactive multimedia product that creates two-way communication/interaction between users and computers. The presence of interactive multimedia science problem solvers in learning activities can create a more effective, engaging, and relevant learning experience in the real world, thus supporting the development of students' collaboration skills and problem-solving skills.

Research Method

This method uses research and development (R&D) with the Sugiyono model. The 10 steps in development research, according to Sugiyono (in Suardana 2019), are (1) potential and problems, (2) data collection, (3) product design, (4) design validation, (5) design revision, (6) product trial, (7) product revision, (8) usage trial, (9) product revision, and (10) mass product. However, this research only reached the ninth stage, namely product revision. The development carried out in this study was the creation of interactive multimedia based on PBL assisted by Articulate Storyline in the subject of science on the human digestive system to improve students' collaboration skills. The following are the steps in development research carried out by the researcher:

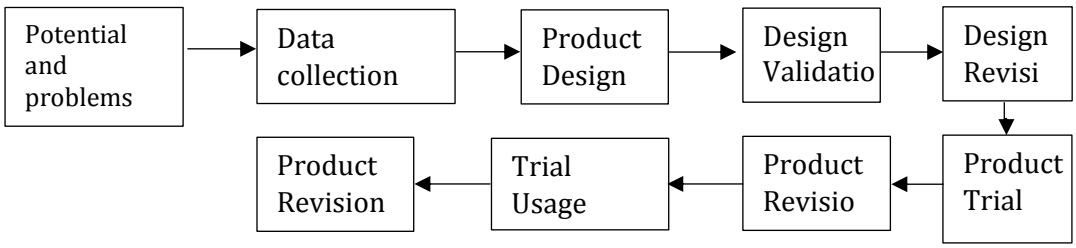

Figure 1. R&D Design Chart of Sugiyono Model

The subjects in this study were teachers and students of class VA SD Inpres Perumnas Palu City, Central Sulawesi. Data collection techniques in this study were observation, interviews, validation instruments, practicality instruments, and collaboration skills questionnaires. Data collection was carried out to collect all data and information. Observation and interviews were used to obtain data at the potential and problem stages, validation and practicality instruments were used to collect validation and practicality assessment data by interactive multimedia users, and collaboration skills questionnaires were used to measure the effectiveness of interactive multimedia in improving students' collaboration skills.

The tools used in this study were validation assessment instruments, practicality, and collaboration skills questionnaires, which were declared valid. Data obtained through research instruments were analyzed qualitatively and quantitatively. Quantitative data analysis used the Likert scale formula 4 to measure the validity and practicality of products based on categories; the following is the formula and criteria for assessing the validity and practicality scores of products based on the percentage assessment criteria according to Riduwan (in Megantoro & Sukarmin, 2021):

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$$P = \frac{\sum \text{skor yang diperoleh}}{\sum \text{skor maksimal}} \text{ X } 100\%$$

Table 1. Percentage of Product Validity Score Assessment

No	Assessment Level	Valid Criteria
1	81 – 100%	Very Valid (no revision needed)
2	61 – 80%	Valid (no revision required)
3	41 – 60%	Less Valid (revision)
4	21 – 40%	Invalid (revision)
5	0 – 20%	Totally Invalid (revised)

Table 2. Percentage of Product Practicality Score Assessment

No	Assessment Level	Valid Criteria
1	81 – 100%	Very practical (no revision needed)
2	61 – 80%	Practical (no revision required)
3	41 – 60%	Less Practical (revision)
4	21 – 40%	Not Practical (revision)
5	0 – 20%	Very impractical(revised)

The prerequisite test for analysis in this study uses a normality test, which aims to determine whether the data distribution is normal. The calculation used in the normality test uses the Liliefors test (Kolmogorov-Smirnov) using the IBM SPSS Statistics 25 program.

This study uses the T-test as a hypothesis testing stage to test and determine significant differences between the two groups. According to Arikunto (Rahmawati, 2022), if the significance value obtained is ≥ α (0.05), then accept the null hypothesis (Ho) of interactive multimedia interactive science problem solver is not practical in improving students' collaboration skills and reject the alternative hypothesis (Ha) of interactive multimedia interactive science problem solver is efficacious in improving students' collaboration skills. Conversely, if the significance value <α (0.05), then reject (Ho) that interactive multimedia interactive science problem solvers are not practical in improving students' collaboration skills and accept (Ha) that interactive multimedia interactive science problem solvers are efficacious in improving students' collaboration skills. In this study, the researcher used the Paired Sample Test with calculations assisted by the IBM SPSS Statistics program version 25.

Results and Discussion

The development of interactive multimedia Interactive Science Problem Solver uses the Sugiyono development model. Here are nine stages carried out by the researcher :

The first stage is potential and problems. At this stage, the researcher conducted observations and interviews with teachers and students of class VA SD Inpres Perumnas to discover learning activity problems. The problem was that teachers were not optimal in implementing innovative and creative learning; teachers still used media in videos and images. One of the subjects that use this media is the subject of science and science. Then, during the learning process, some students were less focused, and when dividing groups, the teacher had difficulty because students were choosing friends when dividing groups.

The second stage is data collection. At this stage, the researcher determines the material after conducting observations and interviews. The selected material is the human digestive system, and topic B is why we need to eat and drink. With the learning achievement, students understand the human digestive system, which is associated with eating and drinking. The learning objectives are: 1) Through the activity of observing

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learning videos and discussions, students can demonstrate an attitude of cooperation and critical reasoning (A4); 2) Through the activity of observing learning videos, students can analyze the digestive organs and their functions correctly (C4); 3) Through the activity of observing learning videos, students can analyze the role of food and drink in the human body correctly (C4); and 4) After the discussion activity, students can work together or collaborate to complete LKPD and make presentations on the material on the human digestive system well (P4).

The third stage is product design. The first step taken by the researcher was to design the background, icons, animations, videos containing material on the human digestive system, and quizzes in the Canva application. Then, the researcher entered the designed design and added audio to the Articulate Storyline. The product produced through Articulate Storyline is by the PBL syntax. The following is a display of interactive multimedia interactive science problem solvers:

Figure 2. Product Design (Title Page)

Figure 3. Product Design (Home Page)

The fourth stage of design validation. Before testing the product on a small group, the product must be categorized as valid or very valid. To obtain this category, researchers conducted validation by material experts, validation by media experts, validation by language experts, and validation by content experts. The following are the results of the validation of the interactive science problem solver design from the experts:

Table 3. Validation Results

No	Aspects assessed	Percentage (%)	Category
1	Media Expert	73,34%	Valid
2	Materials Expert	87,97%	Very Valid
3	Linguist	92,98%	Very Valid
4	Content Expert	100%	Very Valid
	Average	88,6%	Very Valid

Based on the table, the validity category of interactive multimedia products meets the very valid category with a value of 88.6%.

The fifth stage is revising the interactive multimedia design of the interactive science problem solver. The researcher made revisions related to what was suggested by the expert validator. The suggestions from the validator are:

1. The material expert suggests adding material on the parts of the teeth and tongue.

Figure 4. Mouth Material Before Revision

Figure 5. After the Mouth Material Revision Added Teeth and Tongue Sections 5

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Advice from media experts

1) Changed the please enter button and added a picture of the digestive organs on the title page.

Figure 6. Title Page View Figure After Revision

Figure 7. Title Page View Figure After Revision

2) Change the text on the learning objectives button, step 1, step 2, step 3, step 4, step 5 and quiz. And add a picture of the digestive organs.

Figure 8. Home Page Before Revision

Figure 9. Home Page After Revision

The advice from language experts is to improve sentence structure..

Figure 10. Sentence Structure Before Revision

Figure 11. Sentence Structure After Revision

The sixth stage of product trial. At this stage, the researcher conducted a trial on a small group of 6 students of class VA SD Inpres Perumnas and teachers of class VA SD Inpres Perumnas, this trial was conducted to determine whether the product produced is practical. The results of the trial from students and teachers of SD Inpres Perumnas are as follows:

Table 4. User Practicality Results

No	Users	Users Percentage (%)	Category
1	Students	97,8%	Very Practical
2	Teachers	97,5%	Very Practical
Average		97,65%	Very Practical

The table shows that the interactive science problem solver multimedia product's practicality category meets the very practical category with a value of 97.6%.

The seventh stage of product revision. After conducting a product trial with a small group (students) and teachers, the researcher made a revision based on their comments. Students commented that the application was very good, interesting, and easy to understand, while teachers commented that the media used was very good and suitable for use in schools.

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Based on these comments, the interactive multimedia developed did not need any revision and was ready to be tested on a large group.

The eighth stage of the trial use. At this stage, the researcher conducted a large-scale trial in class VA of SD Inpres Perumnas, with 22 test subjects consisting of 11 males and 11 females. At the trial use stage, the researcher implemented interactive multimedia interactive science problem solver in the teaching treatment after conducting a pre-test on class VA students. After implementing interactive multimedia interactive science problem solver, the researcher conducted a post-test on students to determine the effectiveness of using interactive multimedia in strengthening students' collaboration skills. The researcher then conducted a normality test to determine whether the distribution of data in the pre-test and post-test data was normal. From the results of the normality test calculation, the post-test value data on the collaboration questionnaire was normally distributed with a number greater than 0.05, namely 0.096 and the value of the pre-test data was 0.047, which means less than 0.05, thus indicating that the post-test data was normally distributed and the pre-test data was not normally distributed. Because the data was not normally distributed, a t-test (non-parametric) was performed using the Wilcoxon test.

In the Wilcoxon Test, a significant difference was obtained from the pre-test and post-test results to determine students' collaboration skills before and after treatment, as shown in Table 5 below.

Table.5 Uji *Wilcoxon*

Statistical Test[a]	
	Postest-Pretest
Z	-2,828[b]
Asymp. Sig. (2-ekor)	0,005

a. Based on negative ratings
b. Wilcoxon Signed Rank Test

The ninth stage of product revision. At this stage, researchers can find out the advantages and disadvantages of interactive multimedia Interactive Science Problem Solver after conducting a trial usage. The advantages of interactive multimedia Interactive Science Problem Solver are that this multimedia can be used anywhere and the language in the interactive science problem solver is easy to understand. Interactive science problem solver contains audio, images, animations and videos designed according to a predetermined theme making this multimedia more interesting for students who like learning while playing. This makes students feel happy so that the material presented is easy to understand and has an impact on achieving learning objectives. Interactive multimedia Interactive Science Problem Solver can be used as a reference by teachers to create innovative learning media. The disadvantage of using interactive multimedia Interactive Science Problem Solver is that when used on a laptop, the audio on the multimedia is not heard clearly. An alternative solution so that the interactive multimedia Interactive Science Problem Solver audio can be heard clearly is to use a loudspeaker when using it.

Discussion

This study is intended to develop interactive multimedia based on PBL for elementary school students to improve student learning, strengthen 4C skills, especially student collaboration skills, and become a reference for teacher-teaching media in learning activities. The interactive multimedia developed is named Interactive Science Problem Solver which contains material on the human digestive system with the topic of why we need to eat and

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drink, phase C of grade V elementary school. This product was developed using the Sugiyono model which consists of 9 stages. The results of the data analysis stated that the validation results obtained an average of 88.6% with a very valid category. The practicality results obtained an average of 97.6% with a very valid category. This is in line with research conducted by (Dwi Septiani & Okmarisa, 2023) if the validity and practicality assessment reaches a value of 81-100%, it meets the very valid and very practical criteria. This study also proves that interactive multimedia science problem solver effectively strengthens students' collaboration skills based on the results of the Wilcoxon test with an Asymp-sig value (2-tailed) of 0.005 <0.05, which means that there is a difference in the average collaboration skills of students before and after the use of interactive multimedia interactive Science problem solvers in science learning in elementary schools. This is the opinion of Azis & Hartini, (2024) who stated that using interactive multimedia in the learning process can improve collaboration skills in students.

Interactive Science Problem Solver is a technology-based learning media developed using articulate storyline software, which contains a problem-based learning phase with digestive system material supported by text, images, sound, animation, and video. Interactive multimedia Interactive Science Problem Solver in learning activities can create a more effective, interesting, and relevant learning experience in the real world. Thus supporting the development of student skills and problem-solving in students. This is supported by research conducted by (Prianggi et al., 2022) explaining that interactive multimedia is defined as a combination of various elements such as text, sound, images, video, and animation, where 5 elements are united and merged into one interactive multimedia product that creates two-way communication/interaction between users and computers.

The advantages of Interactive Science Problem Solver are: (1) Easy to use to support the learning process, (2) Has an attractive appearance so that it can increase students' learning motivation, (3) Can be used anytime and anywhere, (4) Contains materials, videos, animations, audio, and quizzes that can attract students' interest in learning, (5) Trains students to be more independent in gaining knowledge, and (5) Makes it easier for students to learn in groups. This is in line with research conducted by (Suprihatin et al., 2022) which states that articulate storylines have the advantages of ease of use, the ability to attract students' interest, make it easier to deliver material, motivate students, can be accessed anywhere and anytime, and can improve students' memory.

The disadvantages of Interactive Science Problem Solver are: (1) Requires a network to install the application and access the link on the laptop, (2) Cannot be used on all materials in science learning, (3) Can only be used on learning models (PBL) and human digestive system materials, and (4) Requires a laptop or smartphone when accessing the interactive science problem solver. This is also by the research conducted (Neliati, 2022) which explains that its use requires facilities such as a laptop, smartphone and a good internet network.

This study supports previous research. A study conducted by (Lufiasari & Pusporini, 2023) stated that using the PBL learning model can increase the activeness of students' collaboration skills in learning. (Aini & Kusumaningrum, 2024) stated that applying the problem-based learning (PBL) learning model can improve collaborative skills and student learning outcomes. Research conducted by (Waldi et al., 2025) stated that interactive media developed with Articulate Storyline 3 based on Problem Based Learning (PBL) has been valid and practical for use in Elementary Schools. This study examines interactive multimedia based on PBL (Interactive Science Problem Solver) to strengthen the

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collaboration skills of elementary school students. It obtains results that this multimedia is very valid, practical to use, and effective in strengthening students' collaboration skills.

Conclusion

The conclusion of the results of this study is that the eligibility criteria for the Interactive Science Problem Solver media product are stated to be valid, effective and practical, as evidenced by the average validation results of material and media experts which are in the very good criteria. The Interactive Science Problem Solver media is stated to be effective in improving students' collaboration skills, after the Wilcoxon signed ranks test was conducted with an Asymp.sig (2-tailed) value of 0.005 <0.05, which means that there is a difference in students' collaboration skills before and after using the Interactive Science Problem Solver media in science learning in elementary schools.

Recommendation

There are recommendations for further researchers to conduct research that discusses other materials in science learning, such as the respiratory and circulatory systems, and to use other learning models, such as cooperative learning models and project-based learning models.

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