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Development Of Mindloops Magazine Based On Augmented Reality (AR) To Minimize Misconceptions About The Solar System In Elementary School Students

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Abstract

Misconceptions or misunderstandings of the material during the learning process can lead to a student's failure at school. Therefore, this study aims to develop a learning tool in the form of AR-based Mindloops Magazine to minimise students' misconceptions about solar system materials. The type of research used is Research and Develop (RnD) with ADDIE model which consist of analyse, design, development, implementation, and evaluation stages. The subjects of this study were the students of grade VI of SDN 1 Tunjungmuli there were an experimental class and a control class. The method of sampling used is random sampling. Learning was done using AR-based Mindloops Magazine in the experimental class whereas learning was done using a student handbook in the control class. Data collection was carried out by interview, questionnaire and tests. The data were analysed both qualitatively and quantitatively. Quantitative analysis includes normality, homogeneity and t-test. The study results show that Mindloops Magazine based on AR is in the category of valid and practical. The data were normally distributed and homogeneous, with values of 0.136 and 0.148 (more than 0.05), as confirmed by statistical tests. Furthermore, the t-test results obtained the significance value of 0.015 (less than 0.05). Thus, it can be concluded that the implementation of AR-based Mindloops Magazine learning media is effective in reducing students' misconceptions on Solar System material.

Keywords: Solar System, Magazine, Augmented Reality, Misconseption

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INTRODUCTION

An alternative conception that conflicts with accepted scientific knowledge is a misconception. Everyday experiences, non-scientific language usage, and mistakes in school learning can lead to misconceptions (Serttas & Turkoglu, 2020a). What we find is that misconceptions are not something that just happen randomly, but are an attempt by students to reconcile their personal experiences with actual contradictory scientific concepts. Misconceptions, if not identified soon, will hinder students' conceptual understanding. Thus, teachers need to identify students' misconception through instructional adjustments (Muhabib et al., 2024).

Astronomy is a science field that is full of misconceptions (Serttas & Turkoglu, 2020b). There are also a few elementary schools that misunderstand the solar system material. The first research was carried out in the Diponegoro Cluster, Koorwilcam Karangmoncol, Purbalingga consisting of 8 schools, totalling 128 sixth grade student respondents through Google Forms by providing questions related to misconceptions in solar system material. The result of the diagnostic test item analysis shows that 52% of respondents still have misconception on the topic of seasons caused by the changes in the distance of the Earth to the Sun and the topic of all the planets orbit the Sun in a perfect path.

Both topics are difficult for students because of the lack of media that can show visualisations of the solar system material. In line with this, interviews with several teachers also revealed the absence of interactive learning media. The available learning media has not been able to explain the abstract nature of the solar system material to students in a more concrete form and minimal use of interactive media of the solar system. Textbooks can also create misconceptions, particularly when they are written in a language that is difficult to understand, contain inaccurate explanations or misleading images or graphs (Laksana et al., 2017). Therefore, it is necessary to develop learning media that can be used as a learning resource for students and can provide a concrete and meaningful representation of the solar system.

One of the alternative media that can be used in learning and as a source of study for students is a digital-based magazine. A magazine is a medium where a collection of written and visual contents are systematically and attractively organised to inform, entertain, or share experiences, ideas or personal reflections with the readers (Asfuriyah & Nuswowati, 2015). Magazines have not only content, but can also have readings in the form of illustrated stories, scientific facts and even quizzes that can deliver content in a more interesting way. Djuroto (in Kurniasari et al., 2022) states that magazines are simple media for children, the content is relatively easy to understand, various stories are included to enhance the atmosphere of the

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content, and their appearance is made diverse. AR-based Mindloops Magazine can provide students with an experience similar to reading a magazine.

Students will have tangible learning experiences when they see or directly experience the natural phenomena that occur. However, for the solar system material teachers cannot bring students to see the solar system directly, but they can use an alternative in the form of AR. AR is a technology that combines virtual objects with the real world to enable users to see reality with virtual elements added to it, which allows students to access and understand complex concepts more deeply and intuitively (Ginanjar et al., 2024).

Students can easily learn by using AR via devices that have an application named Assemblr. Assemblr is an AR platform that makes it easier to design 3D contents that will be displayed in AR form later on. For users it is done efficiently and beneficially (Ginanjar et al., 2024). This application can be downloaded by teachers and students for free through Playstore or directly with barcode scanner application. The presence of learning media in the form of Mindloops Magazine based on AR is expected to bridge the gap between the reality of science with the imagination of students, so that the concepts that were initially abstract and difficult for students to understand can become a concrete and fun visual experience. Therefore, this research aims to develop AR-based Mindloops Magazine product to minimise misconceptions about the solar system on elementary school students. This research meets the aspects of validity, practicality, and effectiveness.

RESEARCH METHOD

This research uses the type of research and development (Research and Development). Research and Development (R&D) is a research method aimed at producing a specific product and testing the effectiveness of that product (Rustandi & Rismayanti, 2021). The chosen development model is the ADDIE model, which stands for Analyze, Design, Develop, Implement, and Evaluate. This research is based on a step-by-step product development process to develop and validate the AR-based Mindloops Magazine product, so that the feasibility of the product can be determined in terms of validity, practicality, and effectiveness to minimize students' misconceptions about the solar system material. The population in this study is the elementary schools in the Diponegoro Cluster, Koorwilcam Dindikbud Karangmoncol, Purbalingga Regency. Meanwhile, the sample consists of 42 students from the sixth grade of SD Negeri 1 Tunjungmuli for the 2025/2026 academic year. The selection of research subjects was conducted using the random sampling technique based on the results of the preliminary study.

The data collection techniques in this study consist of tests and non-tests. The test is in the form of a posttest applied after the treatment using the AR-based Mindloops Magazine in the

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experimental class and the use of student books in the control class, developing a post-test only design research. For non-test data collection, interviews and questionnaires were used. Interviews are conducted to gather information at the beginning of the research related to the product that will be developed. The interviews conducted are unstructured interviews because the interview guidelines only contain an outline of the problem. The questionnaires used include a product feasibility questionnaire and a practicality questionnaire. The product feasibility questionnaire consists of validation conducted by subject matter experts, media experts, and language experts. The product practicality questionnaire consists of responses given by students and teachers regarding the developed product.

The data analysis techniques used include feasibility, practicality, and effectiveness analysis. Feasibility analysis is conducted by incorporating all assessment results from expert validators in content, media, and language, which are then converted using a score range and qualitative criteria. Product practicality analysis is conducted by incorporating questionnaire data from student and teacher responses, which are also converted using quantitative data in the form of user assessment scores. The analysis of product effectiveness is conducted using statistical tests assisted by SPSS version 23, which includes normality tests, homogeneity tests, and t-tests.

RESULTS & DISCUSSION

Results

The research results are presented according to the stages of the ADDIE model, with the aim of producing the Mindloops Magazine product based on AR, based on the results of validity, practicality, and effectiveness.

Stage Analyze/Analysis.

Based on the needs analysis results from the preliminary research involving sixth-grade teachers in the Diponegoro Cluster, Koorwilcam Dindikbud Karangmoncol, it can be concluded that the development of innovative learning media in the form of AR-based Mindloops Magazine is highly needed. The analysis results indicate that the current learning media have not maximally increased students' motivation and interest in learning, nor have they strengthened material comprehension. Therefore, it can be concluded that in the IPAS learning of the solar system material, engaging, innovative, and interactive learning media are needed to enhance students' motivation and interest in learning as well as to improve material comprehension. These findings serve as the basis for the researchers to develop the AR-based Mindloops Magazine product.

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Design Stage

The design stage referred to is the phase in designing the Mindloops Magazine AR-based learning media by first determining the supporting media used in the creation, then the content, and finally the initial product design. The supporting media used are Canva and Assemblr Edu. Next is the compilation of the magazine's content, which includes gathering solar system materials that will become an important part of the magazine's content, dividing the material for each page, and organizing the content of each page starting from the front cover, preface, AR usage instructions, table of contents, main material, solar system facts and myths, quiz, author introduction, and back cover. Finally, there is the initial product design stage of the magazine, which includes the magazine theme, selection of the main characters in the magazine, magazine layout, and AR creation. A more detailed explanation of the initial product design of Mindloops Magazine based on AR solar system material is presented in Table 1 below.

Table 1. Initial Product Design of Mindloops Magazine based on AR

No	Media Section	Description
1		Front Cover Page
2		Main Material with AR-based QR Code

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3		Facts & Myths about the Solar System
4		Quiz about the Solar System material

At this design stage, in addition to designing the magazine, the researchers also design learning devices in the form of teaching modules that will be used by teachers in both the experimental and control classes.

Development Stage

The development stage involves the implementation of validity testing by experts, namely subject matter experts, media experts, and language experts. The assessment results from the three experts are presented in the following Table 2.

Table 2. Expert Validity Test

No	Aspect	Score	Category
	Material Expert		
1	Alignment with the curriculum and learning objectives	82	Valid
2	Truth and accuracy of scientific concepts	82	Valid
3	Depth and coherence of the material	84	Valid
4	Contextual appropriateness and student engagement	83	Valid
	Language Expert		
1	Readability and clarity of language	81	Valid
2	Language appropriateness for learners	82	Valid

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3	Language accuracy and consistency	83	Valid
4	Communicative and engaging language	81	Valid
	Media Expert		
1	Content and material suitability	81	Valid
2	AR appearance and design suitability	82	Valid
3	Language and communication suitability	81	Valid
4	Learning and interactivity suitability	81	Valid
5	Technical and usability suitability	82	Valid

Based on the table, data from the validity test results of the three experts show that each component is declared valid. First, the assessment by the content expert shows an average score of 82.8 with a valid category. Second, the assessment by the language expert with all categories declared valid and an average score of 81.8. Third, the assessment by the media expert also shows that all components achieved a valid category with an average score of 81.4. Thus, it can be concluded that based on the assessment by the three experts, the AR-based Mindloops Magazine on the solar system material developed has met the validity criteria.

Implementation Stage

After receiving feedback from the three validators, revisions or improvements are made to the AR-based Mindloops Magazine according to their suggestions and input. Next, in this stage, limited trials or small group trials and field tests are also conducted. The limited trial involved 22 students from class VA at SD Negeri 1 Tunjungmuli. This limited trial was conducted to determine whether the students encountered any difficulties while using the magazine. The result showed that the students were able to use the AR-based magazine smoothly. The average score obtained from the practicality questionnaire by 22 students was 85, indicating that the AR-based Mindloops Magazine is categorized as practical for students to use in supporting learning related to the solar system material. Field tests in the form of the application of the AR-based Mindloops Magazine media were conducted in both classes over three meetings.

Evaluate Stage/Evaluation

This final stage involves a comprehensive evaluation of the achievement of product usage based on statistical testing results to determine the effectiveness of learning using the AR-based Mindloops Magazine in minimizing student misconceptions about the solar system material thru posttest activities. The following Table 3 shows the results of the normality test using Shapiro Wilk.

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Table 3. Shapiro Wilk Normality Test Results

Tests of Normality						
	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Posttest Eks	.186	20	.068	.927	20	.136
Posttest Kont	.144	20	.200*	.957	20	.483
*. This is a lower bound of the true significance.						
a. Lilliefors Significance Correction						

Based on Table 3, the significance value in the experimental class is 0.136 and in the control class is 0.483, which means these results are greater than 0.05. Therefore, it is concluded that the data meet the normal category and can proceed to the homogeneity test, with the results shown in Table 4 below.

Table 4. Homogeneity Test Results

Test of Homogeneity of Variances			
Science Posttest Results			
Levene Statistic	df1	df2	Sig.
2.175	1	40	.148

The results of the homogeneity test using the Levene Test showed a significance value of 0.148, which is greater than 0.05. Therefore, it can also be concluded that the obtained data meet the homogeneity category. Next, a descriptive statistical test was conducted on both classes with the results shown in Table 5 below.

Table 5. Descriptive Statistics Results

Descriptive Statistics

	N	Minimum	Maximum	Mean		Std. Deviation
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic
Experiment	22	7	15	11.91	.474	2.223
Control	20	5	15	9.90	.648	2.900

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Valid N (listwise)	20					

Table 5 shows the results of descriptive statistics on the mean statistic, mean standard error, and standard deviation in both classes. It can be seen that the average concept understanding score in the experimental class is 11.91, while in the control class it is 9.90. This value indicates that the score in the experimental class is higher compared to the score in the control class. These results are also supported by the t-test results in the following Table 6.

Table 6. Independent Sample Test Results

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Result Posttest IPAS	Equal variances assumed	2.175	.148	2.533	40	.015	2.009	.793	.406	3.612
	Equal variances not assumed			2.501	35.548	.017	2.009	.803	.379	3.639

The t-test results obtained a significance value of 0.015, which is less than 0.05, indicating a difference in the average scores between the experimental and control classes. The average concept understanding score in the class using the AR-based Mindloops Magazine is better compared to using just the student book. Additionally, the learning in the experimental class is also more active and enjoyable. Thus, learning using the AR-based Mindloops Magazine on solar system material is effective in minimizing misconceptions among elementary school students.

The results of the practicality test obtained from user response questionnaires showed data of 85% from students and 88% from teachers. This shows that the AR-based Mindloops Magazine media is easy to use for both students and teachers. Additionally, it can also serve as evidence that thru the AR-based Mindloops Magazine, students are more interested in participating in learning and find it easier to understand the material.

DISCUSSION

The results of the research conducted show that the AR-based Mindloops Magazine developed has met the aspects of validity and practicality, making it suitable for use in learning.

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This validity shows that both the content of the magazine, the physical appearance of the magazine, and the components of the magazine are presented in accordance with the learning objectives and the characteristics of elementary school students. On the other hand, the practicality aspect shows that the media is easy to use by both teachers and students and can effectively support the implementation of learning in the classroom. These findings are in line with previous research that states the use of AR can enhance students' understanding (Abu Bakar et al., 2020).

The results of the normality test statistical analysis were 0.136 for the experimental class and 0.483 for the control class, and the homogeneity test result was 0.148, where both data were greater than 0.05, thus meeting the prerequisites for hypothesis testing using the t-test. The t-test result was 0.015, which is less than 0.05, indicating a significant difference between the learning outcomes of students in the experimental class and the control class. The results of the statistical test can serve as a basis that the AR-based Mindloops Magazine is effective in minimizing misconceptions about the solar system among elementary school students compared to the use of student textbooks.

The findings of the research can have a significant impact on the implementation of learning in elementary schools, especially in terms of utilizing technology as an innovative and engaging learning medium. The use of the AR-based Mindloops Magazine has proven to be not only effective in enhancing learning but also in helping students better understand abstract learning concepts and minimizing misconceptions about the solar system material. Therefore, the AR-based Mindloops Magazine learning media can be used by teachers as an alternative to more interactive and contextual learning strategies. On the other hand, the research results also show the importance of integrating AR in supporting learning to make it more meaningful and student-oriented. Therefore, the development of technology-based learning media also needs to be advanced to support the improvement of learning quality at the elementary school level.

CONCLUSION AND SUGGESTIONS

Based on the research results, the AR-based Mindloops Magazine has met the criteria of being valid, practical, and effective for application in the IPAS learning process on the solar system material to minimize misconceptions among elementary school students. This is supported by the results of statistical analysis showing that the data is normally and homogeneously distributed, allowing for hypothesis testing, which indicates a significant difference between the experimental class and the control class. Thus, this learning media can serve as an innovative alternative in

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enhancing concept understanding among elementary school students.

The findings of this research have several limitations, namely the sample size, which is still limited to two classes from one school, the relatively short duration of the research, which cannot demonstrate long-term impacts, and the scope of the material, which only focuses on the solar system. Therefore, the recommendation for future research is to involve a larger and more diverse sample to enhance the generalization of the findings. Furthermore, the duration of the research is expected to be longer to explore the influence of media on students' thinking abilities in greater depth. Lastly, media development can be conducted on different subjects or educational levels to provide a broader picture of the impact of using AR-based magazines in learning.

FUTURE DIRECTIONS

For future research, it is recommended to extend the implementation of the AR-based Mindloops Magazine to other educational contexts and subjects in order to evaluate its long-term efficacy and flexibility in elementary education. Future studies could examine the combination of AR technology with other interactive learning approaches such as gamification, collaborative learning or problem-based learning to further develop students' critical thinking, creativity and digital literacy skills. Moreover, researchers are encouraged to involve larger and more diverse participants from different regions and educational backgrounds to improve the generalizability of the results. Further research is also needed to explore the long-term effects of AR-based learning media on students' retention, motivation, and conceptual understanding, especially in science learning. Furthermore, future research should aim to improve the accessibility, usability and technological compatibility of AR media so that teachers can use it more effectively in different classroom conditions and educational environments.

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