



# Development of Digital Cognitive Learning Media on Magnetism Material to Empower Problem-Solving Skills of Fourth Grade Elementary School Students

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## Abstract

This research aims to develop an interactive digital guide for magnetism experiments to empower problem solving skills among fourth-grade school students. The guide is intended to be valid according to experts, practical for users, and effective in enhancing students problem solving abilities. The research follows the five stage of the ADDIE Model, which are analysis, design, development, implementation, and evaluation. Data analysis techniques include both qualitative and quantitative methods. The result of this media development project show that the material validation achieved a score of 98%, media validation reached 98% and user validation received 99%, all categorized as highly valid. In terms of practicality during testing phase, a percentage of 98,67% was obtained, indicating a high level of practicality. Therefore, the research and development of this interactive digital guide for magnetism experiments, designed to enhance problem solving skills among fourth-grade elementary school students, is highly valid according to experts in the field, practical according to users, and effective according to students.

**Keywords:** Experiment Guide, Magnetism, Problem solving, Media

## 1. Introduction

Efficiency in education can be achieved by involving digital learning media. This is because digital learning media offer practical value and are more efficient in assisting students' learning activities. This statement aligns with Jediut et al. (2021), who emphasized the digitalization of learning media through various internet-based platforms. Digital learning media play a key role in enhancing the ease with which students absorb the material being taught.

The role of digital learning media is as an intermediary. This intermediary function means that the media present the material being studied during the learning process. According to Erka (2015), having the right material presenter helps students grasp abstract topics more quickly and concretely. This is the core practical value of having digital elements in learning media. Additionally, students are already accustomed to using smartphones, and the use of smartphones by students can be an attraction and motivation for their learning.

Recent curriculum changes show efforts to improve the quality of education for Indonesian students. In this era, the curriculum changes include the "Kurikulum Merdeka" (Freedom Curriculum) with a focus on higher-order thinking. This goal represents the foundation of educational objectives that support student autonomy based on the Freedom Curriculum. The Directorate General of Teachers and Education Personnel (Ditjen GTK) aims to improve the quality of learning and student outcomes in Indonesia (Ariyana et al., 2018).

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In the teaching process, teachers are also entitled to provide freedom in gaining learning experiences based on knowledge and skills. Learning experiences to achieve higher-order thinking skills can be supported as a form of freedom in learning at school. With the Freedom Curriculum, students are expected to explore learning experiences more freely, actively, and broadly. This is intended so that students can independently develop their cognitive skills more critically. Problem-based learning (PBL) can be used to address issues that may arise around students, serving as initial training to enhance critical thinking skills. Applying these skills will be useful when students encounter everyday problems and need to solve them easily.

Critical problem-solving skills are an output of implementing problem-solving learning. This indicates a strong need for problem-solving-based learning for students starting from primary education (Ariyani & Tego, 2021). Therefore, it is necessary to teach problem-solving from early education to train students to get accustomed to solving problems.

The Freedom Curriculum has integrated the subjects of Science (IPA) and Social Studies (IPS) into a combined subject called IPAS. In its implementation, Science content is taught in the odd semesters, while Social Studies content is taught in the even semesters. Additionally, the Freedom Curriculum has categorized students into learning phases, with Grade III and IV in Phase B.

Based on interviews with teachers and some fourth-grade students at SDN 03 Bence and a needs assessment questionnaire, it was concluded that there is a need for learning media for the magnetism content in Science education. The results from the student responses in the needs assessment questionnaire indicated that the majority of fourth-grade students at SDN 03 Bence agree with the development of digital media for learning. Both teachers and students expressed support for teaching the magnetism material using digital media. This material is often not well understood by students due to its brief discussion, the infrequent creation of learning media, and a lack of variety in learning experiences, which makes students unaware of the everyday uses of magnets. As a result, the less effective teaching of magnetism means that students' problem-solving skills are not well developed, even though such skills are a significant expectation for students.

In line with the need for a product, for the fourth-grade students at SDN 03 Bence regarding Science material on magnetism, there is a need for the development of digital learning media that can train cognitive development and is based on problem-solving. Given the potential, an interactive experiment guide is a suitable choice for developing digital cognitive learning media. This research is expected to benefit both teachers and students. Teachers can assist students in learning in an engaging and practical way, and students can become more interested in learning critically, especially about magnetism.

## 2. Method

This research and development follow the ADDIE model, which includes five research phases: Analysis, Design, Development, Implementation, and Evaluation (Maydiantoro, 2020).

The ADDIE model is more comprehensive than the 4D model and is systematic. This is because each phase includes an evaluation stage, resulting in more effective products. Additionally, the phases of the ADDIE model are more detailed compared to those in the Borg and Gall model. The flowchart of the ADDIE model is illustrated in Figure 1.

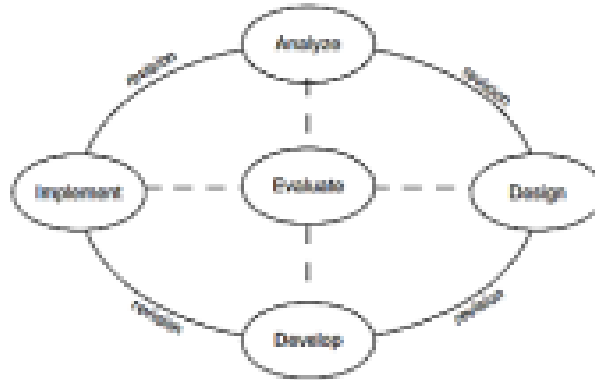


Figure 1. The Phases Of The ADDIE Model

The types of data used in this research and development are qualitative and quantitative. Qualitative data consists of descriptive information obtained from interviews, feedback, and suggestions from material experts, media experts, and users. Quantitative data consists of numerical information derived from the results of student needs assessments, validation scores by material experts, media experts, and users. Data collection techniques in this research and development involve interviews and questionnaires.

This research and development use primary data sources. Primary data are collected directly from informants. These sources include material experts, media experts, users, and students. The research and development involve experts, practitioners, and students. The experts include a validator professor with expertise in magnetism content for science and development of learning media for elementary education. The practitioner involved is a classroom teacher at an elementary school. Additionally, this study includes 25 fourth-grade students. The research and development are conducted at SDN 03 Bence, located on Jl. Raya Bence, Kec. Garum, Kabupaten Blitar, East Java.

Data obtained from student needs assessments, validation questionnaires from experts and users, and student responses regarding practicality are analyzed quantitatively. The needs assessment questionnaires are distributed to fourth-grade students at SDN 03 Bence. The questionnaire model used in this research is the Guttman scale, which has two response options: “yes” and “no”. In the Guttman scale, the highest score is one for the “yes” response and the lowest score is zero for the “no” response.

Based on the collected data, both descriptive and inferential quantitative analyses are performed. Descriptive analysis is based on feedback from material experts, media experts, and users (teachers) regarding the validated product. Quantitative descriptive data analysis is based on the validation forms completed by validators and the practicality questionnaires completed by students, processed according to the formulas referenced from Pranatawijaya et al. (2019)

and product validity percentages according to Cahyo et al. (2021), as well as the practicality percentage of the product.

### 3. Results and Discussion

#### 3.1 Result

The results of the research and development were conducted with the aim of producing a digital interactive experiment guide to enhance problem-solving skills in magnetism that is valid, practical, and effective. The developed product, which was submitted for validation by experts, is illustrated in Figures 2 and 3 as follows.



Figure 2. : Interactive Application Display in the form of a PowerPoint file for students



Figure 3. Problem-Solving Project Display

Based on the developed product, the following steps were undertaken to achieve the research and development objectives. Each analysis is detailed as follows:

#### Product Validity

The digital interactive experiment guide has undergone validation by material experts, media experts, and users (teachers). A summary of the product validation results is shown in Table 1 as follows.

No.	Research Aspect	Maximum Score	Assessment			Mean	Category
			Content Expert	Media Expert	User (Teacher)		
1.	Content	4	3	-	4	99%	Highly Valid
2.	Scope Of Content	4	3	-	4	99%	Highly Valid
3.	Systematics Of Presentation	4	4	-	4	100%	Highly Valid
4.	Language Use	4	4	-	4	100%	Highly Valid
5.	Product Presentation	4	-	4	4	100%	Highly Valid
6.	Application Of Interactive Digital Experiment guide	4	-	3	3	98%	Highly Valid
7.	Product Usage	4	-	3	4	99%	Highly Valid
8.	Product Operation	4	-	4	4	100%	Highly Valid
Score			14	14	31		
Total Score			59				
Percentage Mean			89,4%				
Total Category			Highly Valid				
Test Decision			Ready To Use Without Revision				

Table 1. Product Validation Results

Based on Table 1, the product validity analysis shows an average score of 89.4%. According to the categorization criteria by Akbar (2017), this score is classified as **highly valid**. Thus, the **Digital Interactive Experiment Guide** for enhancing problem-solving skills in magnetism is concluded to be highly valid and can be used in teaching. The validity scores for each aspect of the digital interactive experiment guide are as follows:

- **Content Accuracy:** 99%
- **Material Coverage:** 99%
- **Presentation Systematics:** 100%
- **Language Use:** 100%
- **Product Presentation:** 100%
- **Application of the Digital Guide:** 98%
- **Product Use:** 99%
- **Product Operation:** 100%

Following the validation phase, feedback and suggestions were provided by subject matter experts, media experts, and users (teachers). Based on these suggestions, the product underwent a revision process to ensure it was refined and accurate before being tested in the research phase. After revising the product, trials were conducted, including implementing the

media, administering a practicality questionnaire to students, and carrying out pre-tests and post-tests to assess the effectiveness of the guide in improving students' problem-solving skills.

### Product Practicality

Digital Product: An interactive experiment guide designed to enhance problem-solving skills in the topic of magnetism for 4th-grade elementary students, which has been developed and validated. Its practicality was measured based on a student response questionnaire concerning its practicality. The respondents for this practicality questionnaire consisted of 25 students. The results of the student responses regarding practicality are presented in the following Table 2.

No.	Indicator	Score	Percentage
1.	Fun	25	100%
2.	Can Be Used Without Specialized Skills	25	100%
3.	Can Be Used Everywhere and Anytime	23	96%
4.	Practical Digital Learning Media Application That Can Be Used Anywhere	25	100%
5.	The Digital Learning Media Application Makes it Easier To Understand Magnetism Concepts	25	100%
6.	The Digital Learning Media Application Is Easy To Use and Easy Accessible	23	96%
<b>Total</b>		<b>146</b>	<b>592%</b>
<b>Mean</b>			<b>98.67%</b>
<b>Category</b>			<b>Very Practical</b>
<b>Description</b>			<b>Can Be Use Without Revision</b>

Table 2. Student Practicality Questionnaire Results

Based on Table 2, the data from the practicality questionnaire for the Digital Product interactive experiment guide designed to enhance problem-solving skills in magnetism for 4th grade elementary students shows a result of 98.67%. This figure is categorized as very practical according to the practicality category in Table 2. The Digital Product interactive experiment guide for empowering problem-solving skills in magnetism for 4th-grade students can be considered highly practical and usable without the need for revision. Students are enthusiastic about using this Digital Product interactive experiment guide in their learning and are eager for other lessons to also incorporate similar interactive experiment guide media.

### Product Effectiveness

The purpose of conducting this product effectiveness test is to evaluate the effectiveness of the Digital Product interactive experiment guide designed to enhance problem-solving skills in magnetism for 4th-grade elementary students. The data analyzed in the effectiveness test are based on the results of pre-tests and post-tests. The effectiveness testing involves prerequisite tests (normality and homogeneity), N-Gain Score test, and T-test (Paired Sample t-Test).

In the normality test using the Kolmogorov-Smirnov test, a significance value of 0.2 was obtained. A value of 0.2 falls into the category of significance > 0.05, indicating that the data is normally distributed. This is shown in Figure 4.

➔ **NPar Tests**

**One-Sample Kolmogorov-Smirnov Test**

		Unstandardized Residual
N		25
Normal Parameters <sup>a,b</sup>	Mean	.0800000
	Std. Deviation	9.59741728
Most Extreme Differences	Absolute	.160
	Positive	.102
	Negative	-.160
Test Statistic		.160
Asymp. Sig. (2-tailed)		.100 <sup>c</sup>

a. Test distribution is Normal.  
 b. Calculated from data.  
 c. Lilliefors Significance Correction.

Figure 4. Results Of Normality Test

Hogeneity test using Levene's test, a significance value of 0.438 was obtained. A significance value of 0.438 falls into the category of significance > 0.05, indicating that the data is homogeneously distributed. This is shown in Figure 5.

➔ **Oneway**

**Test of Homogeneity of Variances**

		Levene Statistic	df1	df2	Sig.
Mater Farmagrat	Based on Mean	1.935	1	49	.171
	Based on Median	1.214	1	49	.275
	Based on Median and with adjusted df <sup>a</sup>	1.214	1	48.689	.275
	Based on trimmed mean	1.824	1	49	.183

**ANOVA**

Mater Farmagrat					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1647.380	1	1647.388	13.220	.001
Within Groups	5981.680	49	124.817		
Total	7628.980	49			

Figure 5. Results Of Homogeneity Test

Continuing with the descriptive statistical analysis of students' problem-solving skills on the indicators of analyzing, solving, concluding, summarizing, projecting, and testing by examining the achievements of pre-test and post-test results according to each indicator. Based on the six problem-solving indicators, each was developed into two learning objectives for magnetism, which were then developed into question grids for each objective consisting of two pre-test and post-test questions, resulting in twelve multiple-choice questions. This descriptive statistical data analysis also includes the N-Gain Score test. The descriptive statistical analysis of problem-solving skills and the N-Gain Score test are presented in Table 3 below.

No.	Indicator	Pre-test		Post-test		N-Gain (%)	Interpretation Categories
		M	SD	M	SD		
1.	Analyze	22,40	8,00	26,88	7,61	73,32	Quite Effective
2.	Solve	21,76	7,79	27,20	8,50	80,94	Effective
3.	Evaluation	20,40	9,81	27,20	8,50	85,00	Effective
4.	Summarize	21,76	9,09	26,68	7,61	76,18	Quite Effective
5.	Project	19,04	10,2	24,48	8,61	94,65	Effective
6.	Test	20,40	9,81	26,52	8,61	96,67	Effective
Mean		22,04	8,53	33,40	7,60	80,19	Effective

Figure 6. Descriptive Statistics of Problem-Solving Skills

Based on Table 3, the analysis of pre-test and post-test results was conducted using mean statistics for the problem-solving indicators of analyzing, solving, concluding, summarizing, projecting, and testing. Generally, there was an increase in the mean post-test score for each indicator compared to the mean pre-test score for each indicator. Table 3 presents the standard deviation (SD) values for the problem-solving indicators, showing a decrease in SD from pre-test to post-test. This indicates that, on average, students' learning outcomes improved after using the digital interactive experiment media on the post-test, with the sample data becoming closer to the pre-test average.

The N-Gain Score test results for the problem-solving indicators were as follows: analyzing had a percentage score of 73.32%, categorized as quite effective; solving had a score of 80.94%, categorized as effective; concluding had a score of 85.00%, categorized as effective; summarizing had a score of 76.18%, categorized as quite effective; projecting had a score of 94.65%, categorized as effective; and testing had a score of 96.67%, the highest effectiveness among the indicators, categorized as quite effective. The average effectiveness score for problem-solving skills from the N-Gain Score test was 80.19%, categorized as effective. Based on the effectiveness interpretation categories in Table 3, it can be concluded that the Digital Product interactive experiment guide effectively empowers problem-solving skills, and it is quite effective in empowering testing skills for students in 4th-grade magnetism topics.

Subsequently, a Paired Sample T-test was conducted based on paired pre-test and post test scores for each problem-solving indicator: analyzing, solving, concluding, summarizing, projecting, and testing. The hypothesis test results, including t-value, degrees of freedom (df), and probability, are presented in Table 4 as follows.

No.	Indicator	t	df	p
1.	Analyze	3,055	24	0.005
2.	Solve	3,361	24	0.003
3.	Evaluate	4,000	24	0.001
4.	Summarize	3,361	24	0.003
5.	Project	2,874	24	0.008
6.	Test	3,166	24	0.004
Effectiveness Problem-Solving Skills		5,859	24	0.000

Figure 7. Results of the Paired Sample T-test for Pre-test and Post-test Problem-Solving Skills

Analysis of the Pre-test and Post-test Results Using the Paired Sample T-test, as presented in Table 4, shows that generally the probability of the test results aligns with the hypothesis that there is a significant change between the pre-test and post-test results with a significance level ( $p < 0.000$ ). There was a significant improvement in students' problem-solving skills across all tested indicators: analyzing, solving, concluding, summarizing, projecting, and

testing. Therefore, it can be concluded that the Digital Product interactive experiment guide for enhancing problem-solving skills in magnetism for 4th-grade students also significantly improves problem-solving abilities in terms of effectiveness.

#### 4. Conclusion

Based on the discussion of the results from the research and development of the digital product, an interactive experiment guide aimed at enhancing problem-solving skills in fourth grade students on the topic of magnetism, it can be concluded that:

- Validation Results : The validation results by media experts, material experts, and fourth-grade students from SDN 03 Bence Garum yielded an average score of 89.4%, which is categorized as very valid.
- Practicality : The practicality of the product, supported by student responses regarding practicality, received an average score of 98.67%, indicating it is highly effective.
- Effectiveness : The analysis of the effectiveness of students' problem-solving skills, based on SPSS testing, shows an average effectiveness score of 0.8405, categorized as high effectiveness.

Based on these research findings, it can be concluded that the digital interactive experiment guide for enhancing problem-solving skills in magnetism for fourth-grade students is valid according to media experts, material experts, and users (teachers), practical, and effective in empowering students' problem-solving skills. Therefore, the developed product is deemed suitable for use in educational activities.

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