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The Effect of the Use of MAGICO Media (Active Magnetics for Games and Cognitive Interaction) on Changes in Understanding the Concept of Magnetism in Grade IV Elementary School Students

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Abstract: This study aims to examine the effect of using the MAGICO learning media (Active Magnet for Games and Cognitive Interaction) on improving fourth-grade elementary students' understanding of magnetism concepts. The background of this research is based on the low level of student comprehension regarding attractive and repulsive forces, magnetic poles, and magnetic fields, which is often due to passive and non-exploratory conventional teaching methods. MAGICO was developed as an innovative, game- and exploration-based learning medium designed to actively engage students in understanding abstract concepts through activities such as magnetic mazes and force-attraction experiment boards. This research employed a quasi-experimental method with a control group and an experimental group design. The study involved 40 students divided into two groups: the experimental class used MAGICO, while the control class received conventional instruction. A conceptual understanding test was administered before and after the intervention as the primary research instrument. Statistical analysis revealed no significant difference between the two groups in improving conceptual understanding of magnetism. Although the experimental group showed an increase in average scores, the difference was not statistically strong enough to confirm the effect of the intervention. Several factors may have influenced these results, including the relatively short duration of the intervention, heterogeneous classroom conditions, varying levels of student participation, and differences in prior knowledge. Additionally, students may have needed more time to adapt to the new learning media. Nevertheless, the upward trend in the experimental group's scores—where 72% of students showed a significant improvement—indicates the potential of MAGICO as an effective learning tool. In contrast, although 77% of students in the control group also showed improvement, the depth and consistency of their understanding were less evident.

Keywords: Elementary science learning; Interactive learning media; MAGICO; Magnet; Understanding concepts

Introduction

Understanding scientific concepts from an early age is essential for building students' scientific literacy. One topic that often poses challenges for elementary students is magnetism, which is abstract in nature and requires visual and experiential approaches to be effectively understood. Magnetism is not only significant in the learning context but also relevant to daily life and modern technologies such as electric motors, generators, and electronic devices.

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Preliminary observations at SDN Manggarai 03 reveal that most students struggle to grasp fundamental concepts of magnetism, such as attractive and repulsive forces, magnetic poles, and objects influenced by magnetic fields. This issue reflects a broader trend in elementary science education, where conventional teaching methods, such as lectures and textbook-based learning.

In addition, the teaching media available usually only focus on visual and informative aspects, without providing an immersive and meaningful learning experience. As a result, many students have difficulty understanding the properties of magnetism, magnetic fields, and magnetic interactions with objects around them (Hartomo et al., 2024; Sukmawati et al., 2021a, 2022).

The low understanding of science literacy skills in grade IV students in teacher-centered science learning and conventional learning methods such as lectures, and according to Sariati, students are not accustomed to doing science literacy test questions (Sianturi, 2024). Along with the development of technology and innovation in learning, game-based interactive learning media is one of the solutions to improve students' understanding of concepts (Latifah et al., 2024; Lestari et al., 2024).

To address this gap, this study introduces and applies MAGICO (Active Magnet for Games and Cognitive Interaction), an innovative learning media that blends exploratory, game-based, and interactive approaches. MAGICO includes tools such as magnetic maze games, force-attraction experiment boards, and magnetism property exploration kits, enabling students to engage directly in hands-on activities and contextual learning. MAGICO is a learning medium designed to improve the understanding of the concept of magnetism by combining exploratory and interactive approaches (A. Fitria et al., 2024; Sukmawati et al., 2021b; Sukmawati & Sari, 2024).

This The novelty of this research lies in the integration of exploratory, interactive, and collaborative elements within a single instructional medium—an approach rarely implemented in previous studies, which tend to focus on concrete or visual aids without encouraging direct student participation through guided experimentation and educational games.

This research is expected to be a significant contribution in developing science learning innovations, especially in elementary schools. By using MAGICO, learning magnetic topics can become more engaging, relevant, and effective, helping students understand concepts in depth and apply them in their daily lives (Saputri et al., 2024; Sukmawati & Rahmiati, 2024).

Method

This research employed a quantitative approach with a quasi-experimental design, Quasi-research or pseudo-experiments basically have similarities with true experimental research. In pure research, especially in the field of education, the subjects or participants involved are selected at random, so that everyone has an equal chance of being involved in the research (Muthi'ah et al., 2023; Sukmawati et al., 2024; Sukmawati et al., 2024; Wahjusaputri et al., 2024).

The participants in this study were fourth-grade students from SDN Manggarai 03 Jakarta, consisting of two classes. One class (4B) was randomly assigned as the experimental group, which received instruction using MAGICO (Active Magnet for Games and Cognitive Interaction), while the other class (4A) served as the control group, receiving conventional textbook-based instruction.

The main instrument used was a conceptual understanding test on magnetism, comprising multiple-choice questions. The test was administered to both groups as a pretest and posttest to measure changes in students' understanding. The validity and reliability of the instrument were evaluated prior to implementation.

Result and Discussion

Result

This research was conducted using MAGICO Media (Active Magnet for Games and Cognitive Interaction). This study aims to determine the change in the learning media of MAGICO to changes in the understanding of the concept of magnetism in grade IV elementary school students.

Based on the results of the independent samples t-test, the Sig. (2-tailed) value obtained was 0.400. Since this value is greater than the significance level of 0.05, it can be concluded that there is no statistically significant difference between the experimental group and the control group. This indicates that the use of the MAGICO learning media did not result in a significantly greater improvement in students' conceptual understanding of magnetism compared to the conventional learning method.

Table 1. Groups Statistic

	Control	N	Mean	Std. deviation	Std. error mean
Experiment	Class experiment	22	68.36	19.080	4.068
	Class control	18	73.33	17.463	4.116

Table 2. Independent Samples Test

		Levene's Test for equality of variances		t-test for equality of means						
									95% Confidence interval of the difference	
		f	sig.	t	df	sig. (2-tailed)	Mean Difference	Std. error mean	Lower	Upper
Experiment	Equal variances assumed	0.5	0.824	-0.851	38	0.4	-4.97	5.84	-16.791	6.852
	Equal variances not assumed			-0.859	37.481	0.396	-4.97	5.787	-16.69	6.751

Table 3. Results of Control Class Analysis with Conventional Learning

Participants	Measure Pre-Test	Measure Post-test	Measure posttest–pretest	Information
A	-0.08	1.12	1.20	Increase
B	0.30	2.83	2.53	Increase
C	0.11	1.94	1.83	Increase
D	-0.08	1.12	1.20	Increase
E	1.36	2.32	0.96	Increase
F	0.69	0.90	0.21	Increase
G	0.11	0.49	0.38	Increase
H	-1.10	-0.66	0.44	Increase
I	0.69	1.94	1.25	Increase
J	-0.66	-0.08	0.58	Increase
K	-0.46	-1.10	-0.64	Decrease
L	0.11	1.63	1.52	Increase
M	0.11	0.69	0.58	Increase
N	-0.46	-1.10	-0.64	Decrease
O	1.94	1.94	0.00	Remain
P	0.90	1.63	0.73	Increase
Q	1.63	1.63	0.00	Remain
R	1.63	2.83	1.20	Increase
S	-0.08	1.12	1.20	Increase
T	-0.66	0.49	1.15	Increase
U	-0.27	1.12	1.39	Increase
V	0.69	0.49	-0.20	Decrease

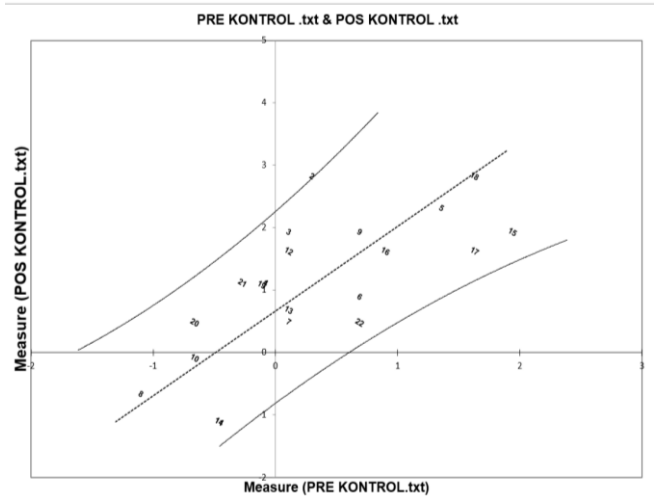

Figure 1. Results of control class analysis with conventional learning

Table 4. Results of the Analysis of the Experimental Class with Learning Using MAGICO Media

Participants	Measure Pretest	Measure Posttest	Measure posttest-pretest	Information
A	-0.28	1.97	2.25	Increase
B	1.66	3.60	1.94	Increase
C	-1.13	3.60	4.73	Increase
D	-1.13	-0.08	1.05	Increase
E	1.97	1.39	-0.58	Decrease
F	1.15	1.97	0.82	Increase
G	1.66	1.97	0.31	Increase
H	2.82	2.82	0.00	Remain
I	0.31	1.97	1.66	Increase
J	1.15	1.15	0.00	Remain
K	1.15	2.34	1.19	Increase
L	0.71	0.71	0.00	Remain
M	0.31	2.28	1.97	Increase
N	1.66	3.55	1.89	Increase
O	1.15	-0.42	-1.57	Decrease
P	-0.48	-0.08	0.40	Increase
Q	-0.90	2.82	3.72	Increase
R	0.31	-0.28	-0.59	Decrease

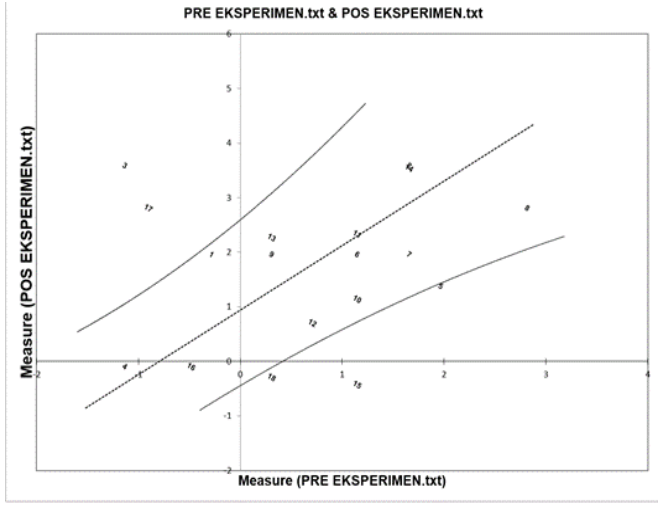

Figure 2. Results of the analysis of the experimental class with learning using MAGICO media

Discussion

Control Group

Based on the table above, it shows that students can be grouped into three main categories based on the change in scores, namely: Increase, Remain, and

Decrease. This analysis aims to look at the effectiveness of the treatment or intervention provided between the pretest and posttest on the participants, as well as evaluate the extent to which the changes occur positively or negatively (Istiqomah et al., 2023; Kusnadi et al., 2023).

Groups Increased

The majority of participants, namely 17 out of 22 people (77%), were included in the increased category. This shows that after the post-test, the students' scores are higher than the pre-test results. This increase in score shows the positive influence of the intervention or learning process undertaken by the students. Some participants showed significant improvement. For example, student number 2 experienced an increase of 2.53 points, from 0.3 to 2.83, and student number 3 increased by 1.83 points, from 0.11 to 1.94. Even students such as numbers 12 and 21 experienced an increase of more than 1.3 points. This shows that the material or approach used in the session is effective for most participants. On the other hand, some students showed smaller but still positive improvements, such as student number 6 who increased by 0.21 and student number 7 who increased by 0.38 points. This is still important to note because while it is not drastic, it still shows the direction of progress.

This condition illustrates that the majority of students are able to benefit from the learning process provided. The increase at various levels also reflects the differences in learning styles and absorption of each individual. In other words, although the rate of improvement varied, most of the learners showed a positive response to the method applied. This can be a solid basis that the current approach is good enough, but further adjustments may need to be made to achieve a more even improvement.

Fixed Group

There are 2 students number 15 and 17 or about 9% of the total students who are classified as permanent groups. This means that their post-test score is exactly the same as the pre-test result. This can be caused by several factors. First, it could be that they have reached a high level of understanding from the beginning so that there is no change in value. Student number 15, for example, obtained a score of 1.94 on both tests, showing stability at a fairly high score level. Student number 17 also showed consistency with a score of 1.63. Second, learners may not get additional benefits from the learning session, either because the methods used are not suitable for their learning style, lack of engagement, or other external factors that affect their performance (M. N. Fitria et al., 2022; Novianti et al., 2023; Ramadhani et al., 2022).

This category is important to note because it shows that not all participants experience changes. This can be used as an evaluation material for whether the intervention is enough to target the needs of all types of participants or not.

Descending Group

A total of 3 students (13.6%), namely students number 11, 14, and 22 were included in the decreased group, where their post-test results were lower than the pre-test. This is an indicator that there may be disruptions in the learning process, lack of understanding of the material, or other factors that affect their performance during the post-test. For example, students number 11 and 14 showed a decrease of -0.64, while students number 22 experienced a decrease of -0.2 points. Although the value has not dropped drastically, this trend still needs to be analyzed further.

Possible causes of this decline can come from internal factors such as motivation, fatigue, or stress experienced by participants. It can also come from external factors such as disturbances during the post-test, differences in atmosphere or environment during the test, or even factors that do not match the learning method with the needs of the participants (Fauziah et al., 2023; Nurliana et al., 2023; Sukmawati et al., 2023). This decline in performance should be of special concern because it shows that not all participants are able to absorb the material effectively and concisely.

Experiment Group

Based on the data above, the results of pre-test and post-test measurements of 18 participants, the results can be grouped into three main categories, namely increasing, steady, and decreasing. The purpose of this grouping is to assess the effectiveness of an intervention or treatment given between the time before and after the measurement, as well as to see how much change students experience both positively and negatively.

Increasing Group

Out of a total of 18 participants, there were 13 students (about 72%) who were included in the increased group, meaning that their post-test scores were higher than those of the pre-test. This is a strong indication that most participants benefit from the learning process or intervention carried out. Some students experienced a very significant increase. For example, student number 3 recorded a spike in scores of 4.73 points, from -1.13 to 3.6. Student number 17 also showed a sharp increase of 3.72 points, from -0.9 to 2.82. This large improvement suggests that the intervention is particularly effective for some individuals, especially those who start with low initial scores. This indicates a significant increase in understanding or skills after the

learning process using learning media, namely using MAGICO media.

In addition, students such as numbers 1, 2, 13, and 14 also showed a marked increase, each experiencing an increase of more than 1.8 points. Meanwhile, other students such as students numbers 6, 7, and 16 experienced a smaller but still positive increase, ranging from 0.3 to 0.8 points. Although not as high as the increase in other students, these results still show significant development.

In general, the majority of students in the group increased showing the success of the process undertaken. This is a positive signal that the materials, methods, and approaches used are quite effective in improving students' performance or understanding.

Fixed Group

Three students numbers 8, 10, and 12 or about 17% of the total population fall into the fixed category, which means that their pre-test and post-test scores have not changed. For example, student number 8 has a fixed score of 2.82, student number 10 remains at 1.15, and student number 12 remains at 0.71. This situation can have two interpretations. First, maybe the student is already at the maximum level of understanding and there is no big room for improvement. Second, it could be that the learning process does not have a significant impact on them due to a lack of engagement, the learning method does not match their learning style, or external factors such as personal conditions during the evaluation (Sukmawati et al., 2021a, 2021b; Sukmawati & Zulherman, 2023).

Although there is no decrease, this stagnant condition is still important to be evaluated so that the implementation of future activities can be more adaptive and target the needs of each student more precisely.

Descending Group

The other three students, students number 5, 15, and 18 or about 17% were included in the declining category, which means their post-test scores were lower than the pre-test. The most striking decrease occurred in student number 15, which decreased by -1.57 points, from 1.15 to -0.42. Students number 5 and 18 also showed a decrease of -0.58 and -0.59 points, respectively. This decrease in score can be caused by various factors, such as lack of understanding of the material using learning media, namely MAGICO media during the post-test, decreased motivation, or even non-academic factors such as fatigue or stress.

This is important to follow up further, as it shows that not all learners respond well to learning. A more individualized approach may be needed to understand their needs and overcome the learning barriers experienced.

Document

Figure 3. Control group

Figure 4. Experimental group

Conclusion

Based on the statistical analysis, the use of MAGICO learning media did not show a significant difference in improving students' understanding of magnetism concepts compared to conventional teaching methods. Although there was an increase in scores in the experimental group, the difference was not statistically strong enough to conclude a definitive effect of the intervention. Several factors may have influenced this result, including the relatively short intervention duration, heterogeneous classroom conditions, varying levels of student participation, and differences in students' prior knowledge. Additionally, students may require more time to adapt to new learning media such as MAGICO. Nevertheless, the upward trend in the experimental group's average scores indicates a positive

potential of using this media. This finding aligns with the study by Arifin et al. (2021), which stated that the effectiveness of innovative learning media often requires a period of adaptation and continuous reinforcement. Therefore, it is recommended that future research be conducted over a longer duration, with a larger sample size, and a more in-depth evaluation approach so that the potential of MAGICO can be measured more accurately and optimally.

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Declare the author states that there is no conflict of interest in the research until the writing of this article. The author also warrants that there are no circumstances or personal interests.

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