Augmented Reality as Learning Media: The Effect on Elementary School Students' Science Processability in Terms of Cognitive Style

Bramianto Setiawan
Universitas PGRI Adi Buana Surabaya

Reza Rachmadtullah
Universitas PGRI Adi Buana Surabaya

Dimas Ardika Miftah Farid
Universitas PGRI Adi Buana Surabaya

Eko Sugandi
Universitas PGRI Adi Buana Surabaya

Vina Iasha
SD Negeri Pondok Bambu 06 Jakarta

This research aimed to determine whether there is an effect of using Augmented Reality media on the science process ability of elementary school students in terms of cognitive style. The method used in this research was experimental. Data were processed using a two-way Anava test technique, with a data analysis design using a treatment by level 2x2 design with a cognitive style moderator variable. The research result showed significant differences in the learning outcomes of science process ability between groups of students who take lessons using augmented reality media and groups of students who take lessons with multimedia media. Then, there was also an interaction effect between Augmented reality and cognitive style on learning outcomes of science process ability and there were differences in learning outcomes of science process ability between groups of students who have an independent cognitive style field and dependent cognitive style field.

Keywords: augmented reality, cognitive style, science process ability, elementary school

INTRODUCTION

Science process skills are important for elementary school students because the results of learning science through the science process produce lasting impressions, are not easily forgotten, and can be used as a basis for solving problems encountered in everyday life. In addition, the skills acquired can be transferred to other fields of knowledge (Elfeky et al., 2020; Yildiz & Guler Yildiz, 2021). Through process skills, students are more appreciative of the things learned through practice, experimentation, searching,

and finding themselves directly, rather than receiving mature information from teachers (Maison et al., 2019; Rachmadtullah et al., 2020; Rasmitadila et al., 2019). But in reality, Indonesia itself is experiencing serious problems regarding science process skills. Based on the results of the 2018 Program for International Student Assessment (PISA) study organized by the Organization for Economic Co-operation and Development (OECD) show that science ability with a score of 396 is in position 71 this result shows that students have a low scientific ability (Sholikah & Pertiwi, 2021).

The success of the science learning process as an educational process in a school is influenced by many factors (Iasha et al., 2022; Supena et al., 2021). The factors in question are for example teachers, students, curriculum, and social environment (Dana et al., 2021). But of these factors, teachers and students are the most important factors. The importance of the teacher and student factors is traced through an understanding of the nature of learning, namely as a conscious effort by the teacher to help students so that they can learn according to the needs of their interests (Febriyanti et al., 2022; Qureshi et al., 2021). In addition, the selection of appropriate learning media is also one of the main factors for the success of a learning process (Sumilat et al., 2022; Suri & Rachmadtullah, 2021; West, 2019). Learning media that is currently being developed and used in several countries is the Augmented Reality learning media (Setiawan et al., 2022). Augmented Reality is an application that combines the real world with the virtual world in two-dimensional and three-dimensional forms that are projected in a real environment at the same time (Ibáñez & Delgado-Kloos, 2018). Augmented Reality (AR) is a technology that incorporates 2D or 3D virtual objects into a real 3D environment and then projects these virtual objects in real-time (Costa et al., 2019; Gybas et al., 2019).

Augmented Reality media can help the student learning process which is expected to achieve a level of success in student learning outcomes. The reasons for using Augmented Reality media in the student learning process include: Teaching attracts more students' attention to foster students' enthusiasm for learning, teaching materials will be more clearly understood by students, and enable students to master the learning objectives taught on that day. The methods used to teach are more varied, students do more learning activities because they not only listen to the teacher's explanation but students also do other activities such as observing videos, drawing, doing, and demonstrating (Gybas et al., 2019; Sumantri et al., 2022).

In addition to Augmented Reality learning media, one thing that also influences learning outcomes is cognitive style. Cognitive style knowledge in learning is needed to design or modify learning materials, learning objectives, and learning methods. With the interaction of cognitive style factors, objectives, materials, and learning methods, learning outcomes can be achieved as much as possible. Cognitive styles that can affect individual characteristics are cognitive style Field Independent (Safaruddin et al., 2020; Trifena Tarusu et al., 2022). There are several characteristics of individuals who have a Field-Independent cognitive style, including (1) having the analytical ability to separate objects from the surrounding environment, so that their perceptions are not affected when the environment changes; (2) the ability to organize unorganized objects and reorganize organized objects; (3) tend to be less sensitive, cold, keep a distance from other people, and individualistic; (4) choosing a profession that can be done individually with material that is more abstract or requires theory and analysis; (5) tend to define their own goals, and (6) tend to work with an emphasis on intrinsic motivation and is more influenced by intrinsic reinforcement (Setiawan et al., 2017; Surur et al., 2020).

Many studies on the use of Augmented reality media have been carried out, research conducted by Aydoğdu (2022) Augmented reality is proven to increase student learning motivation, furthermore Drljević et al. (2022) the use of Augmented reality media has a positive impact on the process of learning activities in schools because it can be used to help visualize abstract concepts for the understanding and structure of an object model. However, the use of augmented reality media on science skills in terms of Cognitive Style is still rarely studied, even though the cognitive style variable is important because cognitive style is one of the characteristics of students which is very important and influences especially on their learning achievement (B. Chen et al., 2020). Cognitive style relates to how they learn through their ways that are inherent and unique to each individual (Sutama et al., 2022). Cognitive style is very closely related to how to receive and process all information, especially in learning. Various tendencies in their learning can be

identified and then classified whether the child is included in the cognitive style field-independent or field-dependent (Giancola et al., 2022; Teghil et al., 2022).

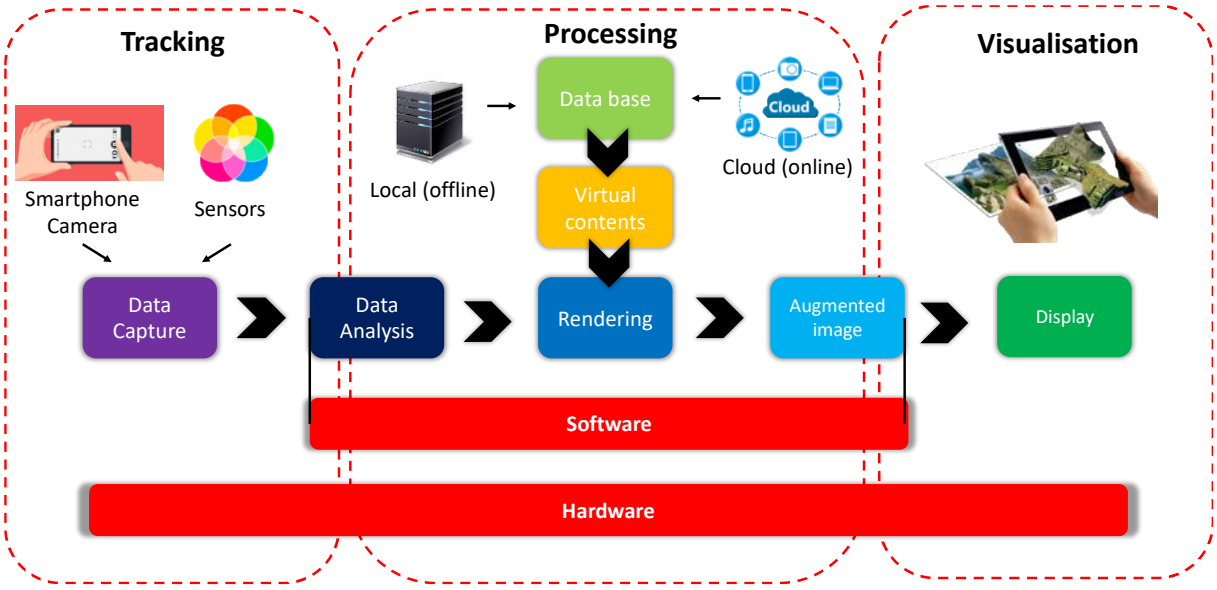
This research theoretically provides benefits as a basis for developing research related to learning and learning processes in elementary schools, while practicing this research provides benefits for teachers because it can provide broad insights and knowledge about learning media Augmented reality, and cognitive style. Making a positive contribution to improving the learning media and methods used in schools and the benefits for students is expected to improve science process skills and gain new experiences in the learning process and make it easier for students to accept learning material. The process of teaching and learning using Augmented Reality learning media can also arouse enthusiasm for learning and high interest from students, besides that it can also generate student learning motivation, and even have a psychological influence on students. The use or use of Augmented reality media can also increase students' understanding of lessons at school.

LITERATURE REVIEW

Augmented Reality

Augmented Reality is an application that combines the real world with the virtual world in two-dimensional and three-dimensional forms that are projected in a real environment at the same time (Setiawan et al., 2022). Virtual objects combined with the actual environment can be in the form of text, animation, 3D models, or videos so that users can feel virtual objects as if they were in a real environment. The Augmented Reality framework is depicted as shown in Figure 1.

FIGURE 1
AUGMENTED REALITY PROCESS FRAMEWORK (MODIFIED)



Mesárošová et al., 2017

Augmented Reality (AR) is adding virtual objects to real objects at the same time. Elfitra et.al., (2021) states that Augmented Reality was first used in 1957-1962 by a cinematographer named Norton Heilig, who was named Sensorama. Sensorama is a simulator that can simulate visuals, vibrations, and smells. In 1966, Sutherland claimed to have invented the head-mounted display, which is often shortened to HMD. HMD became the forerunner to the use of Augmented Reality which uses hardware and is installed on the user's head. An example of using HMD at the moment is Google Glass. In the 2000s, in 2009 to be exact, Sqoosha introduced FLARToolkit, which was the result of development from ARToolkit. FLARToolkit

can be used to add Augmented Reality to websites because the output produced by FLARToolkit is in the form of Flash.

Science Process Ability

Science process ability is an ability in science learning which assumes that science is formed and develops through a scientific process which must also be developed for students as a meaningful experience and can be used as a provision for further self-development (Solé-Llussà et al., 2022). Science process abilities are ability that involves all students' abilities in acquiring knowledge based on phenomena. The students' abilities in question are the skills of observing, grouping, interpreting, predicting, asking questions, hypothesizing, planning experiments, applying concepts, communicating, and carrying out experiments.

The science process ability component consists of several abilities that cannot be separated from each other, but there is a special emphasis on each of these. Elfeky et. al., (2020) stated that science processability can be divided into two groups, namely 1) the basic (simpler) process skills and 2) integrated (more complex) process skills. The basic process skills consist of 1) observing, 2) inferring, 3) measuring, 4) communicating, and 5) classifying, 6) predicting. Meanwhile, those included in integrated process skills are 1) controlling variables, 2) defining operationally, 3) formulating hypotheses, 4) interpreting data, 5) experimenting, and 6) formulating models. All of these process abilities, both basic process abilities, and integrated process abilities, are very important to have and be trained in students in the learning process.

Cognitive Style

Cognitive style is the difference in response that a person raises related to differences in the approach to the person's perceptual and intellectual characteristics that lead him to respond to the situation at hand (Koć-Januchta et al., 2020). Cognitive style can be conceptualized as attitudes, choices, or strategies that stably determine a person's typical ways of receiving, remembering, thinking, and solving problems. Its influence includes almost all human activities related to understanding, including social functions and functions between humans. Cognitive style is a very important variable that influences students' choices in academic fields, the pace of academic development, how students learn, and how teachers and students interact.

The field-dependent and field-independent cognitive styles are the learning styles of the Witkin, Oltman, Raskin, and Karp models carried out longitudinally from 1940 to 1970, and involving 1600 students (Boccia et al., 2019). This study then produced two types of learning styles that exist in individuals, namely the field independence learning style and the field independence learning style. There are various opinions regarding the characteristics or tendencies of individuals who have field-dependent and field-independent cognitive styles. Someone with a field-dependent cognitive style is a person who thinks globally, accepts existing structures or information, has a social orientation, chooses professions that are social skills, tends to follow existing goals and information, and tends to prioritize external motivation, while someone who has The independent cognitive style is someone with the characteristics of being able to analyze objects separately from their environment, being able to organize objects, having an impersonal orientation, choosing an individual profession, and prioritizing motivation from within oneself.

METHODS

Research Design

This research used an experimental method with the treatment by 2x2 design. The 2x2 design treatment was chosen because researchers not only want to see the effect of the independent variable on the dependent variable but also the interaction effects of the two variables independent of the dependent variable. By using this experiment the researcher tried to treat the use of Augmented Reality learning media with multimedia learning media. The research subjects were divided into four classes, namely the experimental class and the control class. The experimental class is taught using Augmented Reality learning media and the control class is taught with multimedia learning media, while attribute variables are classified into Cognitive styles

divided into the independent field and dependent field cognitive styles developed by Witkin (Liu & Ginther, 1999). The treatment by level 2x2 research design can be seen in table 1.

TABLE 1
TREATMENT DESIGN BY LEVEL 2X2 RESEARCH

		Learning Media	
		Augmented Reality (A_1)	Multimedia (A_2)
Cognitive Style	Field Independent (B_1)	A_1B_1	A_2B_1
	Field Dependent (B_2)	A_1B_2	A_2B_2

Information:
A_1; Augmented Reality
A_2: Multimedia
B_1: independent field
B_2: dependent field

Sample and Data Collection

This research involved participants who tend to be homogeneous to reduce the selection of attitudes. The participants in this research were fifth-grade students at Public Elementary School 1 Panggung, Cirebon. The participant to be used as the experimental class was randomized through simple random sampling. The number of participants in this research was forty students.

The research instruments include (1) Students' cognitive style test (Group Embedded Figure Test = GEFT). GEFT is a cognitive style test developed by Philip K. Oltman, Evelyn Raskin, dan Herman A. Witkin (Witkin et al., 1977). (2) Science process skills test. In this research, the science process skills that were measured included the ability to interpret, plan experiments, make observations, communicate investigation results, apply, make hypotheses, predict, and ask questions. Students' science process skills are measured using a science process skills test which consists of eight cognitive aspects. Interpretation includes the skill to look for relationships between observations and statements or to state the characteristics of an object or event that has been given meaning by others.

Analyzing of Data

Data analysis techniques in quantitative research use statistics, in which there are two kinds of statistics used for data analysis in research. The hypothesis testing carried out in this research uses a two-way analysis of variance (ANOVA) research technique. Factorial design analysis is used to evaluate the impact of a combination of two or more treatments on the dependent variable. Through the treatment by 2x2 between-subjects design, researchers can find out whether there is a main effect (main effect) of a factor on the dependent variable and whether there is an interaction effect between factors (interaction effect) more efficiently. The main effect is the main effect that comes from a single factor on the dependent variable while the interaction effect is the effect that arises when the effect of an independent variable on a different response at each level of the second independent variable, the test is carried out at a significance level $\alpha = 0.05$.

FINDINGS AND DISCUSSIONS

Findings

This research aimed to determine whether there is an effect of using Augmented Reality media on the science process skills of elementary school students in terms of cognitive style. The results of this research are explained in table 2.

TABLE 2
DESCRIPTIVE STATISTICS ON THE USE OF AUGMENTED REALITY MEDIA ON THE SCIENCE PROCESS SKILLS OF ELEMENTARY SCHOOL STUDENTS IN TERMS OF COGNITIVE STYLE

Cognitive Style	Learning Media	Mean	Std. Deviation	N
Independent Field (B_1)	Augmented Reality (A_1)	87.167	1.5275	12
	Multimedia (A_2)	80.000	5.1824	8
	Total	84.300	4.9215	20
Dependent Field (B_2)	Augmented Reality (A_1)	85.556	3.5395	9
	Multimedia (A_2)	67.727	6.7393	11
	Total	75.750	10.5824	20
Total	Augmented Reality (A_1)	86.476	2.6385	21
	Multimedia (A_2)	72.895	8.6274	19
	Total	80.025	9.2251	40

Based on table 2, the results of the descriptive analysis show that students' science skills are cognitive style; the independent field is 84.3, and the dependent field is 75.7. this means that in general, the use of Augmented reality media on the science process skills of elementary school students in terms of cognitive style has differences. Furthermore, students' science process skills with cognitive style field independent and field dependent styles are higher using Augmented Reality learning media compared to using multimedia.

TABLE 3
TEST THE HOMOGENEITY OF THE USE OF AUGMENTED REALITY MEDIA ON THE SCIENCE PROCESS SKILLS OF ELEMENTARY SCHOOL STUDENTS IN TERMS OF COGNITIVE STYLE

	Levene Statistic	df_1	df_2	Sig.
Based on Mean	4.427	3	36	.010
Based on Median	2.289	3	36	.095
Based on Median and with adjusted df	2.289	3	25.487	.102
Based on trimmed mean	4.570	3	36	.008

Based on the data that can be seen in table 3, it can be concluded that the significance value is based on the mean 0.010 > 0.05. So, it can be said that the variance of the data is the same or homogeneous.

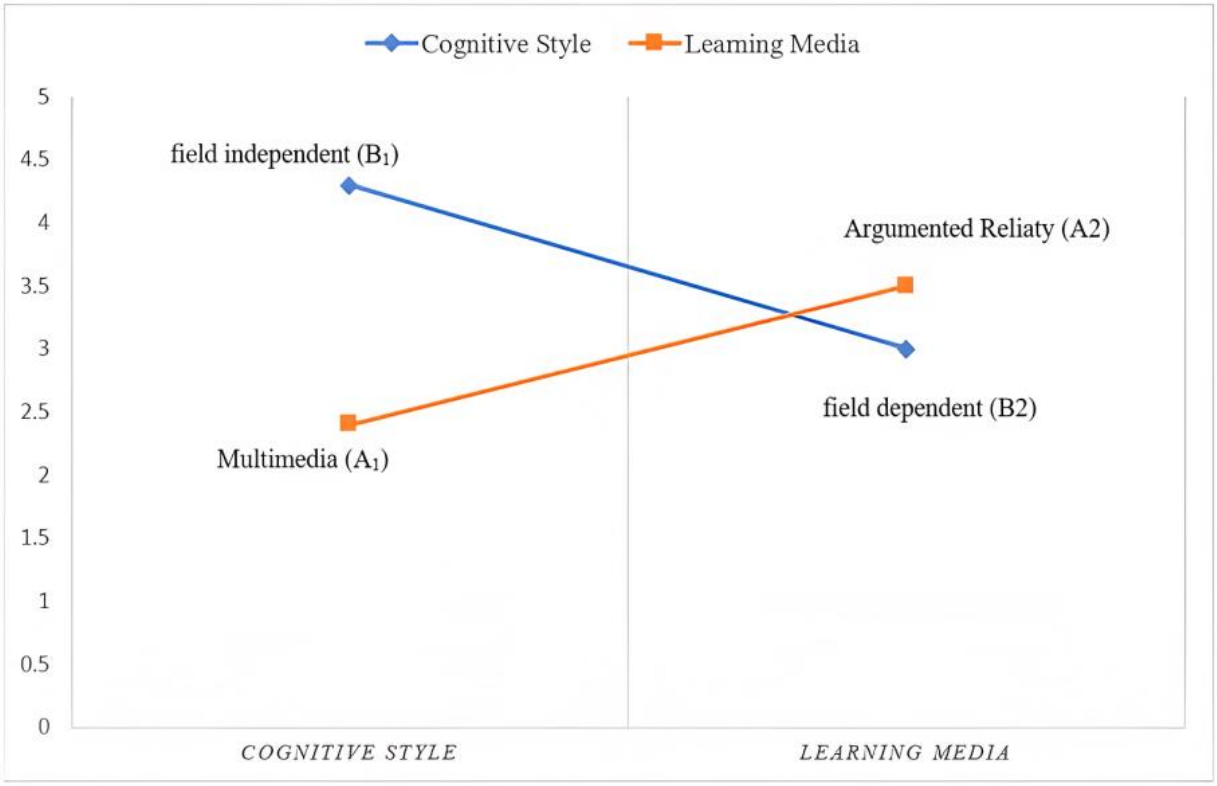
TABLE 4
HYPOTHESIS TESTING OF THE USE OF AUGMENTED REALITY MEDIA ON SCIENCE PROCESS SKILLS OF ELEMENTARY SCHOOL STUDENTS IN TERMS OF COGNITIVE STYLE

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	2550.904[a]	3	850.301	39.854	.000
Intercept	250242.462	1	250242.462	11729.036	.000
Cognitive Style	469.744	1	469.744	22.017	.000
Learning Media	1522.462	1	1522.462	71.359	.000
Cognitive Style * Learning Media	277.005	1	277.005	12.983	.001
Error	768.071	36	21.335		

Total	259479.000	40			
Corrected Total	3318.975	39			
a. R Squared = .769 (Adjusted R Squared = .749)					

Based on table 4. the first hypothesis Fo (A) = 469,744 with p-value = 0.000 < 0.05, or Ho is rejected, this means that there is an average difference in cognitive style ability between students who have cognitive style type field independent and field dependent. Then the second hypothesis Fo (B) = 1522.462 with p-value = 0.000 < 0.05. or Ho is rejected, this means that there is an average difference in the use of learning media between students who use augmented reality and students who use multimedia learning media. Next is to see the interaction of the use of Augmented Reality Media on the Science Process Skills of Elementary School Students in Terms of Cognitive Style in Figure 2.

FIGURE 2
THE INTERACTION OF USING AUGMENTED REALITY MEDIA ON THE SCIENCE PROCESS SKILLS OF ELEMENTARY SCHOOL STUDENTS IN TERMS OF COGNITIVE STYLE



Discussion

Based on the findings of this research, there was a significant difference in the learning outcomes of science process skills between groups of students who take lessons using augmented reality media and groups of students who take lessons with multimedia media. Science process skills are important to teach elementary school students because they can train students to think at a higher level and behave actively in the learning process so that they can have higher quality and quantity of learning outcomes than just memorizing. In addition, to achieve the learning objectives regarding science process skills, it is necessary to support cognitive style because of the importance of cognitive style because it can affect choices for

students in the academic field, continuation in the academic field, how students learn and how students and teachers interact in the classroom (Zulela et al., 2022).

Cognitive style can be seen as a variable in learning, its position is a variable characteristic of students, and its existence is internal. This means that cognitive style is a person's capability that develops along with the development of his intelligence. For students, this cognitive style is given and can affect their learning outcomes. It is hoped that there will be an interaction of cognitive style factors (M.-R. A. Chen & Hwang, 2022; Lu & Lin, 2018), objectives, materials, and learning methods, and student learning outcomes can be achieved as much as possible. the differences between cognitive style and the learning outcomes of Field Independent (FI) students and Field Dependent (FD) students include that Field Independent (FI) students in proving something tend to use reasoning skills more and prefer to learn on their own, while Field Dependent (FD) students in proving something tend to use less reasoning skills and prefer to learn in groups (Arifin et al., 2020; Jelatu et al., 2019). Independent cognitive style fields tend to be more analytic and involve themselves in the fields of science, mathematics, and architecture, while cognitive style field dependents mostly involve themselves in the fields of social, human, and global interactions that are widespread (Reed & Burton, 2020; Sa'dijah et al., 2020)

In addition to cognitive style in improving students' science skills, it is also influenced by variables in the use of learning media. Reality itself has entertainment aspects that can increase students' interest in learning and play as well as projecting it in real terms and involving the interaction of all the five senses of students with this Augmented Reality technology (Hadi et al., 2022; Kasoyan, 2019). This is because Augmented reality has almost the same characteristics and functions as learning media, namely it functions to convey information between recipients and senders or educators and students, can clarify the delivery of information provided by educators and students in the learning process, and can provide motivational stimulation and interest. in the learning (Gao et al., 2023; Iasha et al., 2020).

The use of augmented reality media and cognitive style has significant results on the science process skills of elementary school students because augmented reality media can channel messages from sender to receiver so that it stimulates thoughts, feelings, concerns and interests and willingness of students in such a way that the learning process occurs to achieve learning objectives effectively (Byvaltsev & Iskritskiy, 2021; Yusuf et al., 2023). The utilization of simple and easy media to implement, for example, utilizing real media found in the surrounding environment, is expected to create interesting and fun learning situations to overcome problems experienced by students to increase student learning motivation (Garzón et al., 2020). Augmented reality technology can combine the virtual and real worlds in real time if supported by technological devices such as computers, tablets, or smartphones. Supported by adequate devices such as smartphones and augmented reality technology, print-based learning media can display objects in two dimensions on paper and in three dimensions, video and sound (Chang et al., 2022). The application of AR technological innovations in learning will create an effective learning atmosphere and provide an overview of the real-world environment in computer-based learning systems (Prit Kaur et al., 2022). AR is applied in the world of education because of the advantages it has by combining real-world situations and virtual objects that can be used to overcome problems in understanding the lessons conveyed (Garzón et al., 2022; Lin et al., 2022).

CONCLUSION

Based on the results, it can be concluded that there is a significant difference in the learning outcomes of science process skills between groups of students who take lessons using augmented reality media and groups of students who take lessons with multimedia media. There is an interaction effect between Augmented reality and cognitive style on learning outcomes of science process skills and there are differences in learning outcomes of science process skills between groups of students who have an independent cognitive style field and groups of students who have a cognitive style field dependent. This research provides a novelty that in improving science process skills, especially for elementary school students, it is necessary to pay attention to the cognitive style possessed by students and the use of

Augmented Reality learning media has proven effective because this technology can combine virtual objects with real objects, making it easier for teachers to convey learning material.

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