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Effects of the Application of Mathematics Learning Media and Cognitive Style on Mathematics Learning Outcomes by Controling the Intial Abilities of Students

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Abstract

This study was aimed to evaluate the effects of mathematics learning media and cognitive styles on mathematics learning outcomes by controlling initial abilities of students. The study was conducted at Public Junior High School 1 and 6 Tondano, Minahasa Regency. The method used was the experimental method with a 2 x 2 factorial design. The sample was grade VII students of Public Junior High School 1 and 6 Tondano where 60 students as samples were obtained based on cluster random sampling. The data were analyzed by analysis of covariance (ANKOVA). The results of the study after controlling the initial abilities of students are as follows: 1) Mathematics learning outcomes of groups of students who employ computer media are higher than those who use teaching aids, 2) Mathematics learning outcomes of groups of students who have independent cognitive field styles are higher than those who have field dependent cognitive style, 3) there is an interaction effect between learning media and cognitive style on learning outcomes, 4) in groups of students who have independent field cognitive styles, the results of mathematics learning groups of students who use computer media are higher than those who use teaching aids media, and 5) in groups of students who use computer media, Mathematics learning outcomes of groups of students who have independent field cognitive styles are higher than those who have field dependent cognitive styles. Therefore, it is expected that mathematics teachers should pay more attention to students cognitive styles and use computer media in learning process.

Keywords
mathematics learning media; cognitive style; mathematics learning outcomes; initial abilities

I. Introduction

Mathematics at junior high school is often cisidered to be difficult to understand, boring, has a low learning outcome value by the public. It is also a subject which is less liked by most students due to non reasonable reasons (math anxiety). When talking about the learning outcomes, it can not be separated from the learning process that occurs outside and inside the student. The learning process which is not in accordance with the characteristics of students and the characteristics of the subject matter will result in learning outcomes. It refers to the results of learning mathematics that has not had a significant impact.

In the connection to the process and learning outcomes (Mulyasa, 2002: 187) the attitudes and characteristics of successful teachers who teach effectively can be classified as follows: 1) have respect and self-understanding, and can control themselves (stable emotions), 2) be passionate and enthusiastic about materials, class, and teaching process, 3) speak clearly and communicatively, 4) pay attention to students individual differences, 5) have a lot of knowledge, initiative, creative, and a lot of sense, 6) avoid sarcasm and ridicule towards students, do not show themselves, and 7) be an example for their students.

When talking about the relation between the learning process and the strategies for material delivery, the appropriate delivery of material strategies will produce a fun learning process and this will reduce the math anxiety of students in mathematics. Therefore, several things should be considered according to the instructional theory as explained by the Ministry of Education and Culture (1991: 39) where learning is a collection of principles that are integrated and provide a description to regulate the learning situation or environment in such a way that can help students to easily achieve learning goals. For these reasons, the media has the function of mediating the way in achieving teaching objectives (Djamarah and Zain, 2006: 122). Based on Mukhtar and Iskandar (2010: 208), Heinick, Molenda and Russel states that there were several steps in learning, one of which was media selection.

In connection to the application of media in learning mathematics, there are computer media and media for teaching aids. Roblyer as quoted by Jacobsen (2009: 277) explains that the technology (in general) and computers (in particular) are also considered as an important part of teaching to help students critical thinking skills. Suherman and colleagues (2003: 293) say that computers have great potential to improve the quality of learning, particularly in learning mathematics. The computer, itself, has electronic equipment consisting of hardware and software. In this case, software referred to Microsoft PowerPoint. It is a Windows application program and a teaching management program that combines text, numbers, and images that have been collected and installed on the slides with professional approaches that meet the needs of students during the learning process.

The mathematics objects are abstract mind objects which can not be observed by the senses. To overcome its abstractness, learning mathematics requires experiences through concrete objects. Media tools, that are cheap and easy to do, can be used as a bridge for students to think abstractly. According to, Suherman and colleagues (2003: 243) by using teaching aids: a) The learning process is motivated for both students and teachers. Their interest, especially students, will arise. They will be happy, interested, since they will be positive towards the teaching of mathematics, b) Mathematical abstract concepts are presented in concrete form and are therefore more understandable, and can be instilled at lower levels, c) The relationship between abstract mathematics concepts with objects in the natural environment will be more understandable, and d) The abstract concepts presented in a concrete form (mathematics models) can be used as research objects or as a tool for researching new ideas and improving new relationships.

This study evaluate the cognitive styles of students since each student is different from one another. In addition to being different in their level of problem solving skills, level of intelligence, or ability to think, students can also differ in how they receive, store and apply knowledge. Witkin as quoted by Vasquez (1994: 195) state that cognitive style is individual differences in feeling, thinking, solving problems, learning, and so on. Moreover, Goldstin and Blackman (1978: 2) explain that cognitive style refers to individual characteristics in organizing their environment conceptually. Therefore, the cognitive style shows that there is variation between students in their approach to a task but

that variation does not indicate a certain level of intelligence or certain pattern of ability. Students who have the same cognitive style may not necessarily have the same abilities.

In connection to the cognitive style of students, Jun Hu (2012) states that, most of the cognitive styles that have been investigated are on a continuum, where most students are between the two poles. Hsiao as quoted by Jun Hu (2012) states that cognitive style involves variables with one dichotomy, such as global-holistic with focused-detail, field independent with field dependent, or left brain with right brain. In this study, used independent field and field dependent are used. Antonietti and Gioletta cited by Yuliang and Ginther (2012) say that students who have independent field cognitive styles tend to be more capable than the field dependent students. The student with the field dependent cognitive style prefers an observation approach. Brown (1983: 348-349) states that, beside the differences in human abilities, there are also broad differences of abilities in the problem solving.

Based on the previous explanation, it turns out that cognitive style can be distinguished in independent and field dependent fields. While the students who have a field dependent cognitive style think more globally and can be influenced by their surroundings, and tend to view problems as confusing, the students who have independent field cognitive styles tend to to pay more attention to parts and components in one pattern and more oriented to the task completion. The students who are cognitive field independent are easier to analyze information and abstract concepts but tend to work alone without expecting rewards from outside. On the other hand, the students who have a field dependent cognitive style perceive patterns as a whole and are more oriented towards fellow students and relationships social, tends to accept information as it is and are less sensitive to abstract concepts, but can work well together.

It should be considered that the initial mathematics ability of students play a role in a learning process because the students initial mathematicas abilities or the initial foundation of knowledge that has formed in students is crucial in the formation of new concepts. Every students in a learning process already have an initial ability in their memory. When finished following the learning process at the previous education level, the students already have initial concepts or skills.

According to Astuti et al (2019) Education is an obligation of every human being that must be pursued to hold responsibilities and try to produce progress in knowledge and experience for the lives of every individual. Education is one of the efforts to improve the ability of human intelligence, thus he is able to improve the quality of his life (Saleh and Mujahiddin, 2020). Education is expected to be able to answer all the challenges of the times and be able to foster national generations, so that people become reliable and of high quality, with strong characteristics, clear identities and able to deal with current and future problems (Azhar, 2018). Education and skills are the main keys in gaining social status in community life (Lubis et al, 2019).

Gafur (1989: 57) demostrate that the initial ability is relevant knowledge and skills that have been possessed before starting the teaching program. According to Degeng (1989: 20), the initial ability affects the implementation and overall learning outcomes. Reigeluth cited by Uno (2008: 160) indicates 7 types of initial abilities that can be used to facilitate the acquisition, organization and re-expression of new knowledge as follows: 1) not organized knowledge, as a place to link the rote knowledge to facilitate retention, 2) analogical knowledge, which links new knowledge with other knowledge that is very similar; which is outside the content being discussed, 3) higher level knowledge, which can be functioned as a framework for new knowledge, 4) level knowledge, which can fulfill its function as associative and / or comparative knowledge, 5) lower level knowledge, which

serves to concretize new knowledge or also provide examples, 6) experiential knowledge, which has the same function as lower level knowledge and aimed to concretize and provide examples for new knowledge, and 7) cognitive strategies, which provide ways to process knowledge new, starting from encoding, storage, until the re-disclosure of knowledge that has been stored in memory. It can be, thus, concluded that the initial ability of mathematics in the learning process includes: 1) knowledge and skills as a prerequisite for certain mathematical material, and 2) mathematics knowledge and skills that have been possessed by students so that the initial ability of mathematics really affects the process and learning outcomes of mathematics. Based on the preliminary description, the purpose of this study is to determine the effect of the application of media and cognitive styles on mathematics learning outcomes by controlling the initial mathematical abilities of students.

II. Research Method

The method used in this study is an experimental method with a 2 x 2 factorial design with the following design as follows:

Table 1. Research Design with 2 x 2 Factorial Experiment

Treatment / Cognitive Style (B)	Learning Media (A)	
	Computer (A_1)	Teaching aids (A_2)
Independent Field (B_1)	$(X,Y)_{11}k$ A_1B_1 / Sel_1	$(X,Y)_{21}k$ A_2B_1 / Sel_2
Dependent Field (B_2)	$(X,Y)_{12}k$ A_1B_2 / Sel_3	$(X,Y)_{22}k$ A_2B_2/ Sel_4

Where:

A1: Groups of students with computer media A2 : Groups of students with teaching aid media

B1: Groups of students with cognitive style of independent field B2 : Groups of students with cognitive style of dependent field

A1B1: Groups of students who receive learning using computer media with a tendency to cognitive style of independent field by controlling the initial abilities of students.

A1B2: Groups of students who receive learning using computer media with a tendency to cognitive style of dependent field by controlling the initial abilities of students.

A2B1: Groups of students who receive learning using teaching aid media with a tendency to cognitive style of independent field by controlling the initial abilities of students.

A2B2: Groups of students who receive learning using teaching aid media with a tendency to cognitive style of dependent field by controlling the initial abilities of students.

X: Covariate is the initial ability of students

Y: Student Learning Outcomes in mathematics.

k: the number of samples in each group.

The population in this study were all grade VII students of Public Junior High School 1 and 6 Tondano. While the sample of 60 students was obtained based on cluster random sampling. All data have fulfilled the test analysis requirements such as, normal, homogeneous, four line alignment.

III. Results and Discussion

3.1 Results

The learning outcome is displayed in Table. 2.

Table 2. Summary of Data Description of Mathematics Learning Outcomes

			Media		Amount
			Computer (A_1)	Teaching Aid (A_2)	
Cognitive Style	Independent Field (B_1)	*N*	15	15	30
		Mean	23	17,17	20,09
		Min	15	9	9
		Max	30	28	30
	Dependent Field (B_2)	*N*	15	15	60
		Mean	16,70	17,40	17,05
		Min	8	10	8
		Max	29	27	29
Amount		*n*	30	30	
		Mean	19,85	17,29	
		Min	8	9	
		Max	30	28	

Where:

A1: Groups of students with computer media
A2: Groups of students with teaching aid media
B1: Groups of students with cognitive style of independent field
B2: Groups of students with cognitive style of dependent field
Y: score of mathematics learning outcomes
n : number of sample
Min : minimum score
Max: maximum score

Hypothesis Testing

a. Main Effect Hypothesis Testing

Main effect hypotheses which will be tested are as follows:

1. The mathematics learning outcomes in students who are taught using computer media is higher than that using teaching aids, after controlling the initial mathematical abilities of students.
   The statistical hypothesis: Ho: $\mu A1 \leq \mu A2$ and H1: $\mu A1 > \mu A2$.
   Since the value of Fcount= 8,84 > Ftab(0,05)= 4,02, it indictaes that Ho is rejected and accepts H1. It is concluded that the mathematics learning outcomes of groups of students taught by computer media ($\mu A1$ = 19.68) are higher than those by teaching aids ($\mu A2$= 17,19) after controlling the initial mathematical abilities of students.
2. The learning outcomes of mathematics of student groups with independent field cognitive styles are higher than those with dependent field cognitive styles, after controlling the initial mathematical abilities of students.
   The statistical hypothesis: Ho: $\mu B1 \leq \mu B2$ and H1: $\mu B1 > \mu B2$.
   Since the value of Fcount = 7,86 > Ftab = 4,016, the Ho is rejected and accepts H1. Therefore, it can be concluded that mathematics learning outcomes of groups of students with independent field cognitive styles ($\mu B1$ = 19.61) are higher than those

with field dependent cognitive styles (μB2 = 17.26) after controlling the student initial mathematical abilities.

b. Interaction Effect Hypothesis Testing

There is an influence of interaction between the media and cognitive style on the mathematics learning outcomes after controlling the initial mathematical abilities of students.

The statistical hypothesis: Ho: interaction of A x B = 0 and H1: interaction of A x B ≠ 0. The results show that Fcount = 4,37 > Ftab(0,05) = 3,96 which means that Ho is rejected and accepts H1. It is, hence, concluded that there is an influence of interaction between media and cognitive style on mathematics learning outcomes, after controlling the initial mathematical abilities of students.

c. Simple Effect Hypothesis Testing

1. The mathematics learning outcomes of students taught using computer media with independent cognitive field styles are higher than those using teaching aids, after controlling the student initial mathematical abilities.
   The statistical hypothesis: Ho: μA1B1 ≤ μA2B1 and H1: μA1B1 > μA2B1
   The analysis results demonstrate that tcount = 3,568 > ttab(0,05) = 2,04 which indicates that H0 is rejected and accepts H1. Therefore, it is concluded that the learning outcomes of mathematics in groups of students taught with computer media with independent field cognitive style (μA1B1 = 21,753) is higher than the results of learning mathematics in groups of students taught with teaching aids media (μA2B1 = 17,463) after controlling the initial mathematical abilities of students.
2. The mathematics learning outcomes fn the student groups taught using computer media with the cognitive style of dependent field is lower than those using teaching aids, after controlling the student initial mathematical abilities.
   The statistical hypothesis: Ho: μA1B2 ≥ μA2B2 and H1: μA1B2 < μA2B2
   The analysis shows that tcount = 0,567 < ttab(0,05) = 2,04 which means H0 is accepted. It can be, thus, concluded that the mathematics learning outcomes in class taught using computer media with dependent field cognitive style (μA1B2 = 21.75) are higher those using teaching aids (μA2B2 = 16.92) after controlling the student initial mathematical abilities.
3. The mathematics learning outcomes in groups of students who use computer media with independent field cognitive style is higher than that with dependent field cognitive styles, after controlling the initial mathematical abilities of students.
   The Statistical Hypothesis: Ho: μA1B1 ≤ μA1B2 dan H1: μA1B1 > μA1B2
   The results show that tcount = 3,515 > ttab (0,05) = 2,04 which means that H0 is rejected and accepts H1. Therefore, it can be concluded that in the group of students taught with computer media with independent field cognitive style, the mathematics learning outcomes (μA1B1 = 21,753) are higher than mathematics learning outcomes in groups of students with dependent field cognitive styles (μA1B2 = 17.6) after controlling the students initial abilities.
4. The mathematics learning outcomes of groups of students who employ teaching aids with independent field cognitive style are lower than those with dependent field cognitive styles after controlling the students initial mathematical abilities.
   The Statistical Hypothesis: Ho: μA2B1 ≥ μA2B2 and H1: μA2B1 < μA2B2
   The analysis demonstrates that tcount = 0,461 < ttab (0,05) = 2,04 which indicates that H0 is accepted and reject H1. It can be concluded that in the group of students taught

with teaching aids with the independent field style (μA2B1 = 17, 46) are higher than mathematics learning outcomes of groups of students who use the dependent field style (μA2B2 = 16.92), after controlling the student initial mathematical abilities.

3.2 Discussion

The study explains that, the computer media is better than the teaching aids in the mathematics learning process where the material is difficult for students to understand due to its abstractness. Simarmata (2006: 65) explains that the computer is an electronic device consisting of hardware and software that has the ability to help human tasks by receiving and processing data entered into the information based on programs that are owned. The results are then displayed, saved, or sent through the output device. According to Isroi (2004: 3), Microsoft PowerPoint is a very popular Windows application program for preparing presentations.

Powerpoint is a presentation management program which combines text, numbers, and images that have been collected and put them on a slide with a professional touch that meets the demands of students during the learning process. According to Jacobsen (2009: 278), computer is not only able to improve teaching (in general), but also to accommodate teaching to meet the diverse needs of different students. Therefore, computer media can be a combination of various media text, graphics, animation, images, visuals, so that it can provide the inter-activity. As a combined medium, this media has the ability to develop better imagination, creativity, fantasy and emotional learning. Some of the studies show that the teaching media that involves more than one senses, and the combination of several media which is equipped with color animation and images are more memorable and has extraordinary appeal compared to media without animated colors and images.

The mathematics learning outcomes among students who have independent field cognitive styles with dependent fields, after controlling the students initial abilities indicate that the independent field cognitive style is better than the dependent field cognitive style. From a theoretical point of view, Sallis (2006: 86) says that all students are different from each other, and they learn using models that fit their needs. Witkin as quoted by Vasquez (1994: 165) states that the cognitive style is the individual differences in feeling, thinking, solving problems, learning, and so on, whereas according to Mclnerney and Mclnerney (1998: 244) cognitive style is individual differences in thinking, learning, solving problems, and dealing with other people. Nasution (2010: 94) takes three learning styles which are related to the teaching and learning process, and one of them is " dependent field " - " independent field ". One of the cognitive styles that will be examined in this study is theindependent and dependent field dichotomy. Based on the description above, it is clear that individuals who have independent field cognitive style tend to be more independent in developing cognitive restructuring skills but less independent in developing interpersonal skills. According to Antonietti and Gioletta as quoted by Yuliang and Ginther (2012), the students with a field dependent cognitive style are not able to analyze the characteristics and dimensions of information, and then arrange them conceptually. Therefore, the students who have independent field cognitive styles tend to be more capable than individual dependent fields.

The results also demonstrated that there is an influence of interaction between the media and cognitive styles on mathematics learning outcomes, after controlling the initial abilities of students. These results prove that between media and cognitive style has an interaction effect on mathematics learning outcomes. It indicates that it is necessary to consider the cognitive style of students when choosing the media to apply in mathematics learning.

For the groups of students who have independent field cognitive styles, it turns out that the mathematics learning outcomes for groups of students taught using computer media are higher than those using teaching aids. In addition, the students with the independent field cognitive style, who have a tendency of analysis in recording subject matter, tends to choose the very important parts of subject material to be recorded. On the other hand, the students with the dependent field cognitive style tend to record all subject material without considering the importance of the material. In other words, students who have the independent field cognitive style will be more focus on making the most important structure and subject matter, while the students who have a field dependent cognitive style will give more attention on things that are more detailed. The students in independent field groups have good ability in problem solving, like the individual activities, have the value of intellectual understanding, and are more confident in their ideas and principles. In the world of education, computers have great potential to improve the quality of learning, particularly in learning mathematics. Many abstract or imaginative things that are difficult for students to think about can be presented through computer simulations. It, of course, will simplify the mindset of student groups with independent field in understanding mathematics, thus all student abilities can be pursued or conditioned so that students can build their knowledge through the problems given to them.

For groups of students with the dependent field cognitive styles, the mathematics learning outcomes of students taught with computer media arere higher than those with teaching aids. The computer media can be a combination of a variety of media text, graphics, animation, images, visuals, so that it can provide interactivity. As a combined medium, this media has the ability for a pleasant learning process since the animation of images and colors alternates, hence the students are more motivated. The groups of students are more concerned with motivation and external reinforcement so that students can develop better imagination, creativity, fantasy and emotion towards learning process. Although the learning is conducted using teaching aids, the students can simultaneously use several senses on the material being explained and even have the opportunity to hold and feel. It can even be dismantled. However, the teaching aids media are not supported by animated images and colors that can change quickly as in computer software. Microsoft PowerPoint is one of the softwares in Windows application program. This device becomes an interesting communication media, images andanimations that can be processed according to the purpose and creativity of their user which are not available in the media of teaching aids. Therefore, the computer media can attract the student attention, encourage students to involve into the lessons, remind about content that has been studied before, and thus be extrinsically motivated. This is in accordance with the characteristics of groups of students with field dependent cognitive styles so that they can be more successful with computer media than on media teaching aids.

For the group of students taught with computer media, learning outcomes in mathematics in groups of students with independent cognitive field styles are higher than those with the dependent field cognitive styles, after controlling the initial abilities of students. The combination of computer media with independent field cognitive style turns out to have a very influential impact on student learning outcomes in mathematics. This is because computer media is not only able to improve teaching in general, but also to accommodate teaching to meet the diverse needs of different students. In the world of education, computer gives great potential to improve the quality of learning, particuarly in learning mathematics. Through computer based learning activities, the teacher solely play role as a facilitator, the students, thus, have more time to create and analyze concepts in more depth. This is in accordance with the characteristics of groups of independent field

cognitive style students. The students who have an independent field cognitive style are called analytical perceptual and are categorized as people who have character and always behave referring to themselves with the impersonal orientation. This character is also seen in the behavior of students studying mathematics at the elementary education level. A student who has an independent field cognitive style tends to actively participate and use a participant approach in the learning process, indicating that a good interaction occurs in solving mathematics problems given by the teacher in learning process.

In the case of groups of students taught with teaching aids, the mathematics learning outcomes in groups of independent field cognitive style are higher than the learning outcomes in groups of students with cognitive style of dependent fields. This can be understood because the learning process with teaching aids, where the teaching aids are cheap, can be found in the learning environment and easy to do. However, since the media is often a collection of inanimate objects that are familiar to students so that the attractiveness of the media is reduced resulting in reduced joy of learning mathematics. In fact, Witkin (1977: 8-14) states that groups of students with dependent field style will be much focused on animation *via* computer, tend to work with the importance of extrinsic motivation and more influenced by extrinsic reinforcement. Animation *via* computer makes objects seem to move / come from one place. On the other hand, the teaching aids are not like computer media, so the dependent field students being less motivated. The students who are independent fields tend to work with the importance of intrinsic motivation and are more influenced by intrinsic reinforcement. Material tends not to be accepted as it is but is analyzed after it is rearranged in its own language.

The core material is separated from the whole material and rearranged using own sentences so that it is more quickly understood and applied in other contexts. Antonietti and Gioletta cited by Yuliang and Ginther (2012) states that students who have an independent field cognitive style tend to be more capable than dependent field individuals. If implemented in the process of learning mathematics, the independent practice will tend to be more capable of being done by independent field students. The independent practice will also help students to solve identical problems. It can be said that independent field students who like to analyze in the process of learning mathematics using computer media or teaching aids are certainly more successful.

IV. Conclusion

Based on the results and discussion, it can be concluded that: 1) The mathematics learning outcomes of groups of students taught using computer media are higher than those using the teaching aids after controlling the student initial abilities, 2) The mathematical learning outcomes the group of students with the independent field cognitive style are higher than those with the dependent field cognitive style after controlling the initial abilities of students, 3) There is an influence of interaction between media and cognitive style on mathematics learning outcomes after controlling the student initial abilities, 4) The mathematical learning outcomes of students taught using computer media with independent cognitive field style are higher than those using the teaching aids, after controlling the student initial abilities, and 5) The mathematical learning outcomes of groups of students using computer media with independent field cognitive style is higher than those with field dependent cognitive styles, after controlling the initial abilities of students.

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