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The application of multiple representations in vector addition

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Abstract
The purpose of this research is to investigate the different of learning outcomes through MOMBI between paired groups of student and peers tutor groups of student. This research was conducted in the department of physics education at 2nd semester students of Manado State University. The type of research used is experimental research. The instrument used was a pretest question of 3 items and postest questions of 4 items. From the results of the study obtained an average value of pretest is 31.76 while the average value of the postest is 70.48. In testing the hypothesis with a value of $\alpha = 0.05$, obtained $t_{count} = 6.18$ and $t_{table} = 2.0639$ so because $t_{count} > t_{table}$ can be concluded that are differences in learning outcome trough MOMBI treatment based on paired groups of student and peers tutor groups of student on the application of multiple representations in vector addition.

Keywords: Multiple representations, MOMBI, paired groups, peer tutoring groups, vector addition

1. Introduction

A vector is a quantity that has magnitude and direction. Graphically, a vector is shown as a piece of line that has a direction. The size or size of the vector is determined by the length or shortness of the line. The direction of the vector is indicated by an arrow.

In physics learning, quite a lot involves vector operations in its completion. Momentum, force, and other physical quantities are examples of vector quantities that require us to understand the concept of vectors in their application. Therefore it is very important for students to understand vector concepts in solving physical problems related to the vector itself.

The initial study conducted in semester 4 of physics education in physics education study program about vector addition found that many students experienced difficulties about the basics of vectors.

According to in the journal Students' difficulties regarding vector representations in free-body systems. According to Poluakan (2019), in physics often involves models of physical phenomena in real life using external representations which include concrete to abstract forms; pictures, diagrams, words, graphs and equations [1].

Research that has been conducted shows that students use different methods to add vectors. And some of these students can have a variety of methods to choose from. But once students in the introductory physics class have difficulty learning vectors even though they have taken basic physics, mathematical physics, and mechanics courses. Understanding of vectors is very important for students who study science and engineering not only for their basic concepts but also for understanding the topic of vectors in greater depth in accordance with the existing curriculum.

According to the educational theory of Lev Vygotsky: a multi dimensional analysis in Vygotsky's learning theory, "mistakes" are important in learning " conceptualization" mistakes always occur. Mistakes are very important and help in learning process in the future. Based on Vygotsky's perspective, " A concept arises in learning in the form of complex interactions aimed at solving problems.

For Vygotsky, learning is needed and is an aspect of the development process especially for humans, and psychological functions. In other words, learning make us real human beings. Vygotsky states that the two main meanings of learning occur through social and language interactions.

According to Fani and Ghaemi (2011), in the implications of Vygotsky's Zone of Proximal Development (ZPD) in teacher education: ZPTD and self-scaffolding one of the main aspect in Vygotsky's theory is the idea that the potential for cognitive development depends on the " Zone og Proximal Development" (ZPTD and self scaffolding). Theories about ZPD describe how cognitive abilities grow in a child [2].

Scaffolding is a step the teacher or lecturer tells the learner to externalize or realize a model that is already understood and they provide feedback. According to Pardjono (2002) in Active learning: the Dewey, Piaget, Vygotsky, and constructivist theory perspectives Vygotsy is also concerned about the mental and physical activities of student learning, he views students as an active organizer of their experiences and emphasizes the social and cultural dimensions of learning [3].

MOMBI. According to Isman (2011), instruction is a systematic process in each component (teacher, student, material and learning environment) that is crucial in realizing the success of learning process [4]. This activity will help students gain knowledge and store it from short-term memory to long- term memory. To make it happen students must learn to practice, symbolize, process, and provide feedback on new knowledge when they need it. According to Hanke (2008), the function of the MOMBI teaching intervention that is "scaffolding" is to make the student model meet the features an descriptions of the scientific development mode l[5]. Because the contruction of the mental model will stop when the model makes new information that make sense and/ or is useful for the

constructor of the model, it is very important for teacher to ensure that students models not only make sense and are useful to them but are also scientifically correct in line with the concept model.

Tabel 1: Subprocesses of learning an teacing interventions of the MOMBI [5]

Subprocess of learning	Teaching intervention
Subprocess 1 provocation of mental disequilibrium	"provocasition"
Subprocess 2 activation of prior knowledge	"activation"
Subprocess 3 Search for further information	"presentation"
Subprocess 4 Integration into a mental model	"scaffolding"
Subprocess 5 schematization	"practice"

To begin the learning process, lecturers must provoke students by asking a question, presenting new ones, or giving them assignment to complete ("Provocation"). Because mental model can only explain new information on the basis of the existence of knowledge the instructor then instruct students to remember their prior knowledge ("Activation").

In most student's prior knowledge, it is not enough to construct mental models that only maka sense and usefull to students themselves but must also be scientifically correct. For this reason, lecturer must look for further information ("Presentation")

Then, lecturers must ensure their student construct science in the correct model ("Scaffolfing"). This included giving support to them individually by giving instructions and giving questions as well as answers. In developing mental model schemes, student must be given the opportunity to practice ("practice")

According to Ainsworth (2006), in generalyzation the presentation of multiple representations has three main functions in learning [6]. The first function is the use of representations that supplying information or help to complete cognitive processes. Second, the use of multiple representation can limit the possibility of misinterpretation from previous representations. Third, multiple representation can be used to encourage students to build an understanding of the situation in depth.

According to Helsy (2017), multiple representation are form of representation that combine text or graphics. Learning by using multimedia has a positive impact on learning outcomes [7]. Kurnaz and Arslan (2014), suggest that in learning, it can be stated that equipping students with more diverse representations by increasing the variation of external representations that have an impact on cognitive abilities that can produce effective result [8].

According to Meltzer (2017), some experts in Multiple Representations in Physics Education: Recent Development and Question for Future Work [9]. Argue about why multiple representations can be very useful in science:

According to Paivio, it can improve memory by utilizing parallel processing system.

Can help connect and organize separated thoughts, making student easier to remember.

According to McDermmot multiple representations are needed to fully understand certain concepts.

2. Research Method

This type of research is an experimental study that aims to compare students learning outcomes that have been apllyed to the multiple representation approach with the one-group-pretest-postest design. In this study, researcher aimed to see differences in learning outcomes between groups of pairs and peers tutor. The research instrument used in the form of pretest questions was 3 items an postest questions were 4 items.

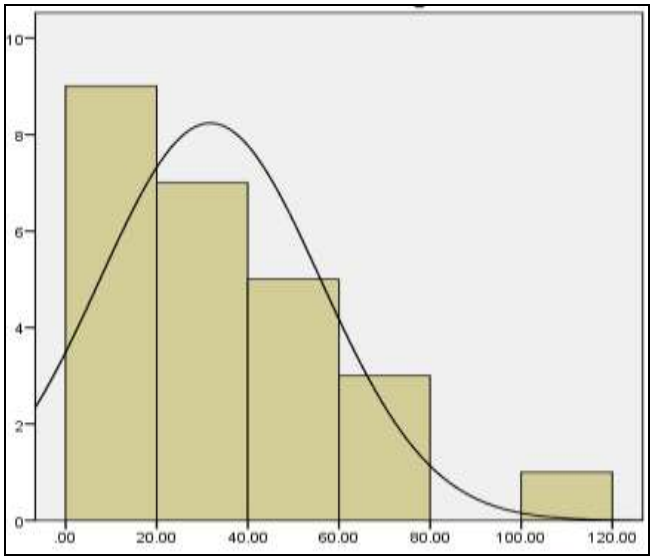

Fig 1: Pre-test histogram

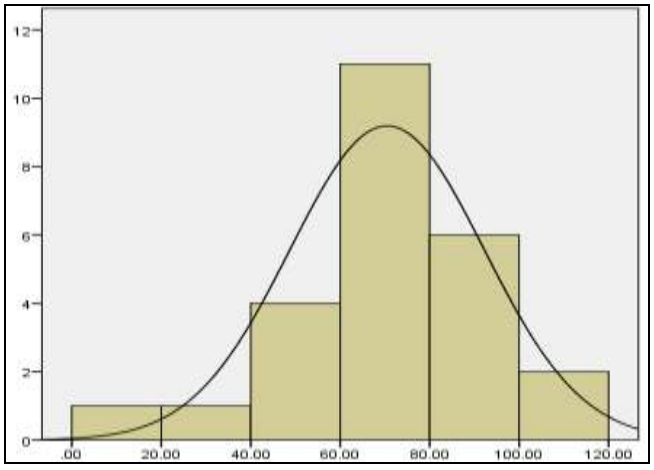

Fig 2: Post-test histogram

The data to be processed is the value of the result of the pretest and postest were then processed using *SPSS* software assistance with a significance level of 0.05 and a total sample of 25. The value of the table for df 25 with $\alpha = 0.05$ was 2.063. The steps of the analysis are: (1) normality test is used to test wheter the sample comes from data that is normally distributed or not; (2) homogeneity test is used to test wheter the variance of the two data groups is homogeneous or not (3) t-test is used to test hyphoteses and see the significance of differences in learning outcomes between the two groups of research subjects.

Based on data processing, values of t_{count} obtained are 6.18

and the value of t_{α} obtained 2.063 then H_0 is rejected and H_1 is accepted. Then, it can be concluded that: There are differences in learning outcomes trough MOMBI treatment based on paired exercises and group exercises on the application of multiple representation in vector addition.

3. Results and Discussion

From the result of research conducted on the second semester students majoring in physucs education at Mando State University, it can be seen that the the average learning outcome of vector addition are quite significant. The average learning outcome of student in vector addition can be seen on this table below:

Table 2

Treatment	Average Score
Before (Pretest)	31.76
Postest on paired group	68.08
Postest on peer tutor group	72.69
After (Postest)	70.48

Basd on the table above, it can be seen the positive effect of applying several representations on vector addition. This was prove in accordance with the increase in average scores before and after the treatment. Student's learning outcomes obtained by pretest is 31.76 while student's learning outcomes provided by with postest are 70.48. Thus, this shows that MOMBI based on pair exercises and peer tutor group on the application of multiple representation has a positive influence on student's learning outcomes, especially on vector addition material which is shown by a significant increase in learning outcomes.

4. Conclusion

Based on the result of research that has been carried out on the second semester student majoring in physics education at Manado State of University in vector learning, especially on the topic of vector addition, it can be seen that average student's learning outcome are better after applying multiple representation compared with student's learning outcome before applying multiple representation. Thus it can be concluded that trough the MOMBI treatment based on paired exercises and peer tutor group exercises on the application of multiple representation themselves has a positive effect on student learning outcome specifically on vector addition material.

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