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Use of representation of unit vector semiotics hrough Cartesian coordinate

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Abstract
Research has been conducted related to the use of vector semiotic representations in physics learning. The purpose of this study was to determine differences in learning outcomes using the Model of Model-Based Instruction (MOMBI) learning model on the use of unit vector semiotic representations through the Cartesian coordinate system and to determine the use of MOMBI in improving learning outcomes about semiotic representation in physics learning. This research was conducted based on group exercises and individual exercises. The results of this study found that there were differences in physics learning outcomes using the MOMBI learning model based on group exercises and individual exercises on the use of unit vector semiotics through the Cartesian coordinate system and the use of MOMBI can improve student physics learning outcomes. More than 68% of students cannot determine the unit vector correctly in the Cartesian coordinate system.

Keywords: MOMBI, semiotics representation, unit vectors through a cartesian coordinate system

1. Introduction

The vector concept is a basic concept that is very essential and fundamental in the field of science, especially physics and engineering. Said to be a very basic and essential concept because the concept of vectors is the basis for higher education. The importance of the vector concept is especially in its application in the fields of mechanics and electrodynamics [1,2].

Unit vector is a vector of one unit size [3]. The unit vector functions to express the direction of the vector in space, where the vector vector is perpendicular to the coordinate axis, and its extension is also parallel to the coordinate axis. In cartesian coordinates xyz, unit vectors are usually denoted unit vectors i for the positive x axis, unit vectors j for the positive y axis and unit vectors k for 3 dimensions.

The unit vector concept is a concept that is difficult for students. The difficulty of the concept will experience very serious problems in mastering physics material at a later stage. The difficulty of students in learning physics is basically caused by the lack of skills and understanding of the concept of vectors to determine the point of capture of vectors and the direction of vectors. Thus, the success of physics learning is largely determined by the level of understanding of the unit vector quantity. However, many researchers say that some students still have a low understanding of the unit vector concept, even though they have learned it before.

In the study of Barniol & Zavala (2010)[4] revealed that students still face some difficulties in determining the unit vector size through the Cartesian coordinate system. In fact, only 22% of students can draw unit vectors correctly. However, students do not have problems in determining the direction of the vector. Difficulties faced by students are when sketching lines, students cannot determine the direction of vector arrows, cannot draw vectors from head to tail, cannot draw vector lines, cannot draw position vectors, and difficulties in basic vector operations themselves even though students have take an introductory lecture in physics. In fact, students have difficulty in representation of unit vector graphics, vector components and calculating vector directions [5]..

Based on the data of the initial findings of the research conducted on students in semester 4 and semester 6 of the Department of Physics Education who have studied basic physics and mechanics about Pretest questions with Unit Vector Topics. Referring to the question: Write the vectors F, N, and W stated in the unit vector, none of the students answered correctly or can be said 100% of students answered incorrectly. The difficulty of students in working on these problems is due to the lack of a basic understanding of semiotic representation. In addition, some students do not yet understand and understand the position of a point can be represented by using the Cartesian coordinate system, where the Cartesian coordinate system makes it easy for students to represent unit vector semiotics.

Therefore, in learning physics representation is very important. Where presenting vector diagram drawings can help students to be able to solve problems procedurally and systematically. Representation is something that can be symbolized or symbols on an object or process [6], while semiotics is the study of signs. Representations in physics in the form of words, pictures, diagrams, graphs, symbols, and so on. The ability to represent semiotics is one of the important and fundamental components for developing students' thinking abilities. Where this semiotic representation makes it easy for students to build their own knowledge.

In the process of teaching and learning certainly need the name of thinking. This process of thinking is called cognitive or cognition. Ways of cognitive development are certainly different, one of them according to Vygotsky. According to Vygotsky the concept of his theory is to use ZPD (Proimal Development Zone) is a variety of tasks that are too difficult for children, but can be learned with adult guidance (teacher or parent). Vygotsky's theory can also improve student understanding. Where the need for learning

models. This learning model discusses about scaffolding, which means providing support to children during the learning stages.

The use of learning models certainly has an important role in the progress of learning. With the learning model can improve student learning outcomes in semiotic representation. One learning model that can be used to improve student learning outcomes in unit vector material is the Model Based-Instruction (MOMBI).

MOMBI learning is a teaching model that consists of lecturer explanations about new concepts and skills, which involves lecturer collaboration with students individually, or in small groups that focus on achieving learning targets by providing skills training that is closely related to the target. The use of the MOMBI learning model is a learning model where the lecturer acts as a model and guides students in the mastery of knowledge especially those related to skills and concepts.

2. Conceptual framework

Vector is a mathematical component which is an essential language for physics [7]. A vector is also a picture or sign of a directed imaginary line. This directed line is an important sign and is used extensively in physics such as the magnitude of displacement physics, velocity, acceleration, force, momentum, field strength.

Vector as a directed line, the direction sign is indicated by an arrow (head) at the end of the vector that is at point P, while the base of the vector that is at point O is called the tail of the vector. In the diagram, each vector is represented by an arrow. The arrows are always drawn so that they point in the direction which is the direction of the vector. The length of the arrow is drawn in proportion to the size of the vector [8].

The vector tail also plays an important role in terms of stating the position or position of the vector placed. For example for a particular object, the position of the capture point must be at the center of mass of the object or the center of gravity of the object in question. The center of mass is at the midpoint of the round object. The gravity vector is weight downward as indicated by the directed line vector. The catch point of the gravity vector is at the center of mass of the object.

The position of the vector tail determines the distance of the vector with another point that becomes the reference. The longer the vector's line represents the vector's size. The magnitude of a vector represents a quantity of physical quantities called scalar quantities. Physical quantities which only state great values, for example distance, rate, energy, power, and so on.

Many physical quantities are described as their place in space. With the placement of physical vector quantities in the coordinate system means we place them in units of scale. Scale units can be said to be the smallest units such as pixels. Pixels are graphic image elements that are calculated per inch. Pixels come from the English acronym Picture Element which is shortened to Pixel. Pixel scale unit density is expressed in ppi or pixels per inch. Making pictures with a computer using the pixel format.

Scale units for length dimensions can also be expressed in standard units of the International System such as meters (m), or other scales larger or smaller than meters, for example nanometers (nm), micrometers (μm), millimeters (mm), centimeter (cm), kilometer (km), and others.

The unit vector is a vector that has been broken down into the x (î), y (ĵ), z (k̂) axes, which are one unit large. The unit vector is used to explain the direction of a vector in coordinates, either two-dimensional, or three-dimensional coordinates. The unit of scale that is depicted in plane coordinates (x, y) or in space coordinates (x, y, z), then becomes the basis called unit vectors.

A vector that has a vector size of 3 units of scale, then the vector writing becomes 3î, or 3ĵ, or 3k̂. This large vector is called a scalar.

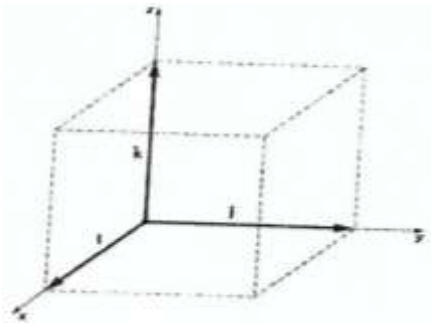

Fig. 1 The unit vector of 3D coordinates $\hat{\imath}, \hat{\jmath}, \hat{k}$

The position of an object is a vector quantity, so it's usually called a position vector. The end of the position vector shows the point or position referred to by the position vector. The characteristic of a position vector is that it depends on the starting point. Two position vectors of the same direction and magnitude do not have to point to the same position. The two position vectors point to the same position if the base points are the same. Conversely, a point or position can also be appointed by two different position vectors at the base [9]..

Vectors expressed in 2D or 3D space with unit vectors x$\hat{\imath}$, $\hat{\jmath}$, and $\hat{k}$ are positions related to the vector capture point at point O, as well as the direction of the vector (head) at point P according to the coordinate system cartesian.

If the vector $\overrightarrow{OP}$ is written as the vector r $\vec{}$, then the position vector is: $\vec{r}$ = x$\hat{\imath}$ + y$\hat{\jmath}$. A position vector $\vec{r}$ if stated in its bases or components or may be called expressed in its unit vector.

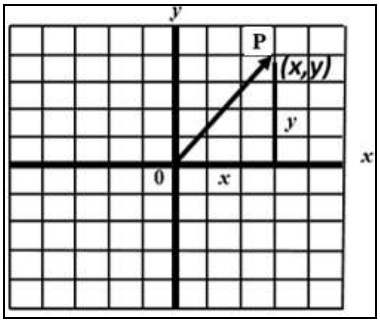

Fig 2: Position vector $\vec{r}$ = x$\hat{\imath}$ + y$\hat{\jmath}$

In space it can be written as: $\vec{r}$ = x$\hat{\imath}$ + y$\hat{\jmath}$+z$\hat{k}$. With x$\hat{\imath}$, y$\hat{\jmath}$, and z$\hat{k}$ called the position vector component $\vec{r}$. The location of the particles of each coordinate axis relative to the base of the coordinates is given by the coefficients x, y, and z. Each $\hat{\imath}$, $\hat{\jmath}$, and $\hat{k}$ are called unit vectors, base vectors perpendicular to each other and the magnitude of 1 unit.

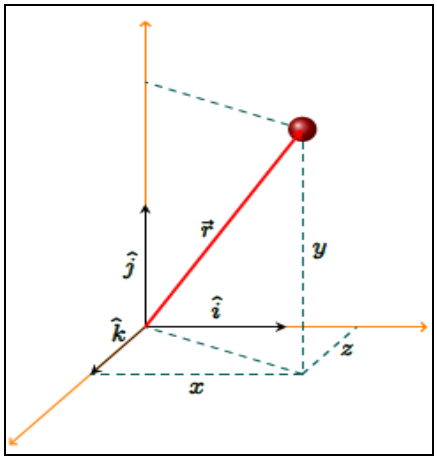

Fig 3: Decomposition of the position vector of a particle (object) with respect to its components.

Cartesian coordinate system is a coordinate system formed of two perpendicular axis systems to each other, and or three perpendicular axis systems to each other perpendicular. Position of an object in the dimensions of the field or space, a reference system is needed which in mechanics or electrodynamics is called a coordinate system.

3. Method

This research was conducted at the Department of Physics at the State University of Manado in class 2 2018 students in the 2018/2019 school year. This study uses the MOMBI learning model which consists of 5 intervention steps: provocation, preconception, presentation, scaffolding and practice. 1) Provocation: the initiation step or starting construction of a mental model where the lecturer raises real questions and problems or conflicting information that makes learners like students think, or condition an instructional intervention to be provocative. 2) Preconceptions: steps to activate or activate previous views or thoughts, or activate preconceptions or prejudices held by students. 3) Presentation: the step of providing information so that learners can answer questions, solve problems, explain conflicting information in other words ensuring the construction of the mental models of learners is the same as the expert models / expert conceptual models. 4) Scaffolding: the step of providing information so that learners can answer questions, solve problems, explain conflicting information in other words to ensure the construction of mental models of learners is the same as the expert models / expert conceptual models. 5) Practice: the final step is to provide an opportunity to reconstruct models repeatedly so that they are stored or settled and schemed on them.

4. Results and Discussion

There are many research findings related to the representation of unit vector semiotics and their relationship to the problem of the Cartesian coordinate system in determining unit vectors, as stated by Barniol P & Zavala G (2014) [5] that only 43% of students answered questions about unit vectors correctly even students experienced difficulty in representation of unit vector graphics, vector components and calculating vector direction [10], in this study new things related to student errors in unit vector learning caused by some students not understanding the Cartesian coordinate system 88%, not understanding the 72% unit vector, not understanding the unit scale in the Cartesian coordinate system 80 %, do not understand the position vector 88% and do not understand the center of weight 84%. Difficulties of students in the topic of unit vectors are also found by Barniol P and Zavala G (2010) [4] that the most common difficulties in determining the direction of vectors, drawing vector lines, do not understand the vector head to tail and difficulty in determining the vector position.

Based on data analysis of research results at Manado State University in Physics Department students in semester 2 of the 2018/2019 school year shows that there are differences in student physics learning outcomes based on group exercises and individual exercises. Where the average score of learning outcomes in group exercises applied to the MOMBI learning model is 87.17 and the average learning outcomes in the individual exercises applied by the MOMBI learning model is 73.18.

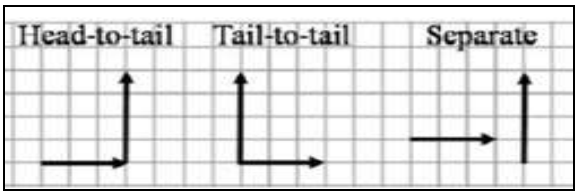

Fig 4

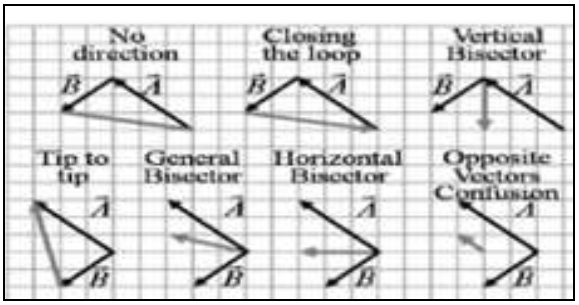

Fig 5

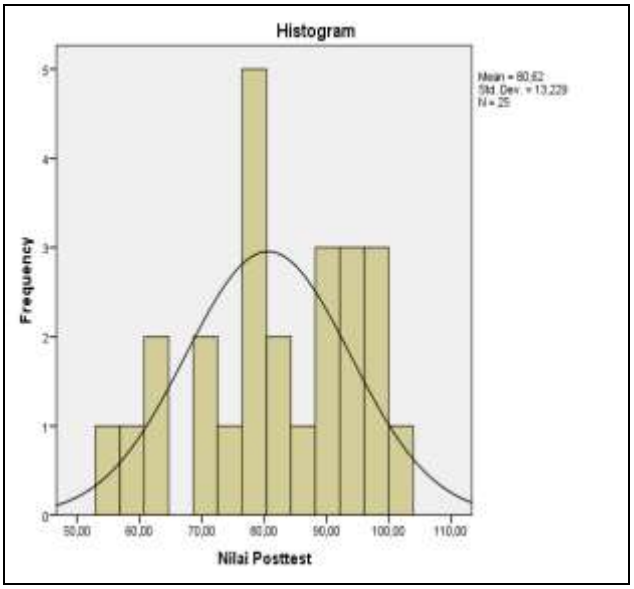

Fig 6: Pretest Results Histogram Data

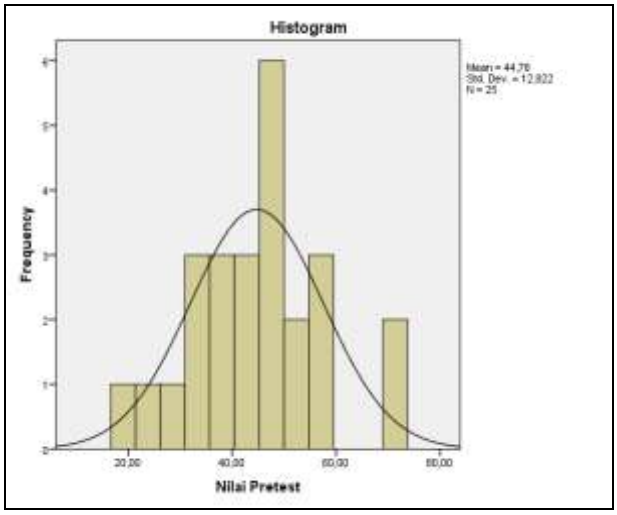

Fig 7: Posttest Results Histogram Data

Using normal distribution statistics (t-test), it is done in group exercises and individual exercises have significant differences as in Table 1.

Table 1: Independent Samples Test

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 Difference	Lower	Upper
Hasil Belajar	Equal variances assumed	2,833	,106	3,516	23	,002	13,97551	3,97489	5,75283	22,19820
	Equal variances not assumed			3,443	17,304	,003	13,97551	4,05886	5,42352	22,52751

The results of the levene test, the sample is homogeneous, then used df = 23 (first row). Based on the table above the value of p 0.002 <0.05 and t_{count} = 3.516> t_{table} = 2.068. This means that H_0 is accepted, meaning that there are differences in student physics learning outcomes using the MOMBI learning model based on group exercises and individual exercises on the use of unit vector semiotic representations through the Cartesian coordinate system. significant between group exercises and individual exercises.

5. Conclusion

The strategy of using MOMBI in terms of using unit vector semiotics representation through the Cartesian coordinate system can improve student learning outcomes. Evidenced by the results of the pretest and posttest there was an increase of 82% and in group exercises and individual exercises there was an increase of 19%. There are even differences in student physics learning outcomes by using the MOMBI learning model on the use of semiotic unit vector representations through the Cartesian coordinate system. Seen from the differences in group exercises and individual exercises with tcount and ttable, which shows that t_{count} = 3.516> t_{table} = 2.068.

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