

# Study of The Vector Product using Three Dimensions Vector Card of Engineering in Pathumwan Institute of Technology

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**Abstract.** The objective of this research was to offer the way to improve engineering students in Physics topic of vector product. The sampling of this research was the engineering students at Pathumwan Institute of Technology during the first semester of academic year 2013. 1) Select 120 students by random sampling are asked to fill in a satisfaction questionnaire scale, to select size of three dimensions vector card in order to apply in the classroom. 2) Select 60 students by random sampling to do achievement test and take the test to be used in the classroom. The methods used in analysis of achievement test by the Kuder-Richardson Method (KR- 20). The results show that 12 items of achievement test are appropriate to be applied in the classroom. The achievement test gets Difficulty (P) = 0.40-0.67, Discrimination = 0.33-0.73 and Reliability (r) = 0.70. The experimental in the classroom. 3) Select 60 students by random sampling divide into two groups; group one (the controlled group) with 30 students was chosen to study in the vector product lesson by the regular teaching method. Group two (the experimental group) with 30 students was chosen to learn the vector product lesson with three dimensions vector card. 4) Analyzed data between the controlled group and the experimental group, the result showed that experimental group got higher achievement test than the controlled group significant at .01 level.

## 1. Introduction

### Objective

Physics are difficult for many engineering students; some of them feel that physics are not important. They may not find it interesting or useful because physics is very “abstract”. Nguyen and Meltzer (2003) many students retained significant conceptual difficulties regarding vector methods that are heavily employed throughout the physics curriculum. Kustusch (2011) students in introductory physics struggle with vector algebra and with cross product direction in particular. Some have suggested that this may be due to misapplied right-hand rules but there are few studies that have had the resolve to explore this. Additionally previous research on students understanding has noted several kinds of representation-



dependence of students' performance with vector algebra in both physics and non-physics. Cataloglu (2006) the effort on teaching vector algebra using free open source software (FOSS) recent studies showed that students have difficulties in learning basic physics concepts. Barniol and Zavala (2011) we can establish two general errors: 1) Misconception in the magnitude of the unit vector and in the  $x$ - and  $y$ -components of this vector, 2) Confusion between the unit vector in the direction of vector  $\mathbf{A}$  with the two component vectors of the vector  $\mathbf{A}$  written in the unit-vector notation.

In this study three dimensions vector cards assist students to understand in the Right Hand Rule and it is the aid for the direction of the vector product. Group of sampling were engineering students at Pathumwan Institute of Technology (PIT's students) by random sampling

Three dimensions vector cards assistant PIT's students to be able to learn and revise it all the time.

### Vector

Vector in physics is a quantity that has both magnitude and direction. It is typically represent by an arrow whose direction is the same as that of the quantity and whose length is proportional to the quantity's magnitude. Vectors can be used to represent displacement, velocity, and acceleration. The length represents the magnitude and the direction of that quantity is the direction in which the vector is pointing. Because vectors are construct this way it is helpful to analyze physical quantities as vectors.

### Product of vector

We will define two different kinds of product of vectors. The first called the scalar product and second called the vector product.

#### The scalar product

The scalar product of two vector  $\mathbf{A}$  and  $\mathbf{B}$  is donated by  $\mathbf{A} \cdot \mathbf{B}$ . The scalar product called the dot product. The scalar product of two vectors can be constructed by taking the component of one vector in the direction of the other and multiplying it times the magnitude of the other vector. This can be expressed in two ways: in terms of the magnitude of  $\mathbf{A}$  and  $\mathbf{B}$  and the angle  $\theta$  between the two vectors or in term of components of  $\mathbf{A}$  and  $\mathbf{B}$ . The scalar product is commutative; for any two vector  $\mathbf{A}$  and  $\mathbf{B}$   $\mathbf{A} \cdot \mathbf{B} = \mathbf{B} \cdot \mathbf{A}$  the scalar product of two perpendicular vector is zero

$$\mathbf{A} \cdot \mathbf{B} = AB \cos \theta = \|\mathbf{A}\| \|\mathbf{B}\| \cos \theta$$

$$\mathbf{A} \cdot \mathbf{B} = A_x B_x + A_y B_y + A_z B_z$$

#### The vector product

The cross product  $\mathbf{A} \times \mathbf{B}$  is defined as a vector  $\mathbf{C}$  that is perpendicular to both  $\mathbf{A}$  and  $\mathbf{B}$  with  $\mathbf{A}$  direction

given by the right-hand rule and a magnitude equal to the area of the parallelogram that the vectors span.

The cross product is defined by the formula  $\mathbf{A} \times \mathbf{B} = \|\mathbf{A}\| \|\mathbf{B}\| \sin \theta$ . Where  $\theta$  is the angle between  $\mathbf{A}$

and  $\mathbf{B}$  in the plane, it is between  $0^\circ$  and  $180^\circ$ ,  $\|\mathbf{A}\|$  and  $\|\mathbf{B}\|$  are the magnitudes of vectors  $\mathbf{A}$  and  $\mathbf{B}$  and in

the direction given by the right-hand rule. The vector product is not commutative; for any two vectors  $\mathbf{A}$  and  $\mathbf{B}$ .

$$\mathbf{A} \times \mathbf{B} = -\mathbf{B} \times \mathbf{A}$$

The vector product of two parallel the angle  $\theta$  between them is either  $0^\circ$  or  $180^\circ$  by the above formula the cross product of  $\mathbf{A}$  and  $\mathbf{B}$  is zero.

$$C = AB \sin \theta$$

$$C_x = A_y B_z - A_z B_y$$

$$C_y = A_z B_x - A_x B_z$$

$$C_z = A_x B_y - A_y B_x$$

## 2. Methodology and Experimental

In experiments to determine the dimensions of the three dimensions vector card by choosing from three sizes and the most popular will be used to create a three dimensions vector card to use in the vector product classroom. The methodology and experimental was divided into four stages.

Stage 1 Make the Satisfaction questionnaires

Stage 2 Make the Achievement test

Stage 3 Make the three dimensions vector card and how to use the three dimensions vector card

Stage 4 Experimental

### 2.1 Satisfaction questionnaires

Made the satisfaction questionnaires to selection the paper size of three dimensions card by random sampling of 120 PIT's students choose the card that will be useful and applied. The results of this questionnaire will be used to make three dimensions vector card in classroom. The three dimensions, size card is:

1. Paper in 9 cm x 12 cm (double size of ID card)
2. Paper in 11.5 cm x 16 cm (half of note book)
3. Paper in 15 cm x 21 cm (half of A-4 paper size)

### 2.2 Achievement test

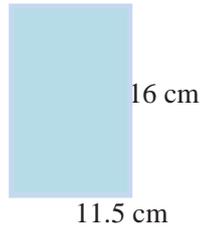
The steps make the achievement test.

1. Random sampling 60 PIT's students to do the achievement test (15 item)
2. Sort the answer sheet score from lowest to highest
3. Use 25% method to get 20 answer sheets in low group and 20 answer sheets in high group
4. Use KR-20 method to find Difficulty (P), Discrimination and Reliability (r)
5. Get only 12 items achievement test for pre-test and post- test

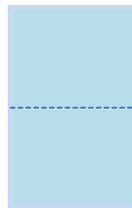
### 2.3 The three dimensions vector card

The steps make three dimensions vector card.

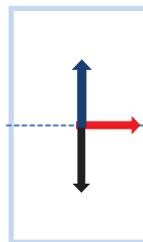
1. Cut the paper from reuse paper (candy box, old book cover and other cardboard) in 11.5 cm x 16 cm (half of the notebook)



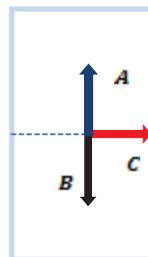
2. Half along it



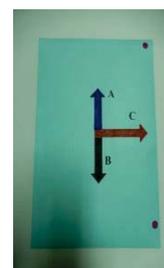
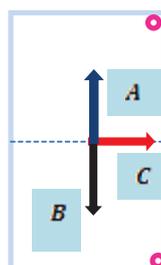
3. Arrows are drawn to represent three perpendicular directions in space



4. Three dimensions vector card for **A**, **B** and **C**



5. Two pink dots are placed on the card to assist in orienting the axis



### How to use the three dimensions vector card

The students can fold the card in the direction from vector A (blue arrow) to vector B (black arrow) the result is the direction of the vector C (red arrow), can used in the angle  $\theta$  between  $0^\circ$  to  $90^\circ$ . The pink dots are placed on the cards to assist students in orienting the axis. In the vector product lesson students can made the three dimensions vector card using recycled paper and took it on their own to find the direction of vector in three dimensions in classrooms.

### 2.4 Experimental

Studied in class

1. Random sampling 60 PIT's students (new group) to do the pre –test
2. The controlled group 30 PIT's students went to studied by the regular teaching method in the vector product lesson and post – test
3. The experimental group 30 PIT's students went to learn the vector product by three dimensions vector card
4. The experimental group 30 PIT's students made three dimensions vector card by themselves and used to find the direction in the classroom in the vector product lesson and post-test

### 3. Analyzed data

1. The satisfaction questionnaires analyzed data finding the average ( $\bar{x}$ ). The simplest number used to characterize a sample is the *mean*, which for  $N$  values  $x_i$ , ( $i=1,2,\dots,N.$ ) is defined by

$$\bar{x} = \frac{1}{N} \sum_{i=1}^N x_i$$

to select the size paper to make three dimensions vector card in the classroom

2. Analyzed data finding the average ( $\bar{x}$ ) and the sample standard deviation (SD) is the positive square root of the sample variance i.e.

$$SD = \sqrt{\frac{1}{N} \sum_{i=1}^N (x_i - \bar{x})^2}$$

We may therefore write the sample variance  $SD^2$  as

$$SD^2 = \frac{1}{N} \sum_{i=1}^N x_i^2 - \left( \frac{1}{N} \sum_{i=1}^N x_i \right)^2$$

From which the sample standard deviation is found by taking the positive square root. Thus., by evaluating the quantities  $\sum_{i=1}^N X_i$  and  $\sum_{i=1}^N X_i^2$  for our sample, we can calculate the sample mean and sample standard deviation at the same time.

Compare pre-test and post-test of physics achievement of PIT’s students, studied the vector product by using three dimensions vector and PIT’s students studied the vector product by the regular teaching method by t-test independent

**4. The result of data analysis**

1. The result of satisfaction questionnaire 120 students select the three dimensions vector size card:

**Table 1** The result of satisfaction questionnaire select size card

Size card	GOOD=3	OK=2	POOR=1	$\bar{x}$
9 cm x 12 cm	11	62	47	1.7
11.5 cm x 16 cm	91	22	7	2.7
15 cm x 21 cm	45	59	16	2.24

The result form the satisfaction questionnaire show 11.5 cm x 16cm card good at  $\bar{x} = 2.7$  this size is better useful and applied this size will be making in the classroom.

2. The results of analyzing pre-test and post-test physics achievement the vector product of PIT’s students are as the following.

**Table 2** The result of physics achievement study, the vector product pre-test

Statistics Sample	N	$\bar{x}$	SD	t-test
Controlled group	30	5.93	1.08	1.03
Experiment group	30	5.63	1.18	

From table (1) Finding an average of the pre-test in physics achievement, the vector product the controlled group studied the vector product by the regular teaching method is 5.93, the experimental group studied the vector product by using three dimensions vector card is 5.63. Using t-test independent sample to compare achievement finds that the experimental group and controlled group achievement is 1.03 it mean different insignificantly.

**Table 3** The result of physics achievement study, the vector product post-test

Statistics Sample	N	$\bar{x}$	SD	t-test
Controlled group	30	7.66	1.02	2.68**
Experiment group	30	8.33	0.97	

\*\* $p < .01$

From table (2) Finding the average of the post-test in physics achievement, the controlled group, studied the vector product by the regular teaching method is 7.66, the experimental group studied the vector product by using three dimensions vector card is 8.33 and an average of the post-test using t-test independent sample to compare achievement finds that is significantly higher at level of 0.01.

It means the achievement of PIT's students studying the vector product by using three dimensions vector card is higher than the achievement of PIT's students studying the vector product by the regular teaching method.

## 5. Conclusion

In this study intended to help improve teaching and learning in the physics of PIT's students in vector product lesson. The Right Hand Rule is an important mnemonic techniques to understand in three dimensions vector but difficult to use and difficult to alignment of their hand and fingers, unusual to watch and difficult to apply. In this experiment the three dimensions vector card that the student created can help the student understand in vector product lesson. The three dimensions vector size card with 11.5 cm x 16 cm is better useful and applied. This size is used to construct in the classroom. This size is half of the notebook can easily be flattened again to be stored in a pocket of the student's. The students can made the three dimensions vector card form the reused paper by themselves and took it in classroom and use to find the direction of the vector product.

In achievement test this studied used 12 items of the vector product to be analyzed by KR-20 program got Difficulty (P) = 0.40-0.67, Discrimination = 0.33-0.73 and Reliability (r) = 0.70. This test is used to measure the achievement of students .The student do the pre-test and after that the students have created a card and bring the card to use in the vector product lesson, and do the post- test. The achievement of PIT's students studied the vector product by using three dimensions vector card is higher than the achievement of PIT's students studied the vector product by the regular teaching method at a level of 0.01 which relates to the specified hypothesis.

This study was taken from the remaining material to create a tool to assist students understand the three dimensions vector better , in future could have to a reusable material used in other lessons of physics, such as wood cube or metal cube used to make three dimensions vector. The instructor uses repeats it in many times for the sake of the classroom environment and reduce global warming.

The three dimensions vector card is simply created, low cost and uses recycled materials, the accomplishment check showed a big distinction between students with and without three dimensions vector card. In this reason the instruction in physics and mathematics is used the three dimensions cards to assistant in the Right Hand Rule and vectors in three dimensions. The three dimensions vector card is applied to the study of three dimensions vector in the other, for example finding the direction of the magnetic field and force, the concepts of torque and angular momentum.

## Acknowledgment

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