ENGINEERING STUDENTS' CONCEPTUAL UNDERSTANDING OF FORCE AND MOTION AND PERSONAL BELIEFS

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Abstract - This study investigated the influence of personal beliefs on conceptual understanding of force and motion of second year engineering students. In this regard, the study employed descriptive-correlational research design. A random sample of 200 civil and electrical engineering students from three universities were involved in the study. Data were collected using a twenty-item five-point Likert-scale type questionnaire for personal beliefs along belief towards learning, physics and superstitious beliefs and Force Concept Inventory for conceptual understanding of force and motion, respectively. The data were analyzed using t-test for independent samples and Pearson Product Moment Correlation at a significance level of 0.05. Results revealed higher conceptual understanding of force and motion among civil engineering students than electrical engineering students. Moreover, conceptual understanding of force and motion was significantly related to superstitious belief but not with belief towards learning Physics.

Index Terms: *Force and Motion*, *Conceptual Understanding*, *Superstitious Beliefs*, *Engineering students*

I. INTRODUCTION

Studies have shown that students have difficulties learning basic physics concept like force and motion (Darling, 2012). These concepts are difficult to learn by students ranging from primary school to university including physics teachers (Martín-Blas, Seidelb, and Serrano-Fernándeza, 2010) and engineering students (Azman, Alia, and Mohtar, 2013).

Force is the central concept of Newtonian mechanics. Newton's laws are important because they have easily visible applications in the daily lives of people. For example, O'Shea (2004) demonstrated the action of Newton's second law by describing the forces involved during snowboard jumping. There is the famous stunt with which most people are familiar, where a full table setting is placed on a table with a tablecloth, and a skillful practitioner manages to whisk the cloth out from under the dishes without upsetting the glasses and other objects (Science Clarified, 2015).

However, when conducting research on conceptual understanding, it is also important to learn how students' conceptual understanding is shaped by personal factors like superstitious beliefs and beliefs towards learning Physics. Superstitious beliefs determine one's personal conception of a science concept. It has been suggested that high school students' superstitious beliefs influence their study strategies and were related to their conceptual development (Chu, Treagust, and Chandrasegaran, 2008). Could this be true to engineering students who are academically matured compared to high school students?

Based on the above argument, the aim of the present study is to determine engineering students' conceptual understanding of force and motion and their beliefs toward learning physics and superstitious belief so that appropriate intervention can be designed.

II. METHODOLOGY

This study employed descriptive-correlational research design. Descriptive since the study aimed at identifying the level of conceptual understanding about force and motion, belief toward learning physics and superstitious beliefs. At the same time, the study was also correlational since the conceptual understanding about force and motion was correlated to beliefs towards learning physics and superstitious beliefs, respectively.

On the other hand, conceptual understanding about force and motion was measured using the Force Concept Inventory by Hestenes, Wells, and Swackhamer (1992). Belief toward learning Physics was determined using the instrument developed by Adams, Perkins, Podolefsky, Dubson, Finkelstein, and Wieman (2006) while superstitious belief was composed by the present author by reviewing the literature.

The study involved 200 randomly selected second year civil and electrical engineering students from three state universities, namely: 57 students from Samar State University (SSU), Catbalogan City, Samar; 44 students from Northwestern Samar State University (NWSSU), Calbayog City, Samar; and 99 students from Eastern Visayas State University (EVSU), Tacloban City, Leyte.

III. RESULTS AND DISCUSSION

As reflected in Table 1, out of the 200 student-respondents, 137 or 68.5 percent have "low" conceptual understanding corresponding to a percentage score of 21-40. Fifty seven or 28.5 percent have "very low" level of understanding with percentage scores 1-20, and six or 3.0 percent have "moderate" level of conceptual understanding at percentage scores of 41-60. The overall level of conceptual understanding is "low" as supported by mean percentage score of 24 with standard deviation of 8. This result indicates that the topic on force and motion is difficult even for engineering students regardless of nationality or culture (Doran, 2009).

Table 1. Level of Conceptual Understanding of Force and Motion

Percentage Score	Level of Understanding	Frequency	Percent
41 – 60	Moderate	6	3.0
21 – 40	Low	137	68.5
1 – 20	Very low	57	28.5
Total		200	100
Mean	24		
SD	8		

As revealed in Table 2, civil engineering students have higher conceptual understanding than Electrical engineering students. This is supported by a t-value of 2.37 whose p-value of 0.019 is lower than the stipulated 0.05 significance level.

Table 2. Conceptual Understanding of Force and Motion Between Civil and Electrical Engineering

Group	n	Mean	SD	t-value	p-value	Inter-pretation
CE	153	24.58	7.90	2.37	0.019	Significant
EE	47	21.40	8.54			

Legend: $\alpha = 0.05$; df=98

The conceptual understanding of force and motion of students according to the university they are enrolled were also compared. As reflected in Table 3, there is no difference in conceptual understanding of force and motion as revealed by an F-value of 0.87 with a p-value of 0.42 which is greater than the 0.05 significance level.

Table 3. Comparison of Student-Respondents' Conceptual Understanding of Force According to School

Group	Sum of Squares	df	Mean Square	F	p-value	Inter-pretation
Between Groups	114.98	2	57.49	0.87	0.42	NS
Within Groups	13088.58	197	66.44			
Total	13203.56	199				

Legend: $\alpha = 0.05$; NS = Not Significant

Table 4 below show the distribution of students regarding their belief towards learning Physics. Out of 200 student-respondents, 105 or 52.5 percent have "uncertain" belief followed by 87 or 43.5 percent "moderately irrational", five or 2.5 percent are "moderately rational" and three or 1.5 percent have "highly irrational" level of beliefs towards learning physics. Overall, the level of beliefs towards learning Physics of students were "uncertain" as supported by a mean of 3.48 and a standard deviation of 0.47.

Table 4. Level of Belief Towards Learning Physics of Student-Respondents

Beliefs	Frequency	Percent
Moderately Rational	5	2.5
Uncertain	105	52.5
Moderately Irrational	87	43.5
Highly Irrational	3	1.5
Total	200	100
Mean	3.48	
SD	0.47	

In terms of supersititious belief, 154 or 77 percent of them were "highly rational" followed by 46 or 23.0 percent "moderately rational" level of superstitious beliefs. As a whole, the student-respondents were "highly rational" as revealed by a mean value of 1.27 with a standard deviation of 0.33. This highly rational superstitious belief is similar to the study of Sagone and De Caroli (2015) which revealed that psychology and pedagogy students expressed a greater personal belief in good luck just like engineering students.

Table 5. Level of Superstitious Beliefs of Student-Respondents

Overall Beliefs	Frequency	Percent
Highly Rational	154	77.0
Moderately Rational	46	23.0

Total	200	100
Mean	127	
SD	0.23	

Pearson Product Moment Correlation revealed a correlation coefficient of 0.040 with a p-value of 0.571 between conceptual understanding and belief towards learning Physics which means the two variables are not significantly related because the p-value is greater than the stipulated 0.05 significance level as reflected in Table 6.

Table 6. Correlation Analysis

Conceptual Understanding vs	r_{xy}	p-value	Inter-pretation
Belief Towards Learning Physics	0.040	0.571	NS
Superstitious Belief	-0.198	0.005	S

On the other hand, conceptual understanding and superstitious belief obtained a coefficient of correlation of -0.198 with a p-value of 0.005. This indicates correlation between the two variables since the p-value is lower than the 0.05 significance level. It implies that the low level of understanding of force and motion may be attributed to their superstitious beliefs but this study did not find a strong relation between conceptual understanding and superstitious beliefs.

IV. CONCLUSION

The results of the study revealed that second year engineering students have low conceptual understanding of force and motion regardless of their major and the university they are enrolled in. Furthermore, students' conceptual understanding of force and motion are not in a way affected with their beliefs in learning Physics. However, their conceptual understanding of force and motion are affected by their superstitious beliefs but this study did not find a strong relation since the value of the Person r is almost negligible.

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