

Diagnostic Test applied in Engineering: Its implication towards an effective enhancement program

Florante D. Poso Jr.,^{a*} Romano Q. Neyra^b, Jaychris Georgette Y. Onia^c, Nino U. Pilueta^d, Antipas T. Teologo, Jr.^e, and Daryl D. David^f

^{a,b,c,d,e,f} Far Eastern University Institute of Technology, Manila, Philippines

*fdposo@feutech.edu.ph

Highlights

- The engineering students got a low score in the diagnostic exam.
- The findings implies a low memory retention in the pre-requisite subject.
- The males are performing better than females in the diagnostic test.

Abstract

The COVID-19 pandemic shifted the normal teaching and learning environment into a fully online set-up. At present, in the new normal, hybrid teaching is implemented. The level of learning during the pandemic become at stake where the academic institutions needed to evaluate the satisfactory implementation of whatever modality or pedagogy is being used in teaching engineering subjects. An implementation of the mandatory diagnostic examination was introduced in the college of engineering of FEU Institute of Technology to measure the memory retention level of the students based on their learning in the pre-requisite subject. The scores in the diagnostic test and the grades of the pre-requisite subject were analyzed. Majority of the engineering students are males. The findings concluded that the engineering students got a grade in Physics within the range of 1.00 to 2.00 or within 70 to 84. Most of the students got a low score in the diagnostic exam. In terms of correlation analysis, the grades in Physics cannot determine the score in the diagnostic test, which can be implied that there is low memory retention on the Physics topics. Analysis of variance shows that there is significant difference on the diagnostic test result for males and females but there is no significant difference on the grades of Physics of males and females. The low performance in the diagnostic examination makes it alarming to the different major subjects in engineering, and resulted to come up with measures that should cope with the need of the students to learn more the basics of science and mathematics.

Key Words: academic performance, diagnostic test; engineering; online learning; pandemic

1. Introduction

In engineering programs, the students struggle mostly in the core mathematical and science aptitudes. The basic foundation in engineering that the students should master are the basic mathematical and science principles. Diagnostic tests can be utilized to determine the level of retention of knowledge learned from the previous subject or the pre-requisite course. There could be factors that can affect the level of knowledge

of the students as they enter the second year level where the students will enroll the first major subject to their chosen program. Their first year experience in the institution should have mold them to acquire the knowledge and skill in mathematics and in science.

With the pandemic situation, two school years had passed that the mode of learning is fully online which impacted the Philippine educational set-up in a significant level (Dy et al., 2021). The pandemic situation becomes a challenge to the engineering programs as it requires a more intensive monitoring of the effectiveness of the modality that is being implemented. The intense shift from the fully online and now to the new normal set-up of classes had urged every institution to revisit the learning management system. In the past two (2) years of online classes, the schools and universities came up with different strategies to deliver academic quality education to students (Poso and Yano, 2021). In the study of Bigotte et.al (2013), many engineering students showed significant deficiencies in core mathematical skills. Diagnostic examination is implemented to incoming first-year students, consistently revealing problems in basic mathematics.

The paper focuses on determining the performance of the engineering students during the diagnostic test. The result of the diagnostic examination was correlated to their grades in the pre-requisite subject to determine the memory retention of the topics discussed in the pre-requisite courses. The college of engineering of FEU Institute of Technology implements the conduct of diagnostic test on all major subjects across different engineering programs. The aim of the college is to determine the students' knowledge retained from the pre-requisite subjects which were taken for the past two years of pandemic period where subjects are offered fully online. The analysis were used to identify measures that can be implemented in the current subject to help the students cope with the topics they find difficult to understand during the online classes.

2. Methods

2.1 Data gathering and analysis

The researchers gathered the scores of the students in the diagnostic exam administered during the 1T SY 2022-2023. For the grades of the pre-requisite subject, only Physics was selected as it is the common pre-requisite subject on all subjects being analyzed. The data gathered were analyzed using descriptive statistics, analysis of variance and correlation analysis to determine the relationship between the dependent and independent variables.

There are 298 total data gathered as regards to the grades in Physics and the Diagnostic Test result. There are 195 BSCE students, 41 are BSME students, 33 are BSEE students and 29 are BSECE students. Table 1 presents the distribution of the number of students where data are used in the study.

Table 1. Distribution of Number of Students.

Program	Total	Percentage (%)
BSCE	195	65.44
BSME	41	13.76
BSEE	33	11.07
BSECE	29	9.73
Total	298	100.00

2.3 The diagnostic examination

Diagnostic tests were administered to all the engineering programs in FEU Institute of Technology as part of its evaluation strategy to determine the topics retention of the pre-requisite subjects once the students are enrolled in the next major subject. A 20-question diagnostic examination was administered. The diagnostic examination questionnaires were validated by the cluster committees based on the Table of Specification (TOS) approved by each of the engineering department. Table 2 presents the list of subjects that the diagnostic examination were deployed. For the civil engineering students, CE0001 (Statics of Rigid Bodies) was selected for this study and for mechanical students, COE0031 (Statics of Rigid Bodies) subject was also selected. For the EE, the subject selected is EE0001 (Electrical Circuits 1) and for ECE, the subject is ECE0003 (Circuits 1). All courses has the same pre-requisite subject which is Physics for Engineers. The subjects that were selected are those that has a common pre-requisite subject that is Physics, thus it evaluates the level of memory retention of the students who took Physics in the previous term. The grades of students in Physics 1 were gathered to further analyze if there is a relationship between their grades in the prerequisite subject and the result of the diagnostic test.

Table 2. The List of Subjects.

Program	Subject	Pre-requisite Subject
BSCE	CE0001 (Statics of Rigid Bodies for CE)	Physics
BSME	COE0031 (Statics of Rigid Bodies)	Physics
BSEE	EE0001 (Electrical Circuits 1)	Physics/Calculus
BSECE	ECE0003 (Circuits 1)	Physics/Calculus

2.4 Statistical Treatment of Data

The data were gathered and analyzed using descriptive statistics. To the the relationship between the grades in the pre-requisite subject and the result of the diagnostic test, the Pearson Product Coefficient of Correlation was administered. Further analysis on the test of differences using the sex of the respondents, Wilcoxon two-sample test was used.

3. Results and discussion

3.1 Profile of the students in terms of Sex

Table 3 presents the sex distribution of the engineering students. The table reveals that 231 or 77.52% are males while 67 or 22.48% are females.

Table 3. Profile on Sex of the Students

Sex	BSCE	BSME	BSEE	BSECE	TOTAL	Percentage (%)
Male	136	38	29	28	231	77.52
Female	59	3	4	1	67	22.48
Total	195	41	33	29	298	100.00

3.2 Grades in Physics 1

Table 4 and figure 1 shows the distribution of grades in Physics as a pre-requisite subject for the major subjects that the students enrolled in the current term. For the BSCE program, majority of the students got a grade of 1.50, for BSME most of the students got 2.00, for BSEE students majority got 1.00 and for BSECE students majority of them got 2.00 grade. Overall, the data reveals that most of the engineering students got a grade in Physics within the range of 1.00 to 2.00. Based on the grading system of the institution the grades are within the 70 to 84.

Table 4. Respondents' Grades in Physics 1

Grades	BSCE	BSME	BSEE	BSECE	TOTAL	Percentage (%)
BSCE						
1.00	44	9	18	7	78	26.17
1.50	56	9	9	7	81	27.18
2.00	54	16	4	10	84	28.19
2.50	22	3	2	3	30	10.07
3.00	10	3	0	2	15	5.03
3.50	6	1	0	0	7	2.35
4.00	3	0	0	0	3	1.01
TOTAL	195	41	33	29	298	100.00

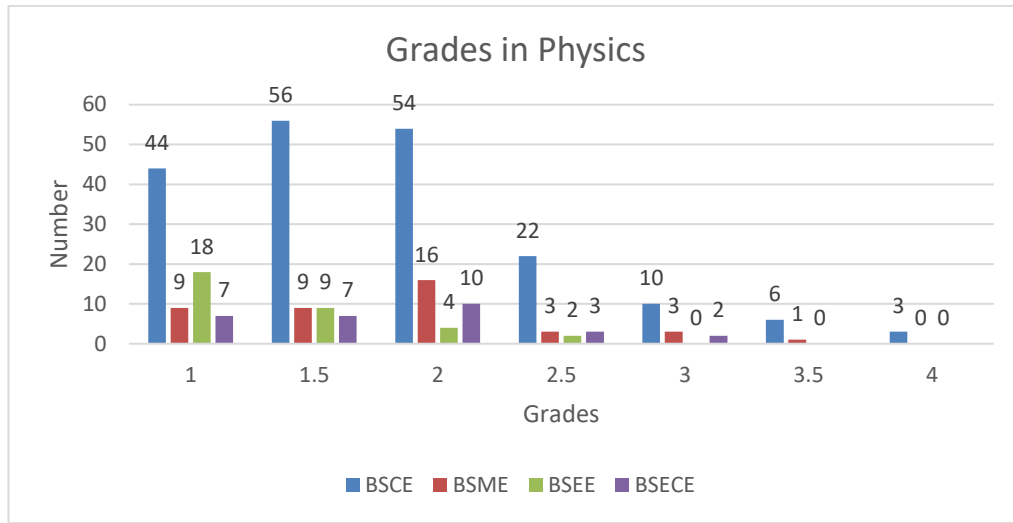


Figure 1. Distribution of Grades in Physics

3.3 Scores in the Diagnostic Test

Table 5 shows the distribution of scores in the Diagnostic exam administered to the engineering students in the current term. The table reveals that majority of the students got a score of 9-10 with 54 or 18.12%, out of the 298 students. It can be gleaned from the result that most of the students got a low score in the diagnostic exam that most of the students scores below half of the 20-item test. Figure 3 shows that there are students who got even zero in the diagnostic test that got a high passing grade in their pre-requisite subject. According to the study of Bigotte (2013), that the difficulties with the core competencies such lead to difficulties in analyzing problems in mathematics and science.

Table 5. Respondents' Scores in the Diagnostic Test

Scores	BSCE	BSME	BSEE	BSECE	TOTAL	Percentage (%)
0	49	1	3	0	53	17.79
1 – 2	6	0	0	0	6	2.01
3 – 4	17	1	0	0	18	6.04
5 – 6	19	6	6	1	32	10.74
7 – 8	27	14	9	3	53	17.79
9 – 10	27	9	7	11	54	18.12
11 – 12	19	2	0	5	26	8.72
13 – 14	12	5	5	5	27	9.06
15 – 16	16	2	2	3	23	7.72
17 – 18	2	1	1	1	5	1.68
19 – 20	1	0	0	0	1	0.34
TOTAL	195	41	33	29	298	100.00

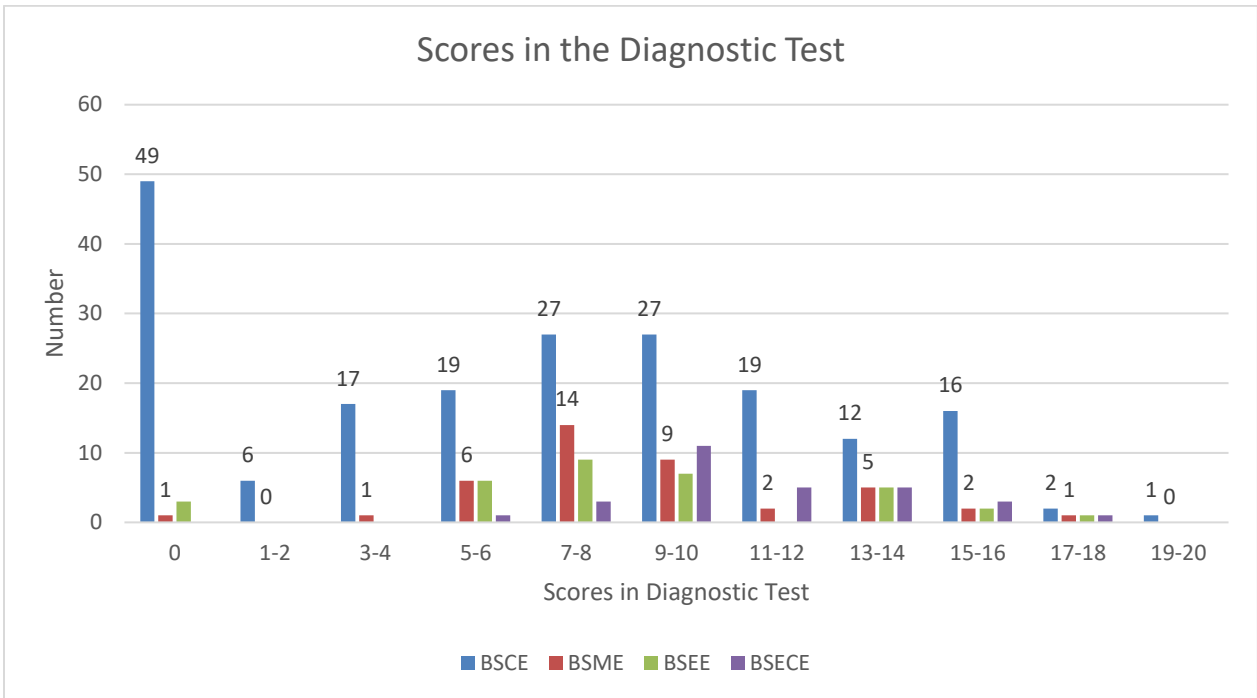


Figure 2. Distribution of Scores in the Diagnostic Test

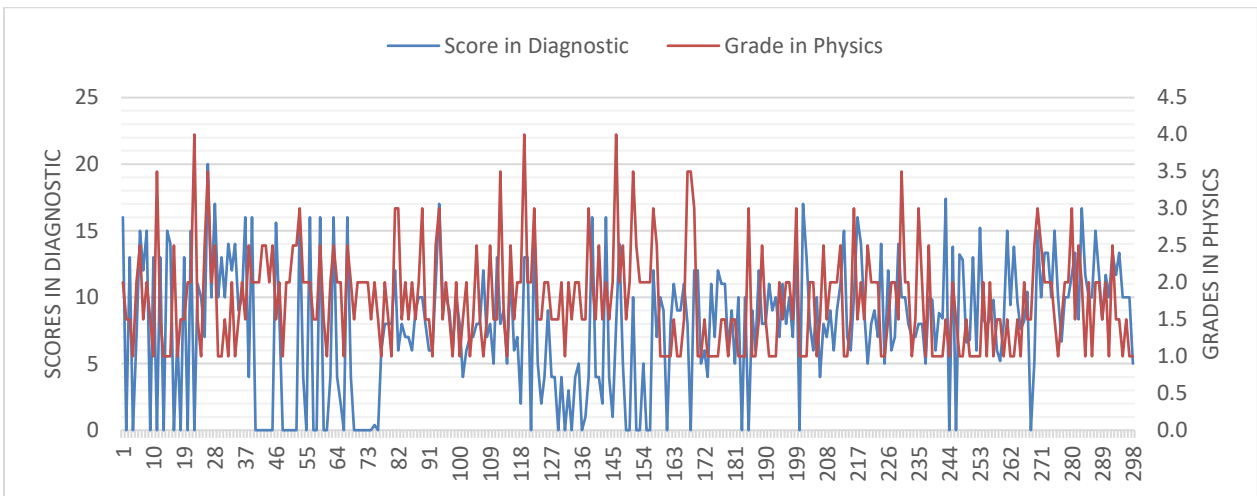


Figure 3. Analysis of Scores in the Diagnostic Test and Grades in Physics

3.6 Statistical analysis result

Table 6 shows the result of the correlation analysis. The findings revealed that there is no significant relationship between the diagnostic test and the grades of the pre-requisite subject. This implies that the grades in Physics cannot determine the score in the diagnostic test which the topic is also Physics. This further implies that there is low memory retention of the Physics topics when the subject was taken last term only. Further correlation analysis shows that sex and diagnostic exam has significant relationship while the sex and grades in Physics is not significant.

Table 6. Correlation result

Source of Variation	N	R Value	P value	Interpretation
Diagnostic Exam and Grades in Physics	298	0.013	0.824	Not significant
Sex and Diagnostic Exam	298	0.130	0.025	Significant
Sex and Grades in Physics	298	0.016	0.785	Not significant

Table 7 presents the result of Wilcoxon Test to test the significant difference for sex and the diagnostic test result and sex versus the grades in physics. The table reveals that there is significant difference on the grades in physics and diagnostic test result for males and females. The mean of the diagnostic test shows that males got a higher average value of 8.09 compared to the females with 6.55 average score. The result implies that males are performing better than females in the diagnostic test. The grades in physics shows also a significant difference between males and females.

Table 7. Wilcoxon Test Table for Sex and Diagnostic Test

Variables	p Value	Remarks
Sex and Grades in Physics	$p < 0.001$	Significant
Sex and Score in Diagnostic Test	$p < 0.001$	Significant

4. Conclusions

The two (2) years of the pandemic set the teaching modality into a fully online. The level of learning during the pandemic situation become at stake where the academic institutions need to evaluate the satisfactory implementation of whatever modality or pedagogy is being used in teaching engineering subjects. The FEU Institute of Technology college of engineering, implements the conduct of diagnostic test on all major subjects to measure the memory retention level of the students based on their learning in the pre-requisite subject. The scores in the diagnostic test and the grades of the pre-requisite subject were analyzed. Majority of the engineering students are males. The findings concluded that the engineering students got a grade in Physics within the range of 1.00 to 2.00 or within 70 to 84. Most of the students got a low score in the diagnostic exam. In terms of correlation analysis, the grades in Physics cannot determine the score in the diagnostic test, which can be implied that there is low memory retention of the Physics topics. The test of significant difference that there is significant difference on the scores of the diagnostic test for males and females, which reveals further that the males are performing better than females. It is recommended that additional review materials, review classes, videocoursewares of the pre-requisite subject should be prepared by the professors handling the major courses. The materials in the Canvas platform should be updated to add the review materials. Enhancement classes should be conducted both in a face to face and online set up. These measures will allow students with less mathematical and science preparedness to attend enhancement classes that enable them to address these shortcomings. A further study is recommended to investigate the effect of other factors such as student engagement, motivation among others and other factors that may affect the performance in diagnostic tests. As the College of Engineering is implementing interventions to improve the students' performance, it is recommended, that a follow up study on the effect of the intervention activities have significant improvement to the students performance.

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