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Mathematical Skills and the Academic Performance of Junior and Senior Electrical Engineering Students of the University of Eastern Philippines

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Authors' contributions

This work was carried out in collaboration between both authors. Author KBFA designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author BDV managed the analyses of the study and managed the literature searches. Both authors read and approved the final manuscript.

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ABSTRACT

The study was conducted to determine the mathematical skills and the academic performance of the junior and senior electrical engineering students of the University of Eastern Philippines. Descriptive-correlational method of research was used with a total enumeration of the regular students from third year to fifth year electrical engineering students.

The findings revealed that male students dominated all the three year levels of the electrical engineering course. It was also found out that there were more regular fifth year engineering students than the third year and fourth year students. Meanwhile, the third year students got the highest average rating in the final grades of first year and second year mathematics and the lowest average rating belonged to the fifth year students. The learning style of the three-year levels was found to be visual while in terms of study habits, the third year students have very good study habit.

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It was also found out that the level of mathematical skills of the three-year levels were low, but the level of academic performance of the three-year levels were found out to be good. Multiple regression analysis was used to determine the relationship of the student profile and their mathematical skills. The results showed that the average of final grades in all first-year mathematics, and the students' year level have significant relationship with the mathematical skills of the students.
Meanwhile, the profile variables found to be significantly related to academic performance were the average of final grades in first year mathematics, average of final grades in second year mathematics and study habits of the students' respondents.
Lastly, the mathematical skills had no significant relationship to the academic performance of the student-respondents.

Keywords: Mathematical skills; study habit; learning style; academic performance.

1. INTRODUCTION

Mathematics is an important subject in electrical engineering. It is the foundation of an engineering discipline and requires a high level of motivation and focus of the learner. Together with physics, mathematics has helped engineering develop [1,2]. Without mathematics, engineering cannot become so fascinating as it is now. Linear algebra, calculus, statistics, differential equations and numerical analysis are taught as they are important to understand many engineering subjects such as electric circuits, mechanics of materials to name a few [3]. In truth, most of the engineering accomplishment and inventions of the 20th century were feats of mathematics.

Every year, the population of engineering enrollees is rising. In fact, engineering bachelor's degrees grew by 5.6 percent during 2011. Almost all fields grew in the number of graduates produced with the notable exceptions of engineering management, engineering science, and engineering physics, which each saw decreases of around 6 percent. The percentage of Bachelor's degrees increased slightly, to 9.1 percent, while undergraduate enrolment increased a full percentage point to 9.8 percent [4].

In the Philippines, the number of students enrolled in engineering courses has slightly increased from 2012 to 2016 with an annual average of 8.94 percent (ched.gov.ph accessed on September 2016) but despite of that, there are many students who shift to other degree programs because they find engineering difficult or some are even advised by the school administration because of their inability to meet the cut off grades or course requirements (www.finduniversity.ph/majors accessed on October 2016).

In the University of Eastern Philippines, the electrical engineering department has produced a number of new electrical engineers in the past and recent board examinations. But despite this result, the percentage of new takers in passing the board examination is still behind the national passing percentage [5,6]. In September 2016 Registered Electrical Engineer licensure examinations, the national passing percentage is 68% and the UEP passing percentage is 57% (prc.gov.ph accessed on October 2016).

Carr [7] stressed that students who took the mathematical assessment have shown that there may be significant number of students who struggle with basic mathematical concepts throughout their entire degree and these problems are clearly endemic and will persist if not tackled in a consistent manner.

Laguador [8] pointed out that students' interest is subjective in nature as it changes overtime based on educational and personal experiences that drive them to behave accordingly. He stressed that divergence on students' interest is very evident in the increase on satisfaction in terms of knowledge and skills acquired in engineering and decrease on the level of students' enjoyment in doing the skills and operations involved in engineering. Student interest during freshmen was related to the academic performance in general education courses but not anymore true to professional courses and their interest in the engineering program after five (5) years. Academic performance in General education courses was significantly related to professional courses.

In this situation, the researcher believe that there is a need to document the mathematical skills and the academic performance of junior and senior electrical engineering students of the college of engineering in order to find out

whether their mathematical skills helped them to improve their performance on their professional subjects that could help them in passing the licensure examination and becoming successful engineers in the future.

The researcher conducted this study to determine the mathematical skills and the academic performance of junior and senior electrical engineering students of the College of Engineering University of Eastern Philippines – Main Campus. Specifically, it aimed to: (1) determine the profile of the UEP Electrical Engineering students in terms of: Sex, year level, average of final grades in all first year mathematics, average of final grades in all first year mathematics, learning styles, and study habits; (2) to find out the level of mathematical skills of third year to fifth year electrical engineering students; (3) to point out the level of academic performance of third year to fifth year electrical engineering students; (4) to assess the relationship between the profile of the students and their mathematical skills; (5) to establish the relationship between the profile of the students and their academic performance; (6) to test the relationship between the students' mathematical skills and the academic performance.

2. METHODOLOGY

This study was conducted at the College of Engineering, University of Eastern Philippines, in Catarman, Northern Samar. The College offers four (4) engineering courses namely: Bachelor of Science in Agricultural Engineering (BSAE), Bachelor of Science in Civil Engineering (BSCE), Bachelor of Science in Electrical Engineering (BSEE) and Bachelor of Science in Mechanical Engineering (BSME). These four engineering courses are completed in five years. The first two years are confined to general education courses/subjects like Algebra, Trigonometry, Geometry, Differential and Integral Calculus, Differential Equations, Engineering Physics, Chemistry, Engineering Economy, English, Filipino, Physical Education, and General Sociology.

The researcher used a descriptive correlational research design. This type of research design describes the characteristics of the respondents profile as well as the relationship of the profile to the mathematical skills which also correlated to the academic performance of the electrical engineering students.

There were two variables in this study the independent variables and the dependent variables. The independent variables consisted of the profile in terms of sex, year level, average of final grades in first year mathematics, average of final grades in second year mathematics, study habits and learning style. On the other hand, the Mathematical skills of student and the academic performance of student in electrical engineering major subjects were the dependent variables.

The respondents of this study were the regular BSEE third year, fourth year and fifth year students of UEP-CE. The third year class was composed of 77 students had 18 regular students, the fourth year class composed of 47 students, 20 were regular students and the fifth year composed of 150 enrolled students had 21 regular students.

In gathering data for this study, the researcher pilot tested first the instrument on mathematical skills then after the test was found to be reliable, the researcher distributed the test instrument to the student-respondents of the study. The instrument used was personally developed by the researcher and were validated by the experts. The Study Habits statements were patterned from the studies of Balbalosa [9] and Salazar [10] while the Learning Style statements were patterned from Felder [11].

The first part of the survey questionnaire gathered the data on respondent's sex, year level, learning styles and study habits while the grades of the respondents were obtained from the registrar's office. The second part of the survey questionnaire were forty (40) mathematics questions aimed at measuring the mathematical skills of the respondents.
The profile data of the respondents were tallied to quantify the percentages, frequencies and means. The average final grade in all first year and second year mathematics and grade point average grade in professional subjects were categorized using the UEP grading system wherein 1.0 is classified as excellent, 1.25 and 1.50 classified as very good, 1.75, 2.0, and 2.25 classified as good, 2.5 and 2.75 classified as fair and 3.00 as passed.

The responses of study habits and learning style of the respondents were coded as:

Response	Score
Always (A)	5
Often (O)	4
Sometimes (S)	3
Rarely (R)	2
Never (N)	1

The averages of the responses gathered were interpreted as follows:

Range	Description
4.20 – 5.0	Excellent
3.40 – 4.19	Very good
2.60 – 3.39	Good
1.80 – 2.59	Poor
1.0 – 1.79	Very poor

Chart 1. Learning style of the respondents

The highest average of the responses gathered corresponded to the learning style of the student-respondents.

To measure the mathematical skills of the respondents, the scores for the examination questionnaires were interpreted as follows:

Range	Description
96% - 100 %	Excellent skill
92% - 95%	Very good skill
84% - 91%	Good skill
79% - 83%	Fair skill
75% - 78%	Passing skill
74% below	Low skill

Chart 2. Mathematical skills of the respondents

The data gathering needed for the completion of the study started when the researcher obtained approval for the conduct of this study from the dean of the college, the chair of the electrical engineering department, the instructors and professors and finally to the student–respondents.

The researcher personally administered the examination to the student–respondents in order to ensure the truthfulness of the data that were collected. After administering the examination, the researcher personally collected/retrieved the questionnaires.

The data were analyzed using frequencies, means and averages. In order to determine the relationship between mathematical skills and the academic performance of the junior and senior electrical engineering students of UEP–CE, multiple regression was utilized because the researcher wanted to predict the academic performance of the respondents in relation to the profile and the mathematical skills.

3. RESULTS AND DISCUSSION

Sex: Table 1.1 shows that out of 18 third year students, 17 or 94.4 percent were males and only one (1) or 5.6 percent was female; that out of 20 fourth year students, 16 or 80 percent were males and 4 or 20 percent were females; out of 21 students, 13 or 61.9 percent were males and 8 or 38.1 percent were females. It indicates that there were more male electrical engineering students from third year to fifth year levels.

This means that male students dominated the electrical engineering course.

Year level: Table 1.2 below shows that there were 18 or 30.5 percent third year; 20 or 33.9 percent fourth year and 21 or 35.6 percent fifth year students in the study. It indicates that there were more fifth year students than the other two year levels.

Table 1.1. The frequency distribution of respondents by sex

Year level	Sex	Frequency	Percentage
Third year	Male	17	94.44%
	Female	1	5.56%
	Total	18	100.00%
Fourth year	Male	16	80.00%
	Female	4	20.00%
	Total	20	100.00%
Fifth year	Male	13	61.90%
	Female	8	38.10%
	Total	21	100.00%
All	Male	46	77.97%
	Female	13	22.03%
	Total	59	100.00%

First year mathematics subjects: Table 1.3 reveals that among the three year levels, only the third year students got an average of 2.24 while the fourth year and fifth year had an average of 2.59 and 2.65 respectively. This indicates that the third year students had good overall grades in first year mathematics than the fourth year and the fifth year students. The finding is similar to the findings of Nahari [12] that the students showed high levels of mathematical achievement.

Second year mathematics: Table 1.4 refers to the average of final grades in second year mathematics. It shows that all of the three year levels had an interpretation of good with averages of 2.02 for the third year students, 2.10 for the fourth year students and 2.16 for the fifth year students. This indicates that the overall grades in second year mathematics of the three year levels are almost equal to each other.

Study habits: The Table 1.5 shows that of the ten responses, "I study and prepare for quizzes and tests" has the highest weighted mean, while spending vacant time in doing assignments or studying lessons got the lowest mean. This means that the third year students had excellent study habits.

The grand mean of implies that the students have a very good study habits, appropriate for an engineering student.

In Table 1.6, it is shown that the highest mean rating is "I study harder to improve my performance when I get low grades", while the lowest mean rating is the statement "I spend my vacant time in doing assignments or studying my lessons". The finding means that the fourth year students would study harder when they got low grades.

The grand mean implies that the study habit of the fourth year students were very good but not as good as the third year students.

Table 1.7 refers to the study habits of the fifth year student-respondents. It shows that the study habit with the highest weighted mean rating is "I study and prepared for quizzes and tests" which is interpreted as excellent while the study habit with the lowest weighted mean is the statement "I spend my vacant time in doing assignments or studying my lessons" which is interpreted as very good study habit. The grand mean implies that the fifth year students have also an impressive study habits but a little degree lower than the study habits of the third year and fourth year students. In general, the third year and fifth year students have similar highest and lowest responses while all the year levels have similar in the lowest response.

Generally, the findings confirm the results of the study of Kumar [13] that students with effective study habits often score good percentage in their examinations.

Table 1.2. The frequency distribution of the respondents by year level

Year level	Frequency	Percentage
3rd year	18	30.5%
4th year	20	33.9%
5th year	21	35.6%
Total	59	100.0%

Table 1.3. The frequency distribution of average grades in first year mathematics of the respondents

Year	Average	Interpretation
3rd year	2.24	Good
4th year	2.59	Fair
5th year	2.65	Fair

Table 1.4. The frequency distribution of average grades in second year mathematics of the respondents

Year	Average	Interpretation
3rd year	2.02	Good
4th year	2.10	Good
5th year	2.16	Good

Learning styles: Table 1.8 presents the learning styles of the students. It shows that in the visual learning style, the third year and fifth year got almost the same average while the fourth year got the lowest average. It indicates that the third year and fifth year are more of the visual learner type of students than fourth year.

In the auditory learning, the highest average was that of the third year students while the lowest average was from the fifth year students. It implies that in terms of auditory learning, there were more third year auditory learners than the fourth year and fifth year students.

In terms of kinesthetic learning, the highest among the three year levels was the fourth year students which has a little bit higher average value than the third year students while the lowest average was for the fifth year students. This indicates that the fourth year students were more of the kinesthetic learners while the fifth year level students had the lowest kinesthetic abilities.

In general, all the three year levels were considered as visual learners. It indicates that learners learn more through graphs, charts, maps and diagrams. It also indicates that the illustrations given by the teacher on the board that includes powerpoint, film showing and problem solving along the board were suited to the abilities of the students.

3.1 Level of Mathematical Skills

Table 2 shows that among the three year levels, the third year students had the highest mathematical skill with an overall average of 64.81 percent and interpreted as low while the fourth year and fifth year levels had an almost identical results of 45.5 and 45.24 percent respectively and both were interpreted as low. This indicates that the three year level students have a low mathematical skills. This confirms the findings of Carr [7] that there are significant number of students that struggle with basic mathematical concepts throughout the entire degree.

3.2 Level of Academic Performance

Table 3 presents the level of the academic performance of the third year, fourth year and fifth year students. It shows that all the three year levels had the same level of academic performance. This negates the results of the study of Laguador et al. [8] that student interest during freshmen is related to the academic performance in general education courses but not anymore true to professional courses.

3.3 Relationship between Students-profile and Mathematical Skills

The Table 4 shows the relationship between the profile of the students and their mathematical skills.

In general, it was found out that among the six independent variables, only the average of final grades in first year mathematics and the year level had a significant relationship with the mathematical skills of the students with a significant probability values of 0.008 and 0.001 respectively.

This indicates in general that the profile of the students did not have a significant relationship with the mathematical skills of the students. It can be inferred that the final grade in the first year mathematics and the year level can influence the mathematical skills of the electrical engineering students.

3.4 Relationship between the Profile of the Students and Academic Performance

The next table presents the correlation between the profile of the students and their academic performance. It shows that the variable sex had no significant relationship with the three year levels while the variables average of final grades in first year mathematics and average of final grades in second year mathematics had a significant relationship to each year levels with both had a significant probability values of 0.000. The study habit was significantly related with fifth year level with a significant probability value of 0.059. The learning style have no significant relationship with the three year levels. This finding negates the study of Chowhan [14] which stated that their learning styles has shown a significant relationship. Chowhan stressed that if students learning styles matches to their chosen academic course, they tend to show better performance and less adjustment problems.

In general, among the six independent variables only three have a significant relationship with the academic performance of all the students. These were the average of final grades in first year mathematics, average of final grades second year mathematics, and study habit. This

indicates that these three variables directly affect the academic performance of the students.

3.5 Relationship between Mathematical Skills and the Academic Performance of the Student-respondents

Table 6 presents the relationship between the students' mathematical skills and their academic performance. It shows that the mathematical skills had no significant relationship with the academic performance of the students. With an overall significant probability value of 0.155 which was higher than 0.05 level of significance. It means that the mathematical skills of the students did not affect their academic performance. This negates the findings of Nizoloman [15] stressing that there is a significant relationship between the student's mathematical skills and the achievement in mathematics.

Table 1.5. Study habits of the 3rd year student-respondents

Study habits	Weighted mean	Interpretation
I study and prepared for quizzes and tests.	4.78	Excellent
I study harder to improve my performance when I get low grades.	4.61	Excellent
I study the lessons I missed if I was absent from the class.	4.22	Excellent
I have a specific place to study at home which I keep clean and orderly.	4.17	Very good
I do my assignments regularly.	4.11	Very good
I exert more effort when I do difficult assignments.	4.0	Very good
I see to it that extracurricular activities do not hamper my studies.	4.0	Very good
I prefer finishing my studying and my assignments first before watching any television programs.	3.72	Very good
I spend less time with my friends during school days to concentrate more on my studies.	3.56	Very good
I spend my vacant time in doing assignments or studying my lessons.	3.06	Good
Grand mean	4.02	Very good

Table 1.6.. Study habits of the 4th year student-respondents

Study habits	Weighted mean	Interpretation
I study harder to improve my performance when I get low grades.	4.45	Excellent
I exert more effort when I do difficult assignments.	4.25	Excellent
I have a specific place to study at home which I keep clean and orderly.	4.25	Excellent
I do my assignments regularly.	4.20	Excellent
I study and prepared for quizzes and tests.	4.05	Very good
I study the lessons I missed if I was absent from the class.	3.95	Very good
I see to it that extracurricular activities do not hamper my studies.	3.65	Very good
I prefer finishing my studying and my assignments first before watching any television programs.	3.55	Very good
I spend less time with my friends during school days to concentrate more on my studies.	3.35	Good
I spend my vacant time in doing assignments or studying my lessons.	3.10	Good
Grand mean	3.88	Very good

Table 1.7. Study habits of the 5th year student-respondents

Study habits	Weighted mean	Interpretation
I study and prepared for quizzes and tests.	4.33	Excellent
I study harder to improve my performance when I get low grades.	4.24	Excellent
I do my assignments regularly.	4.24	Excellent
I exert more effort when I do difficult assignments.	4.1	Very good
I have a specific place to study at home which I keep clean and orderly.	4.0	Very good
I spend less time with my friends during school days to concentrate more on my studies.	3.57	Very good
I prefer finishing my studying and my assignments first before watching any television programs.	3.57	Very good
I study the lessons I missed if I was absent from the class.	3.52	Very good
I see to it that extracurricular activities do not hamper my studies.	3.52	Very good
I spend my vacant time in doing assignments or studying my lessons.	3.43	Very good
Grand mean	3.85	Very good

Table 1.8. Learning style of the student-respondents

Learning styles	Year level		
	Third year	Fourth year	Fifth year
Visual	3.92	2.76	3.90
Auditory	2.98	2.00	1.82
Kinesthetic	2.41	2.47	1.70
Interpretation	Visual	Visual	Visual

Table 2. Level of mathematical skills of the student-respondents

Year level	Level of mathematical skills	
	Average	Interpretation
3rd Year	64.81	Low
4th Year	45.50	Low
5th Year	45.24	Low

Table 3. Level of academic performance of the student-respondents

Year level	Level of academic performance	
	Average	Interpretation
3rd Year	2.10	Good
4th Year	2.00	Good
5th Year	2.13	Good

Table 4. Correlation between the profile of the students and mathematical skills

Student profile	Parameters	Mathematical skills			
		Third year	Fourth year	Fifth year	All year levels
Sex	Pearson Correlation	-0.031	0.270	0.063	-0.014
	Sig. (1 tailed)	0.451	0.125	0.392	0.458
	Interpretation	Not significant	Not significant	Not significant	Not significant

Student profile	Parameters	Mathematical skills			
		Third year	Fourth year	Fifth year	All year levels
First Year FG	Pearson Correlation	-0.098	-0.313	-0.065	-0.313
	Sig. (1 tailed)	0.350	0.089	0.390	0.008
	Interpretation	Not significant	Not significant	Not significant	Significant
Second year FG	Pearson Correlation	-0.349	-0.009	-0.056	-0.131
	Sig. (1 tailed)	0.078	0.484	0.404	0.161
	Interpretation	Not significant	Not significant	Not significant	Not significant
Study habit	Pearson Correlation	0.353	0.259	-0.068	0.154
	Sig. (1 tailed)	0.075	0.135	0.385	0.123
	Interpretation	Not significant	Not significant	Not significant	Not significant
Learning style	Pearson Correlation	0.324	0.181	-0.281	0.177
	Sig. (1 tailed)	0.095	0.223	0.108	0.090
	Interpretation	Not significant	Not significant	Not significant	Not significant
Year level	Pearson Correlation				-0.382
	Sig. (1 tailed)				0.001
	Interpretation				Significant

Table 4.1. Model summary for multiple regression

Model summary

Model	R	R square	Adjusted R square	Std. error of the estimate
1	.437[a]	.191	.098	5.82243

a. Predictors: (Constant), Learn style, study habit, second year FG, sex, year level, first year FG

Table 5. Correlation between the profile of the students and academic performance

Student profile	Parameters	Academic performance			
		Third year	Fourth year	Fifth year	All year levels
Sex	Pearson Correlation	0.159	-0.216	0.305	0.083
	Sig. (1 tailed)	0.264	0.180	0.089	0.266
	Interpretation	Not significant	Not significant	Not significant	Not significant
First year FG	Pearson Correlation	0.739	0.482	0.633	0.521
	Sig. (1 tailed)	0.000	0.016	0.001	0.000
	Interpretation	Significant	Significant	Significant	Significant
Second year FG	Pearson Correlation	0.855	0.387	0.703	0.616
	Sig. (1 tailed)	0.000	0.046	0.000	0.000
	Interpretation	Significant	Significant	Significant	Significant
Study habit	Pearson Correlation	-0.192	-0.331	-0.351	-0.278
	Sig. (1 tailed)	0.223	0.077	0.059	0.016

Student profile	Parameters	Academic performance			
		Third year	Fourth year	Fifth year	All year levels
	Interpretation	Not significant	Not significant	Significant	Significant
Learning style	Pearson Correlation	0.280	-0.227	-0.213	-0.017
	Sig. (1 tailed)	0.130	0.168	0.177	0.448
	Interpretation	Not significant	Not significant	Not significant	Not significant
Year level	Pearson Correlation				0.062
	Sig. (1 tailed)				0.320
	Interpretation				Not significant

Table 6. Correlation between mathematical skills and the academic performance of the students

Parameters		Academic performance			
		Third year	Fourth year	Fifth year	All year levels
Mathematical skills	Pearson Correlation	-0.363	-0.152	-0.149	-0.135
	Sig. (1 Tailed)	0.069	0.262	0.260	0.155
	Interpretation	Not significant	Not significant	Not significant	Not significant

Table 6.1. Model summary of multiple regression

Model Summary

Model	R	R square	Adjusted R square	Std. error of the estimate
1	135[a]	018	001	23149

a. Predictors: (Constant), mathematical skill

4. CONCLUSIONS AND IMPLICATIONS

As the findings of this study unfolded, it is concluded that the electrical engineering degree program was dominated by male students. It was revealed that the third year electrical engineering students had better average of final grades in all first year mathematics, the third year students had better performance in terms of the average of final grades in all second year mathematics, that the third year had the best study habits, but all of them were visual learners. It implies that electrical engineering third year students have better overall performance, however, most of them learn more using visual aids.

In general, the third year, fourth year and fifth year students had low mathematical skills, but among the three year levels, the third year students had the best performance in their mathematics subjects. This is due to the fact that the third year students can still vividly recall the past mathematical concepts learned in first and second years than the fourth year and fifth year students.

The level of academic performance of the three year levels were found out to be good. This indicates that the three year levels were not performing well in their major subjects.

It was found out that among the six variables of the student's profile, there were two variables with significant relationship with the mathematical skills of the students the average of final grades in all first year mathematics and the student's year level. The researcher concludes that the average of final grades in first year mathematics have a significant effect to the students mathematical skills since first year mathematics subjects are their foundations to continue to the next year level.

There was a significant relationship between average of final grades in first year mathematics, average of final grades in second year mathematics and study habits of the students' respondents. It indicates that the students profile had a major effect to the academic performance of the students.

Basically, the mathematical skills had no significant relationship to the academic performance of the students. The researcher concludes that the mathematical skills of the students do not affect their performance in major subjects and hence there may be other factors/variables that have a direct effect to their academic performance.

CONSENT AND ETHICAL APPROVAL

As per international standard or university standard guideline participant consent and ethical approval has been collected and preserved by the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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