

Enhancement Program to Bridge the Gap in Mathematics

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Abstract

In K to 12 Basic Education Program under the Department of Education (DepEd), all academic tracks except STEM have no Basic Mathematics in their curriculum. Basic Mathematics is offered in the STEM curriculum which includes General Mathematics, Basic Calculus, and Pre-Calculus wherein the topics are interconnected to Calculus 1. Based on the records from the College of Engineering office, almost half of the enrolled students in Engineering programs for the school year 2018-2019 failed Calculus 1. The study aimed to determine the performance of first-year engineering students in Basic Mathematics, the percentage rate of students passing Calculus 1, the significant difference in the performance of STEM Graduates to Non-STEM Graduates in Engineering Mathematics, and techniques and methods to bridge the gaps in enhancing the performance in Basic Engineering Mathematics of the incoming first-year students.

Data showed that among 197 students enrolled in Calculus 1, only 104 students passed. An online questionnaire via Google Form was also conducted to determine the insights of the students regarding their performance in mathematics courses taken in Senior High School coupled with assessment/test questions check their knowledge and skills acquired. One of the main factors that affect students' level of understanding of the SHS Curriculum is the lack of foundation and knowledge on the major subjects, specifically Basic Mathematics. An enhancement program to bridge the gap in mathematics is highly necessary by conducting summer classes in basic engineering mathematics for STEM and Non-STEM students.

Keywords: Performance, Basic Mathematics, STEM Graduates, Basic Education, General Mathematics

Introduction

K to 12 is a Basic Education Program under the Department of Education (DepEd) that aims to enhance learners' basic skills, prepare graduates for lifelong learning and employment and to produce more competent citizens ("k12philippines", n.d.). Furthermore, its goal is to create a functional basic education system that will produce productive and responsible citizens

equipped with the essential competencies and skills for both life-long learning and employment, (“Republic Act No. 10533”, 2012)

The K to 12 Program covers Kindergarten and 12 years of basic education (six years of primary education, four years of Junior High School, and two years of Senior High School) to provide sufficient time for mastery of concepts and skills, develop lifelong learners, and prepare graduates for tertiary education, middle-level skills development, employment, and entrepreneurship. Students acquire in-depth knowledge, skills, values, and attitudes through continuity and consistency across all levels and subjects. Subjects are taught from the simplest concepts to more complicated concepts through grade levels in spiral progression (“The K to 12 Basic Education Program”, n.d.)

As early as elementary, students gain knowledge in areas such as Biology, Geometry, Earth Science, Chemistry, and Algebra. This ensures a mastery of knowledge and skills after each level. In the previous curriculum in High School, Biology is taught in 2nd Year, Chemistry in 3rd Year, and Physics in 4th Year. In K to 12, these subjects were connected and integrated from Grades 7 to 10. The same method was adopted in other Learning Areas particularly in Mathematics. Senior High School is a two-year specialized upper secondary education; students may choose a specialization based on aptitude, interests, and school capacity. The choice of career track will define the content of the subjects a student will take in Grades 11 and 12.

There are seven learning areas under the core curriculum. These are Languages, Literature, Communication, Mathematics, Philosophy, Natural Sciences, and Social Sciences. Current content from some General Education subjects are embedded in the SHS curriculum. Each student in Senior High School can choose among three tracks: Academic; Technical-Vocational-Livelihood; and Sports and Arts. The Academic track includes three strands: Business, Accountancy, Management (BAM); Humanities, Education, Social Sciences (HESS); and Science, Technology, Engineering, Mathematics (STEM). The Technical-Vocational-Livelihood (TVL) track is designed to develop students’ skills useful for livelihood projects at home and it provides a curriculum that is a combination of core courses required for all SHS strands and specialized hands-on courses that meet the standard hour requirement and competency-based assessment of TESDA. The Sports and Arts track provides an understanding of the basic principles and techniques in relation to physical education and recreation; offers to discuss various factors that affect social, psychological, and cognitive development in sports leadership and management; and professions that are related in this track are fitness trainer, game officials, tournament manager, recreation attendant, masseur, or gym instructor. As a consequence, to the implementation of K-12 program by DepEd, CHED reduced the number of years for engineering program from five (5) to four (4) year. This was achieved by removing some courses, notably, Algebra, Trigonometry, Analytic Geometry and Solid Mensuration, which were previously offered in the first year of the old five-year engineering curriculum. Rationale given by CHED was that these courses were already covered in high school.

During enrolment, a student can be accepted to any chosen program regardless of his Academic track in senior high school provided he was able to pass the admission policy of the University. All academic tracks except STEM have no Mathematics in their curriculum.

Unfortunately, many students who took up engineering programs came from non-STEM tracks. Therefore, almost half of the enrolled students have failed to pass the subject Calculus 1 during their first year in engineering. This problem was observed at the Catanduanes State University, College of Engineering during the School Year 2018-2019 when the new curriculum was implemented.

The study aims to address the problem in the performance of the first-year students (Batch 2018-2019) in engineering mathematics that will further lead to the development of a bridging program i.e. conducting an enhancement class before the start of classes every school year. Enhancement program will be spearheaded by the faculty members who also handles the higher mathematics courses in 1st and 2nd year levels.

In order to effectively identify strategies and methods to close the gaps affecting said students' overall performance, the study's findings are expected to reveal information on the performance level of freshman students as well as the significant difference between STEM and Non-STEM graduates' performance in basic engineering mathematics. Specifically, the study aimed to determine the: 1) performance of first year engineering students in Basic Mathematics, 2) percentage rate of students passing Calculus 1, 3) significant difference of the performance of STEM Graduates to Non-STEM Graduates in Engineering Mathematics, and 4) techniques and methods to bridge the gaps in enhancing the performance in Basic Engineering Mathematics of the incoming first year students.

Materials and Methods

Research Design

This study utilized descriptive research method. The descriptive method according to Aquino (1974) is fact-finding with adequate interpretation. Manuel and Medel (1976) define descriptive research as 'what is'. It involves the description, recording, analysis, and interpretation of the present nature, composition or processes of phenomena. The data will be collected and analyzed using frequency tables and percentage. Qualitative analysis was also presented to interpret the insights of the students found from online questionnaire via google form as well as to determine the appropriate actions to be done.

Online questionnaire via google form was applied in determining the insights of the students on their performance in basic mathematics in senior high school level. Likewise, other factors affecting their learning efficiency were also identified using the same instrument.

Record of grades of the students who took up Calculus 1 was also considered to their performance in relation to their basic engineering mathematics foundation in senior high school level. Other personal information was also utilized to evaluate their academic track.

Research Site

The study was conducted at the Catanduanes State University, College of Engineering where sources of data were found from its office and was participated by 1st year engineering students of said college.

Sources of Data/Sampling

After having a thorough investigation, researchers have identified the best possible respondents of the study. Student's performance in Calculus 1 is the only way to evaluate the level of learning effectiveness in basic engineering mathematics in senior high school level. List of students who enrolled in Calculus 1 were gathered from the teachers who handled said course. These students were the first graduate in the K-12 program. They have graduated in various academic (STEM / Non-STEM) tracks and enrolled in the College of Engineering programs.

Random Sampling was used to determine the number of populations to be subjected for online questionnaire via google form process. This type of sampling is one in which everyone in the population of the inquiry has an equal chance of being selected to be included in the sample. After the random sampling, online questionnaire via google form was conducted. It serves as the supplemental tool in gathering data for this study.

Data collection / Instrumentation

The researcher composed a letter request addressed to the Registrar to provide the list of officially enrolled 1st year students for the school year 2018-2019 from both Bachelor of Science in Computer and Civil Engineering programs. Upon having the list, online questionnaire via google form was conducted to gather the insights of the students. Likewise, records from the College of Engineering was considered which could contribute for further assessment of the students' performance in basic mathematics.

Results

Topics in Basic Engineering Mathematics were incorporated in the course Calculus. Performance of students was based on their ratings in quizzes for the entire semester. Fifty percent is the passing rate to attain a grade of 3.0 as the numerical value. Based on the data presented, the median is 37.7% which divides the distribution into two equal parts. This means that 50% of the students incurred a rating below 37.7% and the other fifty percent had a rating above this value. Furthermore, based from the data, only 34.01% of students attained a rate of above fifty percent.

The percentage rate of students passing Calculus 1 is 52.79% based on the available data at the College of Engineering office. There were 197 students enrolled in the said course and only 104 students passed the said course.

The significant difference of the performance of STEM Graduates to Non-STEM Graduates in Engineering Mathematics is also computed. There are 190 students, 102 are STEM graduates, 88 are non-STEM graduates and 7 students graduated before the K-12 program was implemented.

Testing the Difference between Two Means:

STEM Graduates

Non-STEM Graduates

$$\bar{x}_1 = 3.30$$

$$\bar{x}_2 = 3.85$$

$$s_1 = 1.35$$

$$s_2 = 1.36$$

Assume that the STEM graduates have the higher level of performance than the Non-STEM

graduates. Use $\alpha = 0.01$

Significance Level: $\alpha = 0.01$, one-tailed test

Test Statistics: Z statistics

Critical region: $z < -2.33$

$$\begin{aligned} s_{\bar{x}_1 - \bar{x}_2} &= \sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}} \\ &= \sqrt{\frac{1.35^2}{102} + \frac{1.36^2}{88}} \\ &= \sqrt{0.0179 + 0.0210} \\ &= 0.1972 \end{aligned}$$

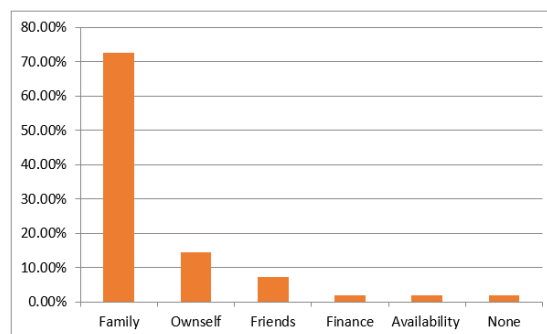
$$\begin{aligned} z &= \frac{\bar{x}_1 - \bar{x}_2}{s_{\bar{x}_1 - \bar{x}_2}} \\ &= \frac{3.30 - 3.85}{0.1972} \\ &= -2.79 \end{aligned}$$

Since the computed value of z is in the region of rejection, the assumption is correct. The average grade of STEM graduates is higher than the average grade of Non-STEM graduates.

An online questionnaire via google form was also conducted to get the insights of the respondents regarding their learning experiences during their senior high school years. The following are the results obtained by the researchers:

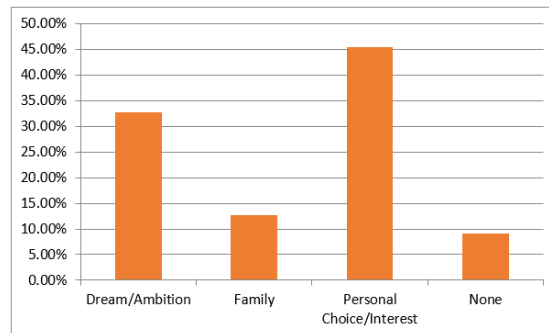
Table 1

Motivation to choose the curriculum



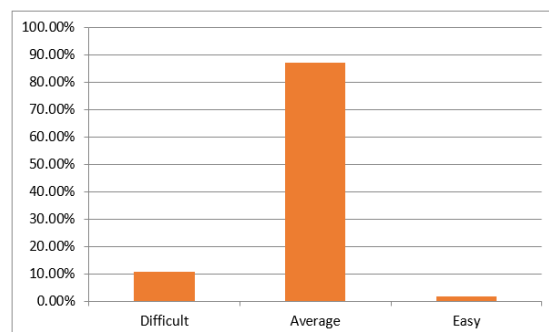
Motivation to students to enter Senior High School is of great importance in choosing the right track. Based on the graph shown above, 72.73% answered that family is their greatest motivation in choosing the curriculum. 14.55% students answered that it is their own decision to choose what curriculum they want. However, the decision of some students was also affected by their peers whom the graph shows 7.27%. In addition, only 1.82% was affected by their financial stability, availability of the programs and no motivation at all.

Table 2
Personal Motivation in choosing the curriculum



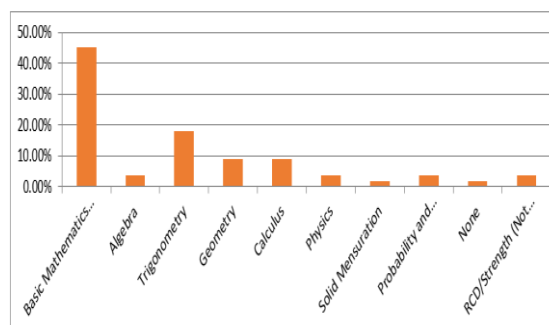
In choosing the right track in Senior High School, personal motivation is one of the major factors. Most students state that it is their personal choice or interest to enroll in their chosen track which the graph shows 45.45%. One of the factors that influence student’s decision is their dream to become an Engineer someday. The graph shows that only 32.73% of students choose their track because of their dream to become an Engineer someday. Only 12.73% was influenced by their family and 9.09% has no reason why they choose the track they are in.

Table 3
Level of difficulty in dealing with the lessons in Basic Mathematics



It is important to know the level of difficulty in dealing with the lessons in Basic Mathematics to address the needs of the students. In the survey taken by the researchers, 87.27% find the lesson in Basic Mathematics average. That means that they can manage to understand some lesson discussed. However, 10.91% of students find it difficult to understand. 1.82% of students find it easy in dealing with the said subject.

Table 4
Level of Difficulty of Specific Subjects in Basic Engineering Mathematics



Basic Mathematics in Senior High School is the foundation subjects when students would want to take Engineering Programs. Some of the students find it difficult to understand the lesson conducted by their teachers in SHS. 45.45% of students find Basic Engineering Mathematics in general difficult. It means that they cannot easily understand their lessons in their entire subject in Basic Engineering Mathematics thoroughly. Some of the students find specific subjects in Basic Mathematics difficult. 18.18% of students are having difficulty in Trigonometry; 9.09% in Geometry and Calculus; 3.64% in Algebra Physics and Statistic; and 1.82% in Solid Mensuration. However, 1.82% of students did not find Basic mathematics difficult.

Discussions

The researchers conducted an online questionnaire via google form with the 2018-2019 first year civil engineering students regarding the factors that affect the level of their understanding in the SHS Curriculum and their learning habit in Basic Mathematics; insights in the said curriculum and the basic instruction provided by their SHS Teachers; and the difficulties encountered from their teacher during instructions.

Factors that affect the level of your understanding to the said curriculum

One of the main factors that affect the level of understanding of students in SHS Curriculum is the lack of foundation and knowledge on the major subjects specifically Basic Mathematics. 38.18% of students are having difficulty to decide what track they will choose after they graduated Junior High School. Once they entered the SHS, students lack basic principles and understanding on the curriculum they jump into. Some of the students states that the environment can be of great influence in understanding the said curriculum.

What can you say about the different curriculum offered in senior high?

Senior high school (SHS) refers to Grades 11 and 12, the last two years of the K-12 program that DepEd has been implementing since 2012. Students begin to study in SHS the subjects that will introduce them to their preferred career path. Result from online questionnaire via google form, majority of the respondents are contented on the different curriculums offered in senior high school. 36.36% states that the curriculum is good enough to prepare them for college. It offers advance knowledge and skill development for every student dedicated to learn from it. In addition, 18.18% of the respondents find the curriculum helpful and properly implemented. However, 18.18% of the respondent's state that the curriculum is not enough to prepare them to tertiary education. Almost all schools in the Philippines lack facilities and competent teachers with skills to enhance the knowledge of the students, says one of the respondents. "Maraming kulang, parang pinilit lang". The remaining respondents also think that if they choose the right track in SHS, it will help them prepare whatever program they choose.

What can you say about the basic instructions provided by your teachers in basic Math course?

Teachers are one of the factors why students learn. "Excellent and Good", says 32.73% of the respondents. But unfortunately, 18.18% of the respondents state that some topics in Basic Mathematics were not discussed due to the reason that they have different curriculums in SHS. For example, their track was TVL, wherein the curriculum is not in line with the curriculum in Engineering. "As the first batch, teachers also need to cope with the new

subjects. But because of this sudden change in the curriculum, they don't even much comprehend the basic math either. It is also hard for them.” says one of the respondents. 10.9% of the respondents agree that some teachers are having difficulty to teach basic mathematics. In addition, the remaining respondents are not satisfied and they find it hard to understand the subject.

State some difficulties encountered from your teacher during instruction

Difficulties encountered during instruction are normal to some students. Difficulties are things that are hard to accomplish, deal with, or understand. Student respondent's state that the lessons are not discussed thoroughly resulting to a slow-paced delivery. 47.27% of the respondents are having difficulty in understanding the lesson for the reason that some teachers are merely solving the problem without explaining properly; some are still adjusting with the new curriculum; some are too fast in the discussion that they cannot cope up with the lessons; and some are unable to use his knowledge flexibly in practice to appraise and adapt instructional materials and to represent the content in accessible way. “Mastery of the subject”, one of the difficulties encountered from their teacher of the 7.27% respondents. 5.45% state that the teacher absence is one of their difficulties. The rest of the respondents have no difficulties encountered at all.

Factor(s) that affects your learning habit in basic Math course

One of the factors that affect the learning habits of students is their focus and concentration. In fact, 54.55% of the respondents agreed that their study habit is greatly affected by some distractions namely; social media, gadgets, other activities in school, environment/peers, and lack of time and interest in the subjects. 10.90% of the respondents believe that the learning habit is also affected with their capacity to understand and analyze problems in Basic Mathematics. However, 10.90% of the respondents think that the teacher is one of the factors that affect their learning habit. Teacher's way and style of teachings greatly affect their study habits. On the other hand, the remaining respondents aggressively point out that their motivation to succeed is the one of the factors to strive more in their studies. Their passion and interest in learning engineering and their ultimate goal in life pushes them to study harder.

Conclusion

Based on the data presented, the performance of first year engineering students in Basic Engineering Mathematics is quite low. The cause of the said low performance is due to the fact that they lack knowledge in the said subjects. Some of the reasons are the lack of facilities, resources and program given by the schools offering Senior High School; the mastery of the teacher teaching the said subject; and the learning habits of the students. As a result, some students who enter college, specifically in engineering program, tend to fail the subject Calculus. Furthermore, there is a significant difference between the performance of STEM and Non-STEM graduates.

Some of the techniques and method to bridge the gaps in enhancing the performance in Basic Engineering Mathematics of the incoming first year students are the following:

1. Teachers in Senior High School should choose and teach topics in line with the curriculum of the specific strand and should acquire mastery of the subject.

2. Improve the facilities and supply sufficient textbooks/references to students to be used by students during their study.
3. Improve the learning of students through an enhancement class before entering tertiary level.
4. First year students should attend review classes or group studies to motivate them to study their lesson habitually.

The respondents of the study were students of the College of Engineering who graduated from Senior High School last March 2018. They are the first batch of students when the K-12 program was implemented. Based from the findings and conclusions, researchers therefore recommend to develop bridging by conducting an enhancement class during summer period or mid-year break in basic engineering mathematics for STEM and Non-STEM students. Since mathematics is the principal tool of engineering courses, the enhancement program in Algebra, Trigonometry, Analytic Geometry and Solid Mensuration will prepare incoming freshmen adequately to take Differential Calculus, Integral Calculus and to the next higher or advanced mathematics. Lastly, replication of this study may be considered in other academic programs.

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Contribution Of Individual Authors

KAB, RBS, PRA, JR. designed the study; KAB, RBS, PRA, JR. conducted the analysis; KAB, RBS, PRA, JR. wrote and edited the paper; and all authors agreed to submit it.

Conflict of Interest

The authors affirm that they do not have any competing interests.

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