

An Attempt To Correlate Poor Performance In Engineering Mathematics During The First Year Of Polytechnic Education With The Grounding Provided In The Student's Secondary Education

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Introduction

Students entering into **Ngee Ann Polytechnic (NP)** are usually of the age of sixteen or seventeen. They had just finished their secondary school education and had sat for the Cambridge GCE "O" levels. Based on their "O" levels results, these secondary school students will have certain options. For the better ones, they will normally choose to continue their education in the junior colleges where they hope to enter the university after two or three years of study in the junior college. And, for those who could not enter the junior college due to poorer GCE "O" levels results, will usually choose to enter the polytechnic. They will then study three to four years in the polytechnic after which they will receive a diploma if they pass the examination.

From the polytechnic's recent year's statistics, there is a frightening trend that students entering into NP are getting poorer in quality in terms of their GCE "O" levels results. And, this trend had already become a norm in the recent few years.

In the meantime, it was also noticed that more and more students fail to obtain a pass during their first attempt in level 1 subjects in NP and Mathematics is just one subject on this list. Students who fail any subject will have to repeat it in the next semester of their course of study. As a result, their timetable will usually be packed by many continuous hours, and they also have odd study hours too. They no longer follow the main stream of students in their course of study. Many of these students felt left out and they lost the motivation and the determination to continue their study anymore. Hence, some of these students gave up halfway. There were some sad cases where students gave up during their second or third year of study, which crudely means that, they had wasted their time in those years.

The **Mathematics, Science and Computing Center (MSC)** in NP has been constantly thinking of ways to help these students, or at least help them in the area of Mathematics. Measures like the Mathematics Enrichment Course is an example of this sort. The Mathematics Enrichment Course is a one-time crash course offered to students before they start their academic journey in NP. This is a preparatory course in Mathematics targeted at the group of students with poor mathematics results in the GCE "O" levels. Other measures also include remedial classes and peer tutoring which can be made compulsory for the weaker students. Also, the syllabus for mathematics had been revised and the structure of course delivery had been modified also. All these are attempts to help our students to cope better in the subject. Some of these measures were carried out with the assumption that poor level 1 mathematics results in the polytechnic is due to poor secondary education grounding. But, is this really the case or are there any other factors that had affected the students which caused their poor results?

The subjects of this study

The study was conducted on a class of students who had failed Engineering Mathematics 1(EM1) in their first year first semester and had repeated the subject in their first year, second semester.

Finding an answer

The study aims to explain the assumption that poor EM1 results is due to poor secondary education grounding and to identify various reasons for causing the poor EM1 results. A survey form was designed for this purpose, and it was designed with the intention of capturing reasons that are both academic and non-academic in nature which might directly or indirectly affect the not-so-satisfactory results during their secondary school education, which might contribute to one of the reasons why they did badly in EM1. Hence, this survey form does not have the usual format, and in some questions, students are allowed to choose more than one item (see appendix for survey form).

The survey aims to capture answers in the following areas:

- Secondary Mathematics background of the students
- Learning style of the students
- Students' attitude towards learning
- Environment for learning and parental intervention in study

Question 1 to Question 5 aim to find some answers to the mathematics ability and mathematics background of the students. Question 6 to Question 9 aim to find out students' learning style and their attitude towards learning. Question 10 and Question 11 study their financial ability and Question 12 and Question 13 study the environmental factor and parental intervention in their study.

Analysis on the Secondary Mathematics Background of this group of students

Out of 33 students who were being surveyed, only 2 (~6%) had studied Additional Mathematics before they entered NP. Additional Mathematics is a secondary school subject, which is only offered to students with better mathematics ability. Out of these 2 students, one had scored grade B3 and the other C5 in their GCE "O" level examination, which showed that even though they had studied the subject, they were not good at it. Also, looking at their Elementary Mathematics grades in their GCE "O" level examination, 4 out of 33 (~12%) scored A, 17 (~52%) scored B, 10 (~30%) scored C and 2 (~6%) scored D. This statistics show that students are average in their Elementary Mathematics grounding. These findings, once again, re-enforce the assumption that poor EM1 results could be the result of poor Mathematics ability and secondary education grounding.

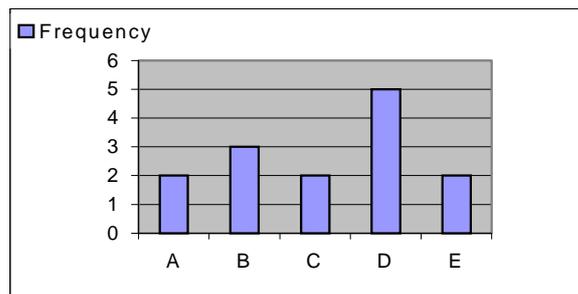
When these students were asked about how they rate the difficulty level of the Elementary Mathematics in the "O" levels (Question 3 of the survey form), almost 82% (27 students out of 33) found it moderately easy to very easy. They could understand the subject matter without the need to put in much effort. Only 18% (6 students out of 33) found it difficult and they can only understand a little when they put in a lot of effort in their studies. This part of the result is very alarming in the sense that students find the subject matter in Elementary Mathematics moderately easy, but this pre-assumption of ability is not reflected in their actual results of the subject.

From here, we may want to conclude that students "**Lack the ability to realize their own ability in learning**" or "**students construct their own theories during the course of their study which turn out to be incorrect or half-truths**". This phenomenon may have been carried forward to their year 1 of study in NP, and may be with them throughout their academic life. This phenomenon could also contribute to one of the factors why they did badly in EM1.

Mestre (1989) also mentioned these misconceptions. *Misconceptions are a problem for two reasons. First, they interfere with learning when students use them to interpret new experiences. Second, students are emotionally and intellectually attached to their misconceptions, because they have actively constructed them. Hence, students give up their misconceptions, which can have such a harmful effect on learning, only with great reluctance.* Similar ideas were also mentioned by Resnick, L. (1983).

Students whose Elementary Mathematics grades which is not A or B, were asked to identify some possibilities that have affected their not-so-satisfactory grade in Elementary Mathematics (Question 4 of the survey form), here are their responses:

- A : No interest in the subject at all
- B : Secondary school teacher did not teach in the way that is easy to understand
- C : No time to study because there were other commitments like working part-time
- D : I was interested in the subject, but do not know why I did not do well
- E : Other reasons

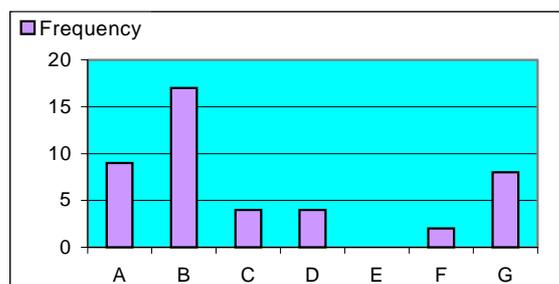


Two students had chosen option E (other reasons), and their reasons given were as follows:

1. Laziness
2. Not in the mood to study

But, the more alarming discovery is, most students had chosen option D that says " I was interested in the subject, but **do not know** why I did not do well ". This response once again coincides with the phenomenon mentioned earlier. Students are not aware of their strengths and weaknesses. They probably lack study skills that play an important role throughout their academic life.

The survey then moved on to ask them for the reasons which they thought that had affected EM1 grade in year 1. The following graph shows their responses:



Reasons

- A : No interest in the subject at all
- B : Lecturer did not teach in the way that is easy to understand
- C : Not aware that I will fail EM1 until the last minute before examination
- D : No time to study because there were other commitments like working part-time
- E : I have too many extra curricular activities/social activities
- F : I was interested in the subject, but do not know why I did not do well
- G : Other reasons

Comparing the responses of this question with that of the previous one, many students had chosen more than one option in this case, and option B was the most popular among all. After some one-to-one interview with the students, it was discovered that in the students' opinion, lecturer's devotion and time spent with them does matters a lot when deciding their performance in the subject. Also, many students had chosen option, A which says "No interest in the subject at all". This could be the consequence of having poor mathematics background and poor study skills which they have brought with them from their secondary education, and have caused them to be lost and disillusioned halfway through EM1. Other reasons given by the students (under option G) were,

1. Poor time management
2. Lack of practice
3. Being barred from the examination due to low attendance record in the previous semester
4. Had some personal problems at that time
5. Laziness

After looking at all the questions in the questionnaire which aim to discover students' mathematics ability and mathematics background, we can conclude that these students

- have minimal knowledge of Additional Mathematics
- have average or below average Elementary Mathematics ability
- lack the skills to identify their own strengths and weaknesses
- lack the ability to realize their own ability to learn

Analysis on students' learning style and attitude towards learning

Question 6 and Question 7 hope to find out about students' attitude towards learning and education. Question 8 and Question 9 ask about their plans for their future career advancement and whether it is directly related to their cause of study in NP. Looking at their responses to Question 6 and Question 7, 29 out of 33 (~88%) of the students are willing to sacrifice the time they spent on other extra curricular/social activities and put in more time in their studies. And, 26 out of 33 (~79%) wanted to attain good grades in their studies. For Question 8, 25 out of 33 (~76%), actually have thought about what they wanted to do in their future career advancement. These responses show fairly high percentage that indicates positive attitude towards learning and study. This high percentage in positive responses also indicates that the students actually know what they want. Let's look further at their responses for Question 9, which ask " Is your ambition related to what you are studying now ". The statistics is as follows: 13 out of 33 students (~39%) say that their perceived future career is related to what they are studying at the moment. But 19 out of 33 (~58%) answered otherwise. And one student answered "Not sure", even though that is not one of the choices given. From the statistics of all the four questions (Question 6 to Question 9), it can be seen clearly that

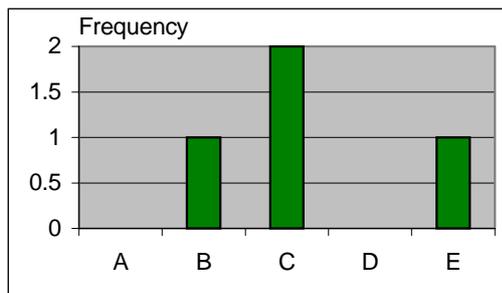
students do have a clear idea of what they want, they are willing to sacrifice their time for other non-academic activities and put in effort in their studies to obtain good grades, they have a clear idea of their future career advancement, but majority are not studying, or in their opinion, they are not studying something which they think is related to what they wanted to be in the future. One likely explanation for such responses could be that students were not given their choice of study when entering NP, due to their "O" level results being not good enough to meet the entry mark of their ideal course. Hence, students lack the interest, as they are not studying something that they have opted for in the first place.

But, there is another possible explanation which, in my opinion, is worth looking at. Supposedly, students enter their first choice of study, which is Electrical Engineering in this case, but, they still did badly in EM1 in their semester 1, year 1, therefore, they were in my class in semester 2, year 1, studying EM1 again. And the responses of this group of students was "Their future career advancement was NOT related to what they are studying NOW". The explanation, which I'm trying to give, is, students may not be able to relate the relevancy of mathematics, or at least, the first year Engineering Mathematics to their main course of study, in this case, is Electrical Engineering. The reason is, most of the topics which are being taught in EM1 are driving at basic mathematical skills. Topics like Quadratic Equations, Functions, Indices, Exponents and Radicals etc, are more focused on basic mathematical skills and very few direct applications on Electrical Engineering. Even if there are applications on Electrical Engineering, it will be very simplified ones and, they are still driving at perfecting basic mathematical skills. Efforts were put in to include more engineering based questions, like those in the topic "Complex Numbers", but again, they are also to some extent simplified versions, as compared with those application problems which are taught in Engineering Mathematics 4. As mentioned in the earlier sections, students' mathematics skills were not excellent when they enter the polytechnic, thus, perfecting their basic mathematics skill, before moving on to in-depth applications problems, is a MUST. But, students may not have realized this, and doubt the relevancy of mathematics in their engineering course. In conclusion, majority of the students who were being surveyed has good attitude towards study. They have a clear idea of their future career advancement, but a large portion of them are not studying something, which they think will be related to their future career advancement.

Responses for students' Financial Ability, Study Environment and Parental Intervention in their study

29 out of 33 students had answered "NO" and 4 had answered "YES" to question 10: "Are you working part-time?"

Responses for Question 11: "What is the reason for working part-time?"

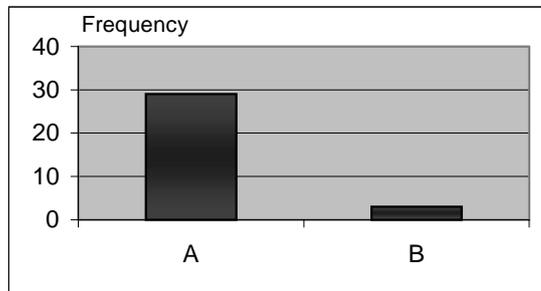


Reasons

- A: Support family
- B: Support my school fees
- C: Support my heavy expenditure
- D: For the fun of it/to makes friends outside campus
- E: Others

From the responses to Question 10 and Question 11, majorities of the students who are being surveyed do not have financial problems. Only 1 out of 33 students need to work to support his school fees. The rest of the students who work need the money to support their heavy expenditure. This means that, the possibility that they have to work and thus hinder their progress in their study does not exist at all.

Let us now look at their responses for Question 12. Question 12 asks, " Do you think that NP's environment is conducive for academic progress? ". Their responses are as follows:

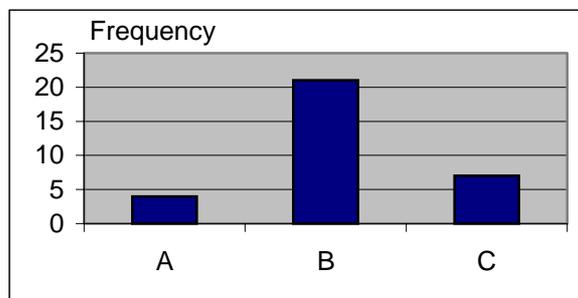


- A: Yes, NP's environment is conducive for academic progress
- B: No. Reasons given by students
 - 1) Don't know
 - 2) Lecturer is not motivating

Judging from their responses, the possibility that NP's environment is hindering their academic progress does not exist at all.

Let us now proceed to the last question of the survey that asks " How much do your parents interfere into your studies? ". And their responses are as follows:

- A: All the time
- B: Sometimes (only when they know that I do not do well in school)
- C: Never



Only 4 out of 33 students (~12%) received constant attention from their parents regarding their studies. This is a fairly small percentage compared with those who answered otherwise. Majority of the students comes from families who give them little or no attention at all. This discovery may tell

us that parental intervention or involvement plays quite an important role in deciding if their children will perform well in school.

Conclusion

Summarizing all the responses of the questions from the survey, we may want to conclude certain characteristics of this particular group of students from the Electrical Department, who failed their Engineering Mathematics 1 in semester 1, year 1, of the course of study and repeating the same subject in semester 2, year 1. Some or all of these characteristics could have contributed to the reasons on why they failed the subject.

- 1) They have no or minimal Additional Mathematics background because, either they did not study the subject in their secondary level education or scored badly for the subject in the "O" levels examination.
- 2) They have average or below average basic mathematical skills as it can be seen from their Elementary Mathematics grade in the "O" levels.
- 3) They lack the ability to identify their own strengths and weaknesses, and they failed to realize their ability to learn, as many of them were not aware that they will fail their Engineering Mathematics 1 until the very last moment.
- 4) They have good attitude towards learning and many of them are willing to sacrifice their time for non-academic activities and put in effort for good results in their studies.
- 5) They have a clear idea of what they want to do in the future.
- 6) Majority thinks that their studies now is not related to what they want to do in the future.
- 7) They have no financial difficulties.
- 8) Majority of the students came from families who give them little or no attention in their studies.

Recommendations for future studies

This study was performed on a fairly small group of students, which only consists of 33 pupils. However, this could be a starting point for future studies in similar area.

For example, this same study could be extended to a bigger group of students of the same subject, i.e. Engineering Mathematics 1 for students from the Electrical Department and continue the same type study for a number of years. In this case, one might be able to draw better conclusions from this long-term study.

On the other hand, one can also use the multi-prong approach, that is, to conduct similar studies on students taking other subjects besides mathematics.

References

1. Mestre, Jose, 1989
Hispanic and Anglo Students' Misconceptions in Mathematics
2. Resnick, L. (1983).
Mathematics and science learning: A new conception
3. Sing Kar Joo, Ng Chee Loong, Koh-Kwok Wan Yee
Identifying students' difficulties in Mathematics

Appendix

Survey for students taking EM1 (January 1999)

Dear student,

The purpose of this survey is for us to have a better understanding of your mathematics background, your learning style, attitude towards learning, environment of learning and other factors that might contribute to your learning abilities.

Kindly give your true opinion for each question.

Thank you very much.

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Experience

1. Do you have Additional Mathematics background in your secondary school education? If yes, please specify the grade you obtained in the “O” levels.
 - Yes. Grade: _____
 - No

2. What was your “O” level E Math grade?
 - A (A1 or A2)
 - B (B3 or B4)
 - C (C5 or C6)
 - D (D7)
 - E (E8)
 - F (F9)

3. How do you rate the difficulty level of E Math in the “O” levels?
 - Very difficult (cannot understand at all)
 - Difficult (can understand a little if put in a lot of effort)
 - Moderate (can understand if put in some effort)
 - Easy (can understand majority of the topics without spending much time)
 - Very easy (no problem understanding at all)

4. If your E Math grade is A or B, **DO NOT ANSWER THIS QUESTION.**

What were the reasons you think that have affected your not-so-satisfactory grade in E Math?
(You can tick more than once)

- No interest in the subject at all
- Secondary school teacher did not teach in the way that is easy to understand
- No time to study because there were other commitments like working part-time
- I was interested in the subject, but do not know why I did not do well
- Any other reasons, please specify: _____

5. What do you think were the reasons for failing EM1 in the last semester? (You can tick more than once)

- No interest in the subject at all
- Lecturer did not teach in the way that is easy to understand
- Not aware that I will fail EM1 until the last minute before exam
- No time to study because there were other commitments like working part-time
- I have too many extra curricular activities/social activities
- I was interested in the subject, but do not know why I did not do well
- Any other reasons, please specify _____

Personality

6. Are you willing to sacrifice the time you spent on extra-curricular activities/social activities (including outside-school activities) and put in more time on your studies?

- Yes
- No

7. What is your objective in your studies?

- To attain good grades by putting in great effort; OR
- To pass the examination by minimal effort

8. Have you thought about what you want to do in the future in career advancement?

- Yes
- No

9. Is your ambitions related to what you are studying now?

- Yes
- No

Financial

10. Are you working part-time?

- Yes
- No

11. IF YOU DO NOT WORK PART-TIME, **DO NOT ANSWER THIS QUESTION**

What is the reason that you are working part-time?

- Support my family
- Support my school fees
- Support my heavy expenditure
- For the fun of it/ to make friends outside
- Others, please specify: _____

Environment

12. Do you think that NGEE ANN POLYTECHNIC environment is conducive for academic progress?

- Yes
- No, please specify _____

13. How much do your parents interfere into your studies?

- All the time
- Sometimes (only when they know that I do not do well in school)
- Never

End of survey

Thank you for your assistance