

# Effectiveness of mathematics education in secondary schools to meet the local universities missions in producing quality engineering and science undergraduates

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**Abstract.** Critical claims by certain quarters that our local undergraduates are not performing well in Mathematics, Statistics and Numerical Methods needs a serious thinking and actions. Yearly examinations results from the Sijil Pelajaran Malaysia (SPM equivalent to A-Level) and Sijil Tinggi Pelajaran Malaysia (STPM equivalent to O-Level) levels have been splendid whereby it is either increasing or decreasing in a very tight range. A good foundation in mathematics and additional mathematics will tremendously benefit these students when they enter their university education especially in engineering and science courses. This paper uses SPM results as the primary data, questionnaires as secondary, and apply the Fish Bones technique for analysis. The outcome shows that there is a clear correlation between the causes and effect.

## 1. Introduction

Mathematics education, especially in secondary schools in Malaysia, are taught in the form of the basic syllabi for Form One to Three, and the advanced syllabi for Form Four to Five. While in the upper secondary schools, that is, Form 6, mathematics education is basically at par with the one in the first year at university. Additional mathematics that a student took the secondary school is useful for those students taking engineering and science bachelor degrees. Undergraduates who took engineering, physics and mathematics as their field of studies may find that the knowledge and understanding in additional mathematics are very helpful.

Mathematical-based subjects such as Mathematics, Numerical Methods and Statistics are the three subjects usually offered to those students majoring in engineering, physics and mathematics at university. These subjects usually involve theorems, formulae and laws, and need a clear understanding on the subject matters which requires derivations, proofing and applications. Mathematics subject alone covers algebra, calculus, integration and derivations [1]. Numerical Methods is basically another ways for solving mathematical problems [2], while Statistics covers probability [3].

## 2. Issues and problem statements

The SPM results from the state of Melaka (table 1) for Additional Mathematics were very encouraging with more than 70% passes has been achieved yearly but at the same time the total number of candidates taking the subject were declining and, this is not a good sign.



**Table 1.** Yearly SPM Results for Additional Mathematics from Melaka.

Year	% Passes	Grade A+	Grade A	Grade A-	Grade G(fail)	Total No. of Candidates
2012	76.89	1013	51	485	1515	6532
2013	79.0	876	222	419	1386	6602
2014	75.5	362	417	389	1581	6463
2015	72.4	191	435	290	1637	5936
2016	70.6	242	373	259	1536	5220

Malaysia Government is introducing STEM (Science, Technology, Engineering and Mathematics) at the school level. The decreasing numbers of students taking additional mathematics at the SPM level means the chances of the local university in Malaysia getting the right quota for STEM courses are at risk. More students are moving to courses that are non-technical or requires less or non-mathematical type of subjects such as information technology, computer science or hotel management.

Undergraduates may find that mathematics, numerical methods and statistics are subjects that requires them to be good in problem solving, derivation and analysis in order to excel in those subjects. Thus, weak students in mathematics will find mathematics at the university level a subject difficult to understand. Therefore, the local universities are producing indirectly graduates who are afraid of numbers.

The main objective of this paper is to show that the above claim or argument has bases. A case study at Universiti Sains Islam Malaysia (USIM), Bandar Baru Nilai, Negeri Sembilan was selected where the primary data was taken from the Faculty of Engineering and Built Environment (FKAB).

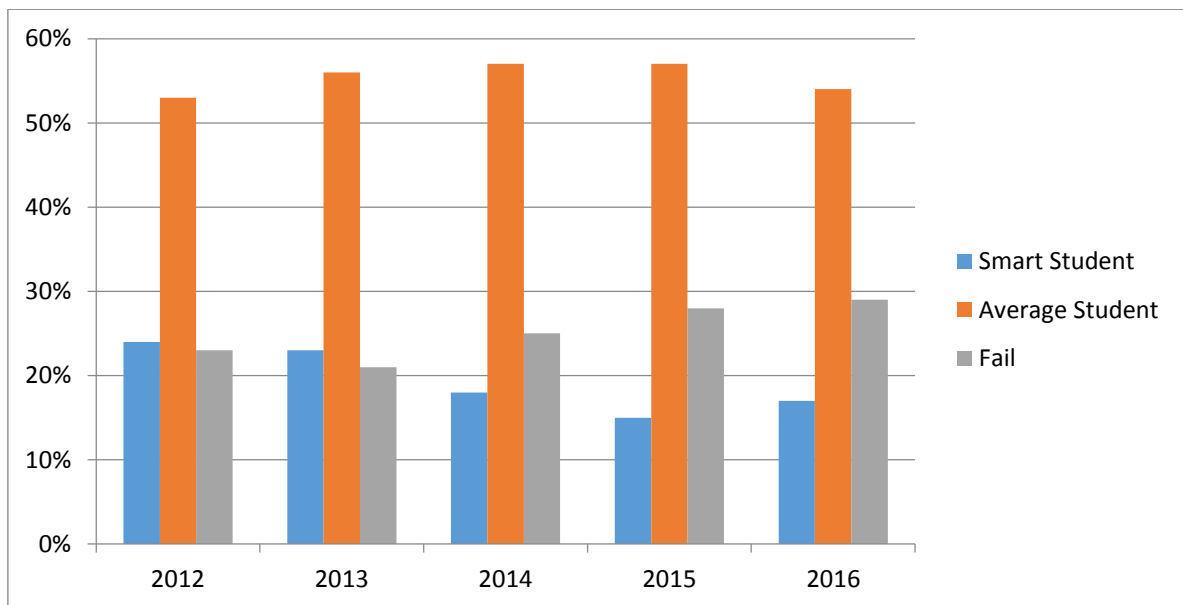
### 3. Analytical and critical analysis

The paper is proposing the Fish Bone technique [4] for analysis purpose that comes together with a hypothesis as follows: Smart students in Mathematics at secondary school will become smart undergraduates in Mathematics at university.

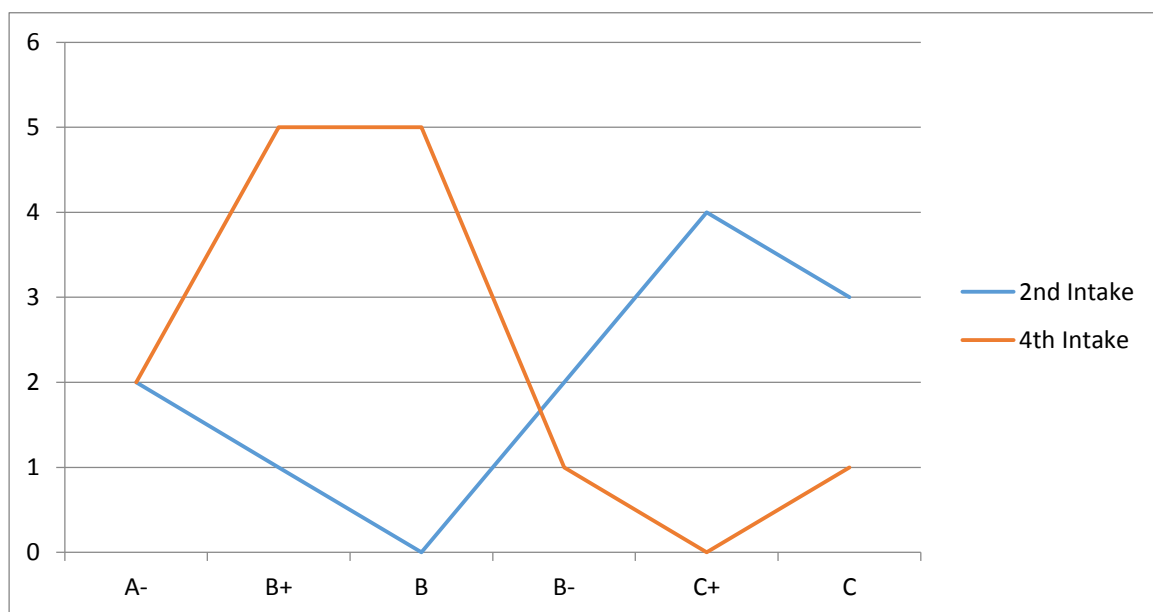
For the primary data collection, data are being collected from USIM undergraduates. From table 1, smart students are defines as those students who obtained grade A+, A and A- in their respective subjects at SPM level. Figure 1 shows the smart students in Additional Mathematics made up 15% to 24% in the state of Melaka, which is quite high in terms of percentage. These students were assumed to continue their studies after finishing their SPM even though this work has no proof to back up the statement. Anyway, in order to support the mentioned hypothesis, data are collected from the smart students (who not necessary came from Melaka) that managed to get a place to study Electronic Engineering degree at USIM.

Figure 2 shows the smart students' results for Mathematics I (KEH1132) are nothing to shout loud where nobody obtained Grade A in their examination. The two intakes were taught by two different Mathematics lecturers in English.

Secondary data collections are conducted by giving three different sets of questionnaires to three groups, mainly (i) Bachelor of Electronics Engineering undergraduates at FKAB (USIM), (ii) Additional Mathematics secondary school teachers from Melaka and Selangor, and lastly (iii) Mathematic Lecturers from USIM.



**Figure 1.** Yearly smart students and failures SPM results for Additional Mathematics.



**Figure 2.** Smart Students at FKAB, USIM for Mathematics I (KEH1132).

### 3.1. Bachelor of Electronics Engineering Undergraduates

From table 2 below, 25 out of 29 undergraduates agreed to Question no. 2 which states that “Do you find any difficulties in excelling Year 1 Mathematics subjects?”. The other four undergraduates who have no difficulties in taking KEH1132 were assumed to be the smart students, and have no means to counter check on this since the questionnaires did not carry any names. Again, all of the undergraduates said “yes” when it came to Question no. 5 which stated that “Do you think that your secondary school Mathematic teachers are good enough?”. Lastly, the undergraduates were about even to Question no. 3: “Do you agreed that the enhancement exercises in Additional Mathematics’ secondary school classes will develop the students to understand less?”.

**Table 2.** FKAB Undergraduates.

Set A	TT	T	ST	R	Y	T	S	TS
Q1	3	25	0	1				
Q2					25	4		
Q3							14	15
Q4							8	6
Q5					29	0		

### 3.2. Additional Mathematic Secondary School Teachers

From table 3 below, around 83% of the secondary school teachers did not agree Q1 which ask “Do you think that the enhancement exercises in Additional Mathematics classes will help the student to memorise the question and answer patterns?”. For Q2, all teachers agreed to a more creative technique to be used in class. The teachers were on even when comes to Q3: “Do you agreed that your secondary school teachers should come from first graders”. All the teachers were saying “not agree” to Q4: “Do you think that your secondary school teachers are not keen in teaching Additional Mathematics?”. None has answered Q5.

**Table 3.** Additional Mathematic Teacherswe

Set B	S	TS
Q1	1	5
Q2	6	0
Q3	3	3
Q4	0	6
Q5	No answer	

### 3.3. University Mathematic Lecturers

From table 4 below all lecturers tended to say “Moderate (S)” rather than “Not Difficult (TS)” when answering Q2: “What is your comments on the level of understanding amongst your Mathematic Year 1 undergraduates?” and Q3: “What is your comment on your undergraduate willingness to master Mathematic Year 1 subject?”. To Q5, most of the lecturers said that the undergraduates needed a better understanding in order to excel in the subject.

**Table 4.** University Mathematics Lecturers

Set C	Y	T	R	S	T	S	TS
<b>Q1</b>	3	1					
<b>Q2</b>			2	2	0		
<b>Q3</b>			1	3	0		
<b>Q4</b>						2	2
<b>Q5</b>			Not good in understanding the subject				

#### 4. Suggested strategies, plan of action and solution

For the short term strategy, it is better to look at the pattern in setting up the SPM examination questions. The present pattern of questions can be predicted rightly by any candidates, that is, by looking through the past year question papers. The pattern has been static for years. This phenomenon is strongly supported by the enhancement exercise carried out by the teachers at schools. The proposed medium term strategy is to look at the criteria in taking in teachers especially at the secondary school level. The criteria should be in the common belief that good students should be creamed by a group of good teachers. Our neighbouring country, Singapore, has put a condition into her teaching profession criteria, that is, only excellent graduates are being considered. Today, Singapore education system is one of the best in the world. Courage implementers at the ministry level must be prepare to work without being influenced by politics is one of the long term strategy that needs consideration.

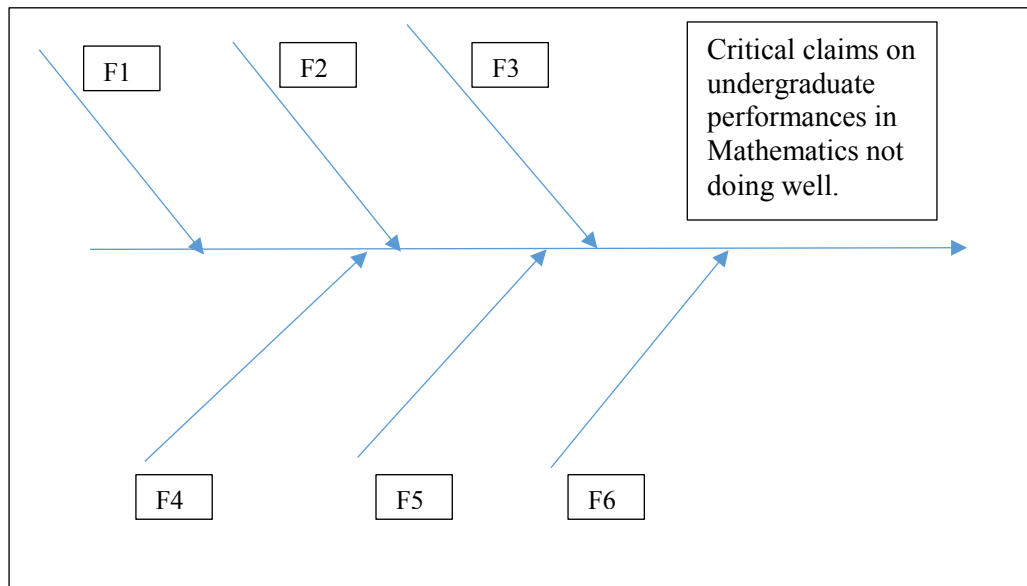
The Ministry of Education should come out with a plan of action to improve the present scenario of education. The scenario of having more than one type of secondary schools, that is, national and non-national type, has indirectly caused the smart students to register with a particular school type. It is well known that in the Chinese school certain subjects are being taught in Chinese and English at two different times. Thus, Chinese school students are better prepared when they entered the examination hall compared to the national type of schools. Again, looking at the develop countries in the world such as Japan, etc. whereby the Japanese school education system is well developed and teachings are in Japanese. The government must believe in herself that one type of schools has been proved successful in other countries such as Germany, USA, Sweden, China and Korea.

Solutions to the problems must be found as soon as possible. Local universities are finding it harder to fill up the intake quotas for engineering courses which has forced some of them to streamline or cancel certain undergraduate courses. Table 2 shows the failures rate in additional mathematics is increasing yearly and this is very serious indicator. This means less students are eligible to enrol in engineering and science courses at the tertiary level.

#### 5. Recommendations for actions

The paper is proposing the following main causes as the inputs to the Fish Bone Diagram (figure 3) as stated below, and these causes came from the three questionnaires' findings and Melaka SPM results:

- F1 - The additional mathematics teachers at the secondary schools are capable to deliver the teaching materials.
- F2 - In Melaka, roughly 75% passes in additional mathematics at SPM level yearly.
- F3 - Around 86% of the engineering undergraduates claimed that Year 1 mathematics subject are difficult.
- F4 - None of the so-called smart students obtained an 'A' in their first year for Mathematic I.
- F5 - A creative technique should be used in the school classes was 100% supported by all the teachers.
- F6 - Subject interest and understanding amongst the undergraduates are questionable.



**Figure 3.** Fish Bone Diagram.

The outcome or effect of figure 3 is that there was a basis on the claim that mathematics at the university level needs a better understanding in order to master it; whereby the enhancement exercise is no more applicable at the university education level.

## 6. Conclusion

From this study, there is no truth in the proposed hypothesis, that is, any smart students at SPM level do not necessarily turned smart when they further their studies into the local university when comes to Mathematics. Our country is producing less and less mathematicians, engineers or scientists who are capable in challenging Albert Einstein's caliber and ingenuity. Vision 2020 and TN2050 are the two milestones that Malaysia needs to achieve with the supports of local universities in producing quality STEM graduates.

## 7. References

- [1] Sullivan M 2015 *Pre-calculus* 10th Ed. Prentice Hall
- [2] Rao K S 2007 *Numerical Methods for Scientists and Engineers* 3rd Ed. Prentice-Hall India
- [3] Navidi W 2014 *Statistics for Scientists and Engineers* 4th Ed. Mc-Graw Hill Higher Education,.
- [4] Fons T and Piet H C 2016 100+ Management Models. MPH Bookstores