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IMPROVING MATHEMATICS LEARNING IN PRIMARY EDUCATION: THE MALAYSIAN INITIATIVES

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Abstract. This paper discusses on the initiatives that Malaysia has embarked in improving mathematics learning at the primary level. The declining performance of Malaysian students in the Trends in Mathematics and Science Study (TIMMS) and the Programme for International Student Assessment (PISA) has resulted in continuous and over-publicized critics by the public on the quality of public schools. One of the main factors in the poor performance is the students' inability to answer questions that require higher order thinking skills (HOTS). This has triggered several initiatives towards improving school education which includes the introduction of the Primary School Standard Curriculum (KSSR) in 2011 starting with Year 1 students and for all grades in primary school by 2016, introduction of the Dual Language Programme (DLP) to settle the lack of compromise on the medium of instruction, total revamp of assessment to help improve students' ability for HOTS and the introduction of school-based assessment to reduce teaching-for-examination practices. Reflecting on the initiatives that have been implemented, this discussion highlights on the appropriateness of these initiatives and includes suggestions on the way forward in improving mathematics learning in Malaysian Primary Education.

Keywords: Mathematics Learning, Primary Education, Initiatives

INTRODUCTION

Within the country, the performance of Malaysian students in mathematics has been a growing concern for all stakeholders amidst all the initiatives that have been proposed by curriculum planners, mathematics educators and researchers, and technology experts. Student performance is benchmarked according to international average scores in Trends in Mathematics and Science Study (TIMMS) and Programme for International Student Assessment (PISA). TIMSS 2011 indicated a downward trend in Malaysia since the 2003 cycle. The declining results of Malaysian students in these international assessments have been the focus of media coverage, meetings and forums and are often highlighted by ministers and politicians. As a result, The Malaysian Education Blueprint (MEB) 2013 – 2025 (Preschool to Post-Secondary Education) paid special attention to student cognitive performance against international standards.

"the Malaysian Education System has emphasized the development of strong content knowledge in subjects such as Science, Mathematics and languages. There is, however, increasing global recognition that it is no longer enough for a student to leave school with the three Rs (Reading, wRiting and aRithmetic). The emphasis is no longer just on the importance of knowledge, but also on developing higher order thinking skills' (Ministry of Education Malaysia, 2012, pp E-4).

TIMSS which is conducted every four years by the International Association for the Evaluation of Educational Achievement (IEA) is a large scale assessment that inform participating countries and their policy makers on the students' performance and provide a cross country comparison. PISA, developed

by the Organisation for Economic Cooperation and Development (OECD) is conducted every three years to measure students' performance in mathematics, science and reading literacies. The focus of PISA is on assessing understanding and application of knowledge and skills in solving problems to meet future challenges. In 1999, Malaysia surpassed the TIMSS international average with a score of 519 but the performance declined throughout the years to merely 440 points in TIMSS 2011. However, Malaysia managed to improve the score to 465 in TIMSS 2015. Throughout the years, Singapore, Korea, Taipei, Hong Kong and Japan maintain as top achievers in TIMSS. Results of TIMSS and PISA showed that Malaysian students lack problem solving ability. This was traced down to the lack of opportunity and exposure to develop higher order thinking skills (HOTS). Thus the New Curriculum for Primary School (KSSR) was introduced in 2011 and the newly introduced school-based assessment focus more on improving HOTS and reduce 'teaching for examination' practices. HOTS is defined by the Ministry of Education (MOE) as the ability to apply knowledge, skills and values in reasoning and reflection in solving problems, making decision, to innovate and to create. Major shifts in national examinations was made and this include increasing apportionment of HOTS questions in the examinations. Other measures taken include retraining of teachers to integrate HOTS elements in classroom instruction and assessment.

The MEB 2013 - 2025 sets the target and direction for Malaysian Education to be at par with performance of developed countries. These initiatives had actually shown positive improvement in the student performance. According to the TIMSS 2015 report (Mullis et al, 2016), Malaysia was among 18 countries that recorded improvements when it scored 465 points, an increase of 25 points from the figure in TIMSS 2011. However, the number of students at the advanced benchmark is only 3%, a mere increase of 1% from TIMSS 2011. The following table provides a comparison between Malaysia and Indonesia on percentage that meets the advanced, high, intermediate and low benchmark in TIMSS. This again suggests that more than 25% of the Malaysian respondents had scores of less than 400. Indonesia has also shown some increase in TIMSS 2015 but the scores are far below the international benchmarks.

Table 1: Malaysia and Indonesia Achievement based on TIMSS International Benchmark.

Percentage	2011 (%)		2015 (%)	
	Indonesia	Malaysia	Indonesia	Malaysia
Advanced Benchmark (>625)	0	2	0	3
High Benchmark (>550)	2	12	3	18
Intermediate Benchmark (>475)	15	36	20	45
Low Benchmark (>400)	43	65	50	72

The discouraging performance of Malaysian students had prompted researchers and policy makers to reveal possible reasons for the poor performance;

i. Standards of examinations are different
   a. Require higher order thinking skills (HOTS).
   b. Questions in TIMMS and PISA are unpredictable;
ii. Students are not trained to answer TIMSS and PISA-like questions. Students had problems in understanding the question context and language;
iii. Students are not serious in answering TIMSS and PISA assessment because there are no implications to their performance and their future;
iv. Issues regarding grading system used for national exams.

RESULT AND DISSCUSSION

Malaysian Newer Initiatives

Malaysia is constantly formulating new initiatives to improve student performance. Various initiatives have been implemented as part of the continuous effort to improve the student performance.

Revamp of Primary School Curriculum

The New Curriculum for Primary School (KBSR) was introduced starting with Year 1 students in 1983. It was then revised and renamed as the Integrated Curriculum for Primary School (KBSR) and revised again in 2003. The Ministry of Education revamped KBSR and introduced the Primary School Standard Curriculum (KSSR) in 2011 for Year 1 students and eventually, by 2016 KSSR was

implemented throughout all grade levels in primary school. Although the major curriculum revision only takes place after 28 years, minor revisions were actually conducted which effect the organisation, sequencing, and the depth of the contents, delivery, assessment and even the language of instruction.

The major changes in KSSR are on content, pedagogy and assessment as follows:

i. Content is restructured and improved to ensure students are provided with the knowledge, skills and values that are relevant to the current needs for the challenges of the 21st century.
ii. Pedagogical approaches emphasises on in-depth learning based on higher order thinking skills (HOTS). Focus is given to inquiry-based learning, problem solving, contextual learning, collaborative learning, project-based learning and Science, Technology, Engineering, and Mathematics **(**STEM) approach.
iii. Continuous assessment is practiced to ensure progress and achievement of student learning. Both summative and formative assessments are implemented. Teachers assess the extent to which students master the learning standards with reference to the prescribed performance standards. Development and actual achievement level of students are recorded and reported descriptively to students and parents. (Bahrum, Wahid & Ibrahim, 2017).

KBSR had focused on arithmetic, writing and reading, however in KSSR, apart from these three, another aspect to be enhanced is reasoning. In TIMSS, Malaysians students did poorly in items that require reasoning (Lessani, 2015). The other cognitive dimensions measured in TIMSS are knowing and applying. In emphasizing reasoning, students are encouraged to estimate, predict and make intelligent guesses (conjectures) in the process of seeking solution and need to be provided opportunities to investigate their predictions or guesses by using concrete material, calculators, computers, mathematical representation etc. Logical reasoning needs to be integrated in the teaching of mathematics so that students can recognize, construct and evaluate predictions and mathematical arguments.

In teaching and assessment, the concentration on HOTs is amplified. The focus is on non-routine problems instead of routine ones. The non-routine problems require analysis and reasoning; may be solved in more than one way and may have many solutions as illustrated in Fig 1 below. On the other hand, routine problems are problems that can be solved using methods that students are familiar which may only require replicating previously learned algorithm. It requires use of known procedures.

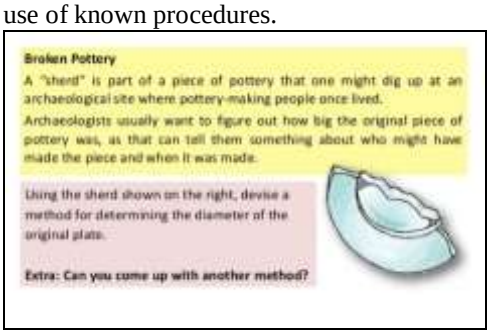

Figure 1: Example of a Non-Routine Problem

KSSR emphasizes on the development of holistic individuals who are critical, creative and innovative. The core of the curriculum framework is thoughtful learning, supported by the learning areas of mathematics, attitude and value, skills and process (Figure 2). The mathematical processes comprise of communication, reasoning, connection, problem solving and representations in mathematics. Communication skills include reading and understanding problems, interpreting diagrams and graphs, using correct and concise mathematical terms in oral presentation and writing, and listening. Focus on connection will enable students to link conceptual to procedural knowledge and relate topics within mathematics and other learning areas in mathematics. By making connections, students are able to see mathematics as an integrated whole rather than just a jumble of unconnected ideas.

Figure 2. Mathematics Curriculum Framework

KSSR enacted standard based content, learning standard and performance standard. The new primary curriculum targets to improve the quality of education and to make it more relevant to the current needs and to prepare students for the challenges of the 21st century. Content standards refers to specific statement about what students should know and can do in a period of schooling, which covers knowledge, skills and values. The learning standards depicts criteria or indicators of the quality of learning and achievement that can be measured for each content standard. The performance standard emphasizes that criteria needs to be set to portray achievement levels of students as indicator that the learning has been acquired. Based on these standards, it ensures that all students should meet the standard that is set. With the requirement to measure skills and values apart from knowledge, this had called for major assessment transformation from centralized to one that is school-based.

KSSR uses the following general descriptors to indicate achievement based on performance standard:

Performance Level	Knowledge Performance Indicator
1	Know basic mathematics knowledge
2	Know and understand basic mathematics knowledge
3	Know and understand basic mathematics knowledge, able to apply basic arithmetic operations, able to apply knowledge on basic conversion
4	Know and understand mathematics knowledge, able to apply calculation procedures in solving routine daily problems
5	Able to apply mathematical knowledge and skills in solving routine daily problems using various strategies
6	Able to apply mathematical knowledge and skills in solving non-routine problems using various strategies creatively and innovatively.

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The major transformation in curriculum need to be cascaded down to the implementers and must be supported with the right pedagogy. Teachers need to internalize the philosophy of KSSR, ready for a change in mind set, and acquire knowledge and skills to implement approaches to warrant the change in the output. Thus teachers are encouraged to integrate thinking skills in teaching and learning, apply multiple intelligence theory in teaching and learning, use of information and communication technology (ICT), practice future research based teaching, constructivist learning, contextual learning, and self-access learning that teaches students to learn how to learn.

Language of Instruction for Mathematics Teaching and Learning

In 2003, MOE made a controversial decision to revert back the teaching of mathematics and science to English, which was the medium of instruction for the English medium schools in the 1960s and 1970s. The Bahasa Melayu (the national language) activists contested this new policy. The move to the teaching of mathematics in science and mathematics (known as ETEMS, English Teaching for Mathematics and Science) was earlier seen as a way to improve students' competency of the English language which was declining. English was considered very important towards modernization of Malaysia and it is regarded as the world's lingua franca. With continued political pressures, the MOE succumbed to the activist that fights for "Memartabatkan Bahasa Melayu" and the language of instruction for mathematics and science was then changed again to Bahasa Melayu in 2012. The decision to change the language of instruction back to Bahasa Melayu was also partly contributed to the declining performance of Malaysian students in TIMMS and PISA in 2007 and 2011. Many critics felt that student poor performance was largely due to the language of instruction. In 2016, since both groups of language activists lack compromise on the language of instruction, the Dual Language Programme (DLP) was introduced in which schools were given a choice to choose the language of instruction that is agreeable by the school community and also the parents. This policy on DLP had stirred mixed responses from stakeholders.

Major Change in Mathematics Assessment

The shift from centralized assessment to school-based assessment is part of an effort to track the progress and achievement of students in their learning. The National Education Assessment System (NEAS), introduced in 2011 comprises of Central Examination and School Based Assessment

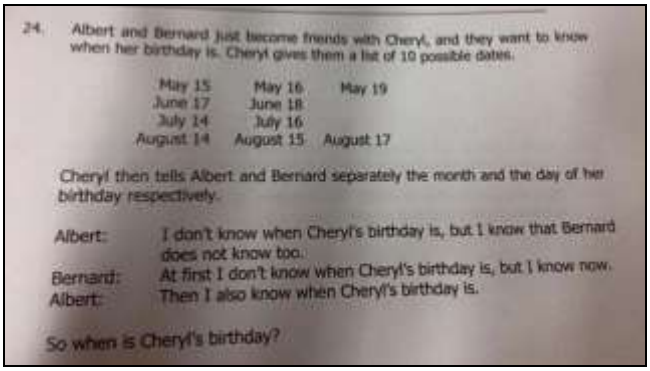
(SBA). SBA is designed to measure student outcomes holistically, collecting information on student involvement, development, and achievement through four types of assessment:

i. School Assessment refers to any form of assessment that is planned, developed, conducted, examined, and reported by teachers in school and that involves students, parents, and other individuals. The main focus of school assessment is to ensure student learning is meaningful.
ii. Central Assessment refers to several forms of assessment whose standards, instruments, scoring rubrics, and guidelines are provided by the Examinations Syndicate (ES) but whose administration, marking, and reporting are conducted by schools.
iii. Psychometric Assessment refers to student profiling in terms of psychological traits and innate or acquired abilities related to learning (i.e., general abilities, aptitudes, personalities, strengths, weaknesses, talents, interests, preferences, attitudes, and inclinations). The information from psychometric assessment helps teachers to understand their students, parents to understand their children, and students to understand themselves in order to enhance learning.
iv. Physical, Sports, and Co-Curricular Activity Assessment refers to an assessment of student involvement, participation, and performance in various co-curricular and extracurricular activities at all levels. Extracurricular activities refer to any kind of activities outside the classroom (e.g., physical education, sports, athletics, camps, and games). Co-curricular activities refer to the activities conducted by societies, clubs, or uniform groups, such as Boy Scouts or Girl Guides.

A centralized assessment, one of the academic components of SBA, is conducted at the end of Grade 9. Student performance on the Form 3 (Grade 9) Assessment and the School Based Assessment, as well as the information gathered in the Psychometric Assessment, determine the placement of students in academic (arts and sciences), technical and vocational, or religious streams at the upper secondary level (Grades 10 to 11).

Assessment of mathematics is done through school and the centralized assessment. To most stakeholders, the change in assessment for mathematics is considered drastic because of the inclusion of greater number of higher order questions in the assessment. The format of the questions is similar to the TIMSS and PISA questions, thus students, teachers and parents find that the questions have high difficulty levels, very challenging and very unpredictable. It used to be that in Malaysian centralized examination, both students and teachers can almost predict the rotation of the questions in the item bank and that may have contributed greatly to students increasing performance in the examinations.

Teachers and students were not ready for the assessment which incorporates HOTS items. Thus, there was a need to retrain teachers on how to formulate questions especially for the SBA to provide resources and continuous training programmes. There have been instances when the questions were incorrect or do not have the needed information or may not seem related to mathematics. Likewise, Singapore had also faced similar experience when the following question from a Singapore Primary Year 5 syllabus went viral in 2015 (Figure 3). It seems that stakeholders regard mathematics as problems that deal with numbers and require calculation to arrive at the solution rather than just using logic. So if it does require calculation, they do not regard them as mathematics.


24. Albert and Bernard just become friends with Cheryl, and they want to know when her birthday is. Cheryl gives them a list of 10 possible dates.

May 15	May 16	May 19
June 17	June 18	
July 14	July 16	
August 14	August 15	August 17

Cheryl then tells Albert and Bernard separately the month and the day of her birthday respectively.

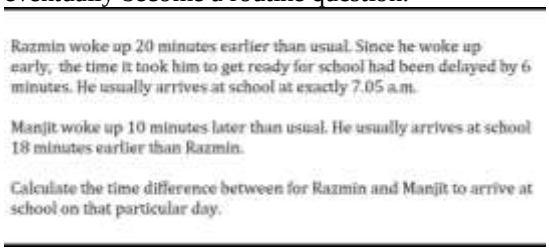
Albert: I don't know when Cheryl's birthday is, but I know that Bernard does not know too.
Bernard: At first I don't know when Cheryl's birthday is, but I know now.
Albert: Then I also know when Cheryl's birthday is.

So when is Cheryl's birthday?

Figure 3: Example of Problem Not Considered Appropriate for Mathematics Test

Example of questions such as the following has been posed in mathematics test although the contexts may be quite different. If these

kind of questions are repeated, it will eventually become a routine question.

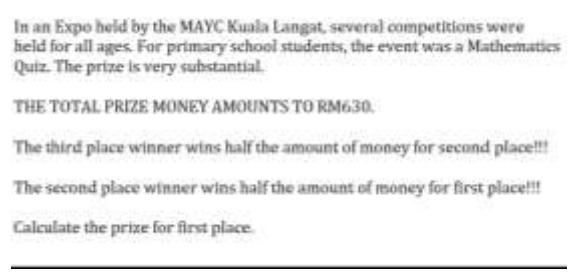

Razmin woke up 20 minutes earlier than usual. Since he woke up early, the time it took him to get ready for school had been delayed by 6 minutes. He usually arrives at school at exactly 7.05 a.m.

Manjit woke up 10 minutes later than usual. He usually arrives at school 18 minutes earlier than Razmin.

Calculate the time difference between for Razmin and Manjit to arrive at school on that particular day.

Figure 4: Example of Problems that are Getting Popular

The following question may not be difficult for students who have learnt algebra, however when it was included in a test for Year 6 who are in the pre-algebra stage, it does appear very challenging. These questions had also gone viral in several social media.


In an Expo held by the MAYC Kuala Langat, several competitions were held for all ages. For primary school students, the event was a Mathematics Quiz. The prize is very substantial.

THE TOTAL PRIZE MONEY AMOUNTS TO RM630.

The third place winner wins half the amount of money for second place!!!

The second place winner wins half the amount of money for first place!!!

Calculate the prize for first place.

Figure 5: Example of Problems Not Considered Appropriate to Students' Level

It is clear from the above examples that the perspective of stakeholders especially students, parents, and teachers are not aligned to the perspective of curriculum planners. Curriculum planners are targeting for the mathematics learning standard to be raised to the international standards while students, parents, and teachers are more concerned with grades. Much needs to be done to increase the readiness of students and teachers and to increase the awareness of the stakeholders.

Literacy and Numeracy Screening (LINUS) Remedial Program

The Literacy and Numeracy Screening (LINUS) is part of the strategies outlines in the National Education Blueprint to ensure Malaysian children acquire basic reading, writing and arithmetic skills after three years of primary school education. Under the Government Transformation Programme, the Education National Key Results Area (NKRA) aims to eradicate the dropout problem caused by students' inability to cope with mainstream education. The Education NKRA has set a 100% literacy and numeracy target for all Year Three pupils in Malaysia.

The remedial program requires screening administered by schools three times a year to identify students in Grades 1 to 3 who do not meet basic literacy and numeracy skill objectives. The first screening test was conducted in March 2010 for all Grade 1 students. Students who do not meet the defined objectives are placed in a remedial program.

Science, Technology, Engineering, and Mathematics (STEM) Initiative

Malaysia has been facing fewer prospective students for higher education in science and technology. The government projects that 60% of enrolment in higher education should be in science and 40% in social sciences and humanities. This is to meet the challenges and demands of STEM-driven economy by 2020 (Ministry of Education, 2012). In Year 9 of schooling, students will have to choose the stream for upper secondary education. The choices are academic stream (Science/Art), Technical and Vocational Stream, and Religious Stream. The number of students choosing science stream seem to be declining over the years.

Thus, the Science, Technology, Engineering, and Mathematics (STEM) initiative has been implemented, which was designed to prepare students with skills to meet the challenges of science and technology and to ensure that Malaysia has sufficient number of qualified STEM graduates. Special programmes for STEM include stimulating student interest in STEM through new learning approaches and an enhanced curriculum, sharpening the skills and abilities of teachers in STEM, and building public and student awareness of STEM. The number of instructional periods for science has been increased and science laboratories in secondary schools were upgraded. Likewise, science rooms are upgraded into laboratories in primary schools (Ministry of Education Malaysia, 2014). Teachers are to conduct the STEM approaches in schools by getting students to:

i. Question and identify problems;
ii. Develop and use models;
iii. Plan and conduct experiments;

iv. Analyse and interpret data;
v. Use mathematics thinking and computational thinking;
vi. Explain and design solutions;
vii. Be involved in arguments and discussions based on evidences.

Use of Technology

Malaysia has embarked on many initiatives to enhance the use of ICT for teaching and learning. As an example, MOE set a target to achieve a minimum ratio of one computer for every 10 students by 2015, to support student learning. However, in 2018, this target has not been fully realized yet. In addition, the MOE plans in equipping 10,000 schools with 4G Internet access and a virtual learning platform that can be used by teachers, students, and parents. The Virtual Learning Environment (VLE) is a learning management system that can be used to deliver instructional materials to students for individualized learning.

Technology enhanced learning is actually not a new initiative. Malaysia started on the idea of Smart Schools way back in late 1990s. Among the problems faced by teachers were connectivity, relevant materials, and time for students to access the e-content. Nowadays, there are abundant of materials available in YouTube, MOOCs, SlideShare, and other platforms that can be used for teaching and learning. However, for Mathematics, chalk and talk may be more practical and effective. MOE also managed a platform, known as EduwebTV, that allows teachers to download videos related to the curriculum, news, and instructional materials and provides a platform for teachers to upload their own materials for sharing.

Way Forward for Malaysia

KSSR is still in the infancy stage to judge whether the content of the curriculum would indeed produce students who are creative and innovative problem solvers and will contribute greatly to the development of the country. Reflecting on the previous curriculum, it can be concluded that the content of the curriculum itself is not the main drivers for the change but it is on how well it is implemented to meet the intended or written curriculum and whether the assessments appropriately measure the attained curriculum. The mismatch between the intended, the implemented and the attained curriculum is also highlighted in the Malaysian Education Blueprint. The intended curriculum is the one prescribed by policy makers, the implemented curriculum is the one that is actually carried out by teachers in their classrooms, and the attained curriculum is the one learnt by students (Howson & Wilson, 1986). Teachers must internalize the philosophy, the aims, and objectives and have the knowledge and skills to implement the suggested delivery methods to meet the intentions of the intended curriculum. There must be allocation for teachers to upgrade their knowledge, to further their education, and to attend continuous professional development courses. Since implementation of TIMSS, Finland had always been looked up as having the best education system in the world. They have small class size, a number of teachers handling a class session together, the best brains becoming teachers and a very attractive pay scheme. Although Malaysia may have many constraints to meet Finland's standards, the continuous upskilling of teachers must be given priority. Mistakes such as having test questions for HOTS which are not correct or having errors would not have happened if teachers are given proper guide whenever there are new changes or expectations. For example, teachers cannot be expected to conduct contextual learning or problem-based learning or to conduct technology-enhanced classes if there are no proper guidance, training or resources. According to Woessmann (2016), based on his analysis of TIMSS and PISA data, differences in expenditure and class size play a limited role in explaining cross-country achievement differences, but what really matters is the teacher quality and instructional time.

Curriculum implementers must understand the whole process of school based assessment. It requires teacher competency to develop school-based assessments that meet the standard of the national assessments. Teachers must also explore the use of alternative assessments.

Since the emphasis on HOTS, teachers and students are focusing on higher levels of the Bloom's cognitive domain. Lesser

memorization of facts or algorithm is required in daily homework or tests. Now, they are forced to think rather than replicate solutions to problems. The focus is on developing the critical and creative minds. This may be the right direction for a developed Malaysia although it is very tough for all. STEM initiatives is also in line with the HOTS initiatives. Hopefully, Malaysia will have enough scientists to leapfrog the economy of Malaysia in the near future.

The dual language programme (DLP) may be the right solution to the unsettled issue on medium of instruction for mathematics. The selected schools are given the choice to decide on the medium of instruction. We have urban schools and children who are brought up in English speaking families. On the other hand, we have disadvantaged students classified as 'urban poor' and also those from the rural areas who are struggling with the English language. The medium of instruction should not deter with their learning. Assessment items are always given in both versions, Bahasa Melayu and English. It is hoped that the new Malaysian government would not make the change again. The focus of instruction should always be on the mathematics not the language.

Most importantly, in any decisions on policy, it must be evidence-based. More studies should be commissioned to determine the appropriateness of implementing a new policy. Universities must embark on policy researches that will provide direct impact to the education system. Research outputs should not only be targeted for publication in good journals but it need to be extended for knowledge transfer to improve the community or system or the country. Taxpayers should get direct benefit from the researches funded.

Continuous efforts of Malaysians to improve the school mathematics achievement have shown some degree of success with the recent TIMSS2015 results. However, there seems to be a divide between mathematics educators at tertiary level with those at school level. With the remerging of the Ministry of Education and the Ministry of Higher Education recently in 2018 as part of the strategy of the Malaysian new government, it is hoped that a unified team continue to identify ways to realize Malaysia's dreams to be a modern and rich nation.

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