

Comprehensive indicators of mathematics understanding among secondary school students.

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Abstract

The Malaysian science and mathematics curriculum has undergone several significant changes within the last two decades. Correspondingly, the approach to learning and teaching science and mathematics has also changed drastically. From the perspectives of science and mathematics education, the teaching of science and mathematics has shifted from the normative to descriptive (naturalistic) view of mathematics. That is, from the absolutist (behaviorist) tradition to the constructive tradition. However, what students have actually acquired in terms of problem solving, science process skills, communication, reasoning, thinking skills and abilities in seeing the interconnectedness of ideas, as stated in the mathematics and science curriculum are still not clearly articulated or defined. Therefore, there is a need to study what our students have actually acquired based on the above aims (or standards). Nevertheless, if these standards are not achieved, there is also a need to study the gap that exists between those ideals and those attained by our students. This paper reports the research study that aims to identify the levels of mathematics understanding amongst secondary school students, related to their abilities in terms of problem solving, communication, understanding the interrelatedness of mathematical ideas, and mathematical reasoning. It takes a comprehensive look and simultaneously explore into students' attainment both in terms of skills and levels of understanding using the School Science and Mathematics Indicators Program (SSMIP) designed by the research team. The methodology and procedures of the research project consist of document analyses of curriculum materials and guidelines to produce some indicators on the levels of understanding students are expected to attain as they proceed through the schooling system, conducting the tests to be used in describing the levels of achievement in specified subject areas, conducting task analyses based on the questions designed by the research team and finally conducting in-depth clinical interviews on selected students. Started in June 2010, the research is still ongoing and expected to be completed in another year. Initial findings indicated that there seems to be significant differences between curriculum expectations and students' levels attainment and understanding as defined by the curriculum standards.

Introduction

Within the perspectives of science and mathematics education, the teaching of science and mathematics has shifted:

- From the perspective normative to descriptive (naturalistic) view of mathematics.
- From the absolutist tradition to the constructive tradition (from the behaviorist to the constructivist approach).

One can safely conclude that the approach to learning and teaching of mathematics has changed drastically (Noor Azlan Ahmad Zanzali, 1995) over the last five decades. Thus the question of how much the students have benefited from these improvements in the curriculum is relevant. Several studies that aimed to look at what the students have acquired from the curriculum have

been conducted. These studies, however, have been generally looked at skills acquired at specific area or level and thus are limited in scope.

This proposed study aims a more comprehensive look and simultaneously probe into students' attainment both in terms of skills and levels of understanding. The inquiry into and creating the School Science and Mathematics Indicators Program (SSMIP) will produce comprehensive and computerized guidelines on school-leavers achievement indicators in both science and mathematics. Potential users will include all higher institutions of learning both public and private institutions, and individual science and mathematics educators. While this type of school achievement indicators are quite common in developed countries, they are, however, new in the Malaysian scenario.

The basic principles of assessment

The word assessment refers to the process of collecting and using evidence about students' learning. Assessment and evaluation both describe the processes of collecting and interpreting evidence for some purpose. They both involve decisions about what evidence to use, the collection of that evidence in a systematic and planned way and the interpretation of the evidence is to produce some of judgment (Harlen, 2007, Harlen2008, Khodori, 200; Salvia, J. &Ysseldke. J. E. 2001).This description is illustrated by the following diagram:

In a nutshell "Educational assessment is formal attempt to determine students' status with respect to educational variables of interest (Popham, 2006; pg 6)

In recent years educators have been urged to broaden their conception of testing so students' status determined via a wider variety of measuring devices – a variety extending well beyond the traditional paper-and-pencil tests. Thus they are many worthwhile learning outcomes not best measured by paper-and-pencil tests. Assessment is a broader descriptor of the kinds of educational measuring teachers do – a descriptor that, while certainly including traditional paper and pencil tests, covers many more kinds of measuring procedures.

Noor Azlan Ahmad Zanzali (2005) emphasized assessment must be based and address several critical issues of teaching and learning. They are

- Issue 1: Underlying assumptions about the philosophy and goals of the curriculum
- Issue 2: Assessment must be in consonance with current learning and instructional considerations
- Issue 3: Specifications of performance standards
- Issue 4: Developing authentic tasks
- Issue 5: Assessment should measure status and growth
- Issue 6: Scoring and what form?
- Issue 7: Reporting –making public

Objectives of the Research

This research program aims to identify

- the levels of mathematics understanding amongst secondary school students, corresponding to their levels of schooling students' abilities to acquire a variety of mathematical concepts,

- The abilities to carry out a variety of mathematical procedures and to use them to solve problems in both familiar and unfamiliar situations.
- The skills and understanding that students are expected to acquire as stipulated by the curriculum expectations.
- The levels of problem solving abilities, communication, understanding the interrelatedness of mathematical and science, and mathematical and scientific reasoning.

A complete guideline on the levels of students' understanding in science and mathematics according the levels of schooling will be produced.

For each component (mathematics and science) students will be assessed at three levels. Each level is related to the understanding of concepts, application, and problem solving in the respective content areas.

- Level 1 – describing the early stages of mathematical and scientific knowledge typical in a secondary school.
- Level 2 - describing the mathematical and scientific knowledge acquired in the intermediate years of secondary schooling.
- Level 3 - describe knowledge and skills acquired by students who have completed the full range of mathematics and scientific courses typical of a secondary school education

Methodology

The research team will consist of 4 groups, each looking at the areas of mathematics, physics, chemistry and general science areas.

The methodology and procedures of the research project are as follows:

- 1) Document analyses of curriculum material and guidelines to produce guidelines on the levels of understanding students are expected to attain as they proceed through the schooling system
- 2) Designing the tests to be used in describing the levels of achievement in specified subject areas.
- 3) Conduct task analyses based on the questions designed in (2).
- 4) Conducting in-depth clinical interviews on selected students.

Both the quantitative and qualitative methods will be used.

- **Quantitative Method:** Sets of mathematical questions to be answered by students for each level. Coding procedures will be used to assess levels of understanding. Tests of questions will be designed by each group.
- **Qualitative Method:** Qualitative procedures such document analyses, interviews, observations, task analyses and small group interactions of selected of students

Initial Results:

At this juncture, the process of collecting is still at the initial stages.

Document analyses are seen through the content, the psychological and the pedagogical perspectives. Our initial analyses do indicate that the intended curriculum places heavy emphasis on naturalistic view of mathematics based on constructivist nature of teaching and learning. The use of problem solving, communication, integration and reasoning of mathematics ideas are heavily emphasized. Two questions need to be addressed. First are the elements emphasized in

teaching and learning? Second, do the students attain those elements as they go through the teaching and learning processes? The answers to the first questions are discussed in my earlier papers. This research attempts to address the second question

We conducted a qualitative survey on the views and attitude of the students, who are our subjects. Initial findings indicate that they do attain above average attitude as expected by the curriculum.

The results of other procedures is still being conducted and we hope to be able to collect and analyze at the end of the year,

Conclusion

The need to assess students' achievements in terms of the elements as emphasized curriculum, but not evaluated by the paper and pencil tests in the high-stake public examinations, is still very important. This will indicate the attainment of students as expected and regarded as the key elements of learning mathematics by the curriculum.

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