

Aspects of Reform in Improving Malaysian Students' Learning of Statistics

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Abstract. The reports of International assessments PISA and TIMSS show that Malaysian students score below the global average in their mathematics performance. For instance, for the year 2012, PISA reported that Malaysia scored 421 in Mathematics whereas the global average score was 494. Moreover, Malaysia is placed in the bottom one-third with a rank of 52 out of 65 countries that participated in the assessment. Malaysia is also placed bottom one-third among more than 70 countries that participated in TIMSS. The learning of mathematics is divided into different subtopics, one which is statistics. This paper presents suggestions to improve Malaysian students' learning of statistics by looking at different aspects of reform.

Keywords: curriculum, instructional materials, statistics education, teaching and learning

1. Introduction

Back in the mid-eighteenth century, the study of statistics was regarded as part of the study of arithmetic [1]. The movement for statistical education took root within the context of the extension of modern education, including mathematics, in the twentieth century [2]. Termed democratization of mathematics [2], it was partly driven by quantization of society that increased the needs for analytical, quantitative and computational skills [3]. Although, statistics is recognized widely as a subject of its own worth now, it is still viewed as a subset of mathematics by some. For instance, Yung (2004) explicitly stated that "statistics is a mathematical subject" [4]. He believed that students who are not mathematically inclined are more likely to find statistics boring.

The reform of statistics education has shifted the traditional view in statistics classrooms that placed importance on skills and procedures to enabling students to be educated users of statistical knowledge and concepts. In Malaysia, statistics education is still largely viewed as a component of mathematics education because in schools and in a majority of undergraduate courses other than the courses specializing in statistical studies, statistics is included in the mathematics curriculum. However, the advancement of statistics education particularly in the developed countries has had a positive impact on statistics education in Malaysia. At present, there are more statistics related courses in the undergraduate and postgraduate studies in the higher education institutions in Malaysia compared to in the past.

Statistics education and research in Malaysia has seen more development over the recent years as evidenced from the increasing number of research in statistics education and publication of papers in internationally recognized refereed journals. While there were only five published papers by Malaysian researchers from years 2000 to 2006, the number increased by three folds from years 2007 to 2012. Also, the papers published in refereed journals increased from 15% (3 papers) to 50% (10 papers) between the two time periods [5]. If Malaysia aspires to realize its' Vision 2020, apart from the transformations in economic and government sectors, the education system needs to be reformed to keep up with her more developed counterparts. Improving the Science, Technology, Engineering and Mathematics education is a priority in Malaysia's education agenda at present.

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2. Aspects of Reform

2.1. Teaching and learning

The present goal of statistics education is to create a global community who are statistically literate [6, 7]. Being statistically literate involves but not limited to being competent and confident users of statistics [8], ability to critically evaluate statistical findings [9], development of interpretative and communication skills [10], and demonstrating appreciation for statistics [11]. These are the skills and capabilities that need to be developed in the teaching and learning of statistics to Malaysian students because statistics is not about computing numbers but more importantly involves ability to work with data in an analytical and critical manner, and the ability to interpret and communicate the results of analysis successfully and effectively.

The learning and understanding of statistics involve many underlying concepts from the basic understanding about mean and standard deviation for instance to the more perplexing understanding of sampling distribution and limitations of an inferential process. Therefore, statistics should be taught and learned with the use of real data and through solving real world problems. When statistics is applied in practical problems instead of having students work with simulated situations they will be able to construct their own understanding and find the statistics learned to be meaningful. Most students know how to compute a mean or a median for example but will not be able to tell what these measures indicate or which measure is more appropriate in a particular situation.

Therefore, in keeping with the reform in statistics education and the emphasis made by the inclusion of statistical literacy in statistics curriculum around the world, the teaching and learning of statistics in Malaysia should place more importance on understanding of concepts instead of ability to perform statistical calculations. In other words, statistics teachers and instructors should give more import in developing students' conceptual knowledge instead of making them work with the mathematics involved in the statistics in a meaningless way.

2.2. Assessment

Assessment is a vital component in the learning of statistics [12] and plays a tremendously important role in achieving the goals of statistics education. In fact, the importance of triangulating assessments with objectives and instructions has been discussed in literature concerning research in statistical literacy [13]. Hence, it is important that assessment tasks meet the instructional objectives and the intended outcomes of a statistics course. For instance, if the intended outcome is students' understanding of a particular statistical concept, then the assessment task should directly assess this understanding but no other related concept.

In the context of Malaysian students, the standardized examinations at school levels are very much focused on the students' computational competency [14] instead of their conceptual understanding. As such, Malaysian students naturally develop a mental habit that emphasizes on the mathematics of statistics but rarely give equal importance to the knowledge and concepts building in their statistical learning. The alternative or authentic assessments can offer solutions to this issue. Moreover, the authentic assessments will serve better in achieving the current goals of statistics education compared to the traditional assessment since the former is student centered.

The focus of authentic assessments is not on the mathematical skills but on the students' continuous development of understanding. For authentic assessments to achieve its target, the assessments tasks should not only require students to apply their critical thinking skills but the tasks ought to be interesting and provide ample scope for the students to demonstrate what they know and what they can do. However, regardless of which type of performance task is preferred, instructors of statistics should take into account the concerns and the needs of all the students when designing assessment materials for the students.

2.3. Design of instructional materials

Idris and Mohd Nor (2008) believed that students in a mathematics classroom should be exposed to problem solving and decision making tasks that requires them to express their reasoning in the process of solving problems and making decisions [14]. Likewise, Marriott, Davies and Gibson (2009) agree that problem solving is the best way to teach statistics [15]. This means that the instructional materials should not

be focused on the development of skills but on developing students' understanding of concepts and developing their reasoning abilities. The design of the instructional materials must be able to encourage as well as enhance students' use of critical thinking skills particularly in statistical applications to real world problems. In addition, the instructional materials must be able to assist students in analyzing, critically evaluating, and drawing inferences or conclusions from data that has some meaning and importance to their lives.

In keeping abreast with the assessment changes in statistics education, the teachers must be open to change and contemplate the success of alternative assessment approaches [16]. Since the changes in assessment are influenced by the changes in the way statistics is taught, there is a need to reform the design of the instructional materials as well. Clearly, the traditional chalk-and-talk and note taking approaches cannot groom students to manage with the demands of the present world. The modern day students enter a statistics classroom with some experience with data. The growth of data technology has created new types of data that students encounter prior to taking an introductory statistics course [17]. Thus, integration of technology with the instructional materials is one way to keep up with the demands of the modern day students of statistics.

2.4. Curriculum development

The new data-based statistics curriculum calls for a curriculum which is more coherent [18]. In developing and implementing a coherent statistics curriculum, considerations should be given to: (i) what is meant by coherent statistical knowledge, (ii) how can students' coherent statistical knowledge be advanced, and (iii) how can students' coherent statistical knowledge be measured. This involves ideas such as conceptual understanding, active learning, use of rubrics, and assessment of students' statistical reasoning. On the other hand, the four-pillar design to improve students' statistical learning particularly the students' conceptual understanding consists of content related considerations, pedagogy related considerations, technology related considerations, and assessment related considerations [19]. Suggestions for content related considerations include working with real data arising from real problem settings and building connections while pedagogy related considerations include cooperative and collaborative approaches. Further, technology be used to help students' understand and visualize abstract concepts and ideas and assessment should focus on the evaluation of students' statistical reasoning and conceptual understanding.

Statistics curriculum is influenced among others by the assessments used to evaluate the success of the teaching and learning process. The extent of the influence depends on the context of the culture and the country. For instance, the curriculum development in Queensland, Australia is influenced more strongly by the resources such as the textbooks and technology instead of the assessments. The education system in Malaysia has been more assessment-oriented with three public examinations taken by school students at different stages of their schooling period before they begin their tertiary education. Therefore, assessments play an important role in shaping the statistics curriculum in Malaysia.

Petocz and Reid (2003) used categories of students' understanding of statistics to advise the curriculum developer of the need to cater to the differences in the students' understanding [20]. Therefore, with assessment being the foundation of the curriculum development in Malaysia, assessments can be used to formulate a curriculum that enhances students' understanding of various concepts of statistics. The important factor is curriculum should stress on the key concepts rather than the mathematical details [21]. In addition, emphasis should be given to the critical evaluation of appropriate techniques and methods instead of focusing on the mechanical calculations and automated production of graphical displays [22]. Students should also be exposed to the qualitative aspects of statistical analysis such as writing about the methodology, findings and interpretation of statistical results [23].

3. Conclusion

In recent years, the direction of education has greatly shifted from the teacher empowered one way dissemination of knowledge towards the students' own knowledge construction with the teacher enacting the role of a mentor in the learning process. The former is obsolete in present-day education scenario because there is an inevitable obligation to produce independent and thinking graduates who are able to meet

challenges of the working population. Organizations do not view prospective employees who scored high on papers as an asset if they are not able to offer creative and innovative solutions to problems when the need arises.

Many graduates fall short in this aspect because they have not been adequately trained to analyze and think critically. The reform of statistics education purports to achieve just that. It aims to produce statistically literate citizens who are able to use data in decision makings and work with data in all settings. To keep up with the demands of the global world, statistics education in Malaysia need to be reformed too. This paper has presented a discussion on how the statistics education in Malaysia can be reformed from the four aspects of education comprising of teaching and learning, assessment, design of instructional materials and curriculum development.

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