STATISTICS EDUCATION IN HONG KONG

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This paper presents an overview of statistics education in Hong Kong. While Statistics is not considered a major domain in school mathematics, it is incorporated into all levels of the mathematics curriculum starting with Primary Two. As Hong Kong is currently undergoing an education reform, statistics education is being directed towards a student-centred, activity-based, and hands-on approach with students encouraged to collect, present and interpret data, basing their work on concrete examples from everyday life whenever possible. Student learning is expected to progress from concrete to abstract, and calculators and computers are expected to be used to facilitate student learning. Implications of these approaches are also discussed.

INTRODUCTION: HOLISTIC REVIEW OF SCHOOL CURRICULUM

Traditionally, the Hong Kong education system has been examination-driven. Students undertake six years of primary and five years of secondary schooling; for students who wish to enter university, there would be two additional years of matriculation prior to university studies. At each transition, progression to the next phase is based on the results obtained by students in public examinations. Performances at public examinations would determine the band (level) of school assigned to the student at Secondary 1, whether the student is accepted for matriculation studies at the end of Secondary 5, and whether the student would have a place at a Hong Kong university after Secondary 7. Currently, only about 18% of secondary school graduates can enter university, which is considered the key to any professional career. Under this atmosphere of examinations and intense competition, schools tended to emphasize the attainment of good examination results as their top priority. In order to achieve this objective, students have been subjected to constant drills on skills and content in order to hone their abilities in writing examinations.

Mathematics is considered a core subject in the Hong Kong school curriculum; primary school students would have mathematics classes every day, and this practice continues through secondary school. In fact, students cannot graduate from secondary school (at Secondary 5) without passing a public examination in mathematics. To ensure successful performance in this subject, Hong Kong students spent more out of school time doing mathematics homework, studying mathematics or attending extra mathematics lessons, especially at the primary school level, than their counterparts in other countries (Mullis et al., 1997). This examination-oriented approach has also resulted in Hong Kong being probably the place with the least flexibility and choice in its mathematics curriculum (CDC, 2000), as teaching and learning must be focused on the public examination syllabus, and on students' proficiency in using routine procedures to work out problems in this syllabus. Primary and junior secondary students seem to associate mathematics with its terminology and content, and doing mathematics is often perceived to be applying a set of rules rather than a thinking process (Lam et al., 1999). One result of these existing practices is that students considered mathematics to be important, and they performed extremely well (4th) in the TIMSS mathematics tests, but some of them did not display a corresponding positive attitude towards mathematics (Mullis et al., 1997).

Another factor that has contributed to the problems of education in Hong Kong is that education, rightfully for an advanced society, has evolved from being a privilege to a right, with the provision of compulsory education up to S3 for all students. However, the curriculum has remained the rather elitist one of a former era, when education had not been designed for all. Consequently, learning has been difficult for many students, especially in a subject such as mathematics, which is often considered to be abstract and complex. In addition, the Hong Kong mathematics curriculum has been found to be content-oriented, rather packed, and difficult (CDC, 2000). A comparative study of the mathematics curricula of major Asian and western countries has found that in Hong Kong, the introduction of topics into the curriculum is on average two years earlier than the international average (CDC 2000).

Concern over the entire education system has prompted the government to establish an Education Commission (EC) to conduct a comprehensive review of the system with a view to define the aims of education and a blueprint for reform for the 21st Century. At the same time, the government-funded Curriculum Development Council initiated a holistic review of the school curriculum in 1999, and a new curriculum framework together with syllabuses would be introduced in primary and secondary schools in 2002 and 2001 respectively. The new mathematics curriculum was designed in accordance with the aims of the education reform, to develop students' abilities in inquiring, reasoning, conceptualizing, problem-solving, and communicating. Students are expected to learn mathematics to enhance these generic skills at the same time that they apply these skills to construct their knowledge of mathematics. The mathematics curriculum is intended for a wider range of students than before, which means it should cater for the diversity of student needs and the wide spectrum of ability among students. There is flexibility for teachers to adopt some enrichment topics to extend their students' horizons, in addition to a foundation part of the curriculum. The curriculum is organized with consideration for the cognitive development of students, student learning is expected to progress from the concrete to the abstract, and connections to everyday experience are to be used to support abstract discussions whenever possible. Calculators and computers are expected to be employed to support learning and teaching activities when appropriate.

The disparity between the old and new curricula can be seen clearly in statistics, between the new S1-S5 curriculum and the existing S6-S7 curriculum. The latter is currently under revision, and the original curriculum emphasized the development and application of computation skills; students were expected to calculate and handle data on a regular basis, and speed in performing calculations was an important consideration, which meant that students were expected to practise doing many routine exercises. This is in contrast to the aims of the new curriculum, in which students are provided with more space and time to explore concepts and to develop familiarity with them. In the school mathematics curriculum, statistics does not occupy a major place. We will discuss below the curriculum content and the emphasis in learning and teaching of this subject.

PRIMARY STATISTICS EDUCATION

Statistics (or Data Handling) is one of the five dimensions of primary mathematics, the others being Number, Shape and Space, Measures, and Algebra. It is recommended that Data Handling should occupy about 6% of the mathematics classes (3% in P1–P3, and 10% in P4–P6, out of a total of 960 mathematics periods for the six years). The learning targets of data handling are to enable students to understand the elementary concepts and representations of statistics. Students are expected to master the methods of data collection and learn to construct and read simple statistical graphs. To achieve these targets, teachers should select practical problems and design learning activities related to students' daily life. Activities should include simple data collection, data recording, constructing frequency tables, making statistical graphs, reading graphs, and drawing results from the data provided by statistical graphs. Through activities, students can apply knowledge and methods to solve simple and practical problems, and to draw conclusions from regular patterns.

In particular, P2 students start to compare the quantity of three or more types of objects by arranging them in lines, read and discuss simple pictograms, and to construct pictograms using a one-to-one representation. This representation is involved in the construction and discussion of frequency tables and block graphs in P4, to be followed by simple bar charts using one-to-one, two, five, or ten representations. This is extended to the construction of pictograms and bar charts using larger ratios (up to one-to-hundred representation) and consideration of compound bar charts in P5. In P6, students learn to find averages of grouped data, solve simple problems, and estimate answers, which are followed by a study of broken line graphs. These are the basic statistics concepts to be introduced to all students; in addition, P6 students can also be encouraged to acquire an elementary experience of the chance of occurrence of an event, and to describe the chance of occurrence using terms such as certain, often, sometimes, seldom, and impossible. As can be seen from the above, the emphasis is on the process of learning and use of activities to facilitate students to learn basic concepts while developing their generic skills.

SECONDARY STATISTICS EDUCATION (S1 – S5)

Data Handling is one of the four dimensions of secondary mathematics, the others being Number & Algebra, Measures, Shape & Space, and Further Applications (a very small dimension). It is recommended that Data Handling should occupy about 14% of the mathematics classes (15% in S1–S3, and 13% in S4–S5, out of the total 680 periods for the five years). Since students have learnt about the use of various statistical diagrams to present discrete data in primary school, they are expected to extend the idea to continuous data in S1-S3. During these years, students are guided to explore and select the most appropriate diagram for representing data; for example, a pie chart may better represent the idea of a portion of the whole than a bar chart. They are also expected to understand the notion of probability and handle simple probability problems by listing the possible outcomes and drawing diagrams. In particular, the following topics will be covered:

· Construct and interpret simple and cumulative frequency polygons and curves
· Explore the construction of diagrams and graphs manually and with the aid of technology
· Present data using various graphs and select the most appropriate means of presentation
· Read and interpret data from given presentations (including percentiles, median)
· Identify sources for misinterpretation of graphs

In S4-S5, students are expected to discuss statistical reports presented in the media. Basic sampling techniques and data collection methods are introduced, and students should engage in activities such as conducting surveys so that they can connect their learning to everyday life. Students can use software to explore concepts such as the measures of central tendency and dispersion, as well as analyze and present the results of surveys they conducted. They are also encouraged to investigate and judge the validity of arguments derived from a data set. Particular topics include:

· Finding mean, median and mode from grouped or ungrouped data
· Construct and compare data sets with given mean, median and mode
· Consider relative merits of different measures of central tendency
· Explore and make conjectures on the effect of the central tendency by addition and removal of data
· Understand the weighted mean and its use in real-life situations such as the stock market index
· Understand the misuse of averages in daily situations
· Explore the meaning of probability and the relationship between probability and relative frequency
· Investigate probability in real-life activities and solve probability problems by applying simple laws
· Calculate theoretical probabilities by listing the sample space and counting, and recognize the meaning of expectation

STATISTICS EDUCATION AT THE MATRICULATION LEVEL (S6-S7)

The new curriculum for this level (S6-S7) is still under revision, and a glance at the existing curriculum would clearly indicate that a revision is needed, in order to achieve cohesion between the new S4-S5 level and the existing matriculation level. At the S6-S7 level, the relevant course that includes statistics is intended for non-science and biology students, and the topics are usually covered at the university level in most western countries. It comprises three topic areas: Differential Equations (1st and 2nd order), Numerical Methods, Probability and Statistics. For the last topic, some recommended references are Ross (1994), Moore and McCabe (1993), Freund and Simon (1995), Iverson et al. (1997), and Anderson and Finn (1996). The topics include:

· Probability theory (including Bayes' Theorem)
· Basic statistical measures
· Random variables, discrete and continuous probability distributions (including binomial and normal distributions, linear combinations of independent normal variables)
· Statistical inference

So it is not surprising that the curriculum is under revision, to make it coherent with the curriculum at lower levels.

THE USE OF TECHNOLOGY IN TEACHING STATISTICS

Calculators and computers have been found to be valuable aids for mathematical explorations, computations, and graphing functions. Most Hong Kong schools have been provided with computers, and the government has greatly encouraged the use of Information Technology (IT) in schools, so that students can acquire the expertise that will prepare them for the work force of a knowledge-based society. Given that these devices can handle most of the routine statistical computations, suitable use of them can facilitate students' experimentation and exploration when learning statistical concepts.

For example, a spreadsheet software such as Excel can be used effortlessly to produce different graphical representations for the same set of data. When different diagrams can be plotted very rapidly, students can focus on understanding and discussing the choice of an appropriate diagram to represent the data. By manipulations on columns of data, the same software can also be used easily to explore the effect on the central tendency when changes are made to the data. Other examples are that this software (or Winstats) can be very useful for the exploration of probabilities involved in simple activities such as tossing a die or flipping coins, in which students can be guided to understand the relationship between theoretical and experimental probabilities.

CONCLUDING REMARKS

From the previous discussions, it should be clear that the future direction of statistics education in Hong Kong schools is towards a student-centered approach within which students are encouraged to conduct hands-on experimentation and exploration, and to construct their known knowledge under the guidance of teachers. Connections to real-life examples are to be made whenever possible, so that mathematics and statistics could be shown to be relevant aspects of students' daily lives. In adopting this approach, it is recognized that students and teachers must have space and time at their disposal, and the traditional syllabus must be trimmed back to a certain extent. These goals are consistent with world trends.

However, in trying to achieve these goals, two issues do require attention. The first is the congruence between the school and university curricula. Given that the latter still tends to be a traditional one involving a much more theoretical approach, a re-thinking of the curriculum may also be needed so that the transition from secondary school to university can be a relatively smooth one. The second consideration involves the need for teacher development. Teachers trained in the traditional methods must be enabled to function competently in the new pedagogical environment through professional development; they must also acquire familiarity with the use of technology in teaching the subject, given that this aspect has only been initiated within the past five years in Hong Kong. Since Hong Kong had traditionally considered primary and junior secondary teaching to be a sub-degree profession, effort is required of teachers so that they can develop into competent and well-prepared practitioners in the implementation of the new approaches. This is an important consideration for the future of mathematics education in Hong Kong.

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