

From Phillips, Brian (Ed.), (1997) Papers on Statistical Education presented at ICME-8 (International Congress on Mathematics Education-8) Seville, Spain, July 14-21, 1996. Hawthorn, Australia: Swinburne Press. ISBN 0 85590 753 3

## DATA ANALYSIS IN SECONDARY SCHOOL EDUCATION IN HONG KONG: CURRICULUM, EXAMINATION AND PROJECTS

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### **Abstract**

Like many countries in the world, data analysis is regarded to be an important element in the basic education of a citizen in Hong Kong. The topic is included as part of the mathematics curriculum and has been treated as one of the long existing mathematics topics. Comparing with many topics in the mathematics curriculum, data analysis requires relatively low skill level but relies heavily on common sense. Teachers in Hong Kong, therefore, tend to skip a proportion of the topic without realizing that although common sense plays a role, it does not imply that students can automatically grasp the ideas by themselves.

This paper describes the extent of data analysis included in the secondary school curriculum (for those aged 12 to 17), identifies the reasons that teachers tend to ignore the teaching of data analysis, the unsatisfactory factors in the teaching of the topic, the examination system and its impact on the teaching and learning, the advantages of introducing a project element in the secondary school, and possible remedies for the Hong Kong situation.

### **Background**

Similar to most countries in the world, data analysis is covered in the mathematics syllabus in the secondary school education. In Hong Kong, mathematics is a compulsory subject for all school students until Grade 11 (the first nine years are compulsory for all children). There are two more years of education, Grades 12 and 13, before students can enter a university and pursue their first degree program. Primary school education consists of grades 1 to 6 while secondary school education consists of grades 7 to 13.

Students finish Grade 11 when about 17 years old when they take the School Leaving Certificate Examination. The mathematics examination syllabus at this level consists of 16 topics, two of which are related to data analysis (simple problems in probability and organization and representation of

numerical data). In almost all secondary schools, these two topics have been treated spirally by letting the students to spend some time every year revisiting the subject with some expansion.

In Grade 12 and 13, mathematical education is optional for the students. This paper will focus on the data analysis in the five years of secondary school education (Grade 7 to 11) where mathematics is a compulsory subject.

### **Curriculum**

Details of the curriculum as outlined in the report of the Curriculum Development Committee, (1985), the *Syllabuses for Secondary Schools: Mathematics (Forms I-V)* is and in the report of the Curriculum Development Council (1994) *Target Oriented Curriculum Programme of Study for Mathematics.*) are given below.

In Grade 7, a unit on statistical data aims at developing the students' ability for collecting data, helping the students to understand the various ways of handling data, to learn and to discuss the various methods of displaying data, to understand the significance of statistical graphs and be able to draw conclusions from them.

In Grade 8, students are taught frequency distributions and cumulative frequency distributions. They should be able to construct and to interpret the various graphical representations of the frequency and cumulative frequency distributions.

In Grade 9, probability and statistical measures are first introduced. Students learn the simple idea of probability. They have to understand the meaning of "chance" and to appreciate its use. Students should also learn the difference between theoretical and empirical probabilities. For statistical measures, only the measures of central tendency including mean, mode and median of a distribution are introduced. The simple ways of measuring the central tendency are taught. Students should be able to draw conclusions from the measures of central tendency and to apply these measures in their daily life.

How statistics is used in daily life, the dangers of misinterpreting statistical data are also introduced in Grade 9. Students are expected to understand the actual reasons why statistical data are so presented. Uses and abuses of statistics are therefore emphasized.

Concepts of probability and statistical measures are revisited in Grade 10 and Grade 11 where students are introduced to addition and multiplication laws of probability. The concept of weighted averages is also emphasized. As for statistical measures, students are introduced to the measures of dispersion including range, mean deviation, variance and standard deviation (grouped and ungrouped data) of a distribution and some applications of the mean and standard deviation.

## Teaching

Apart from probability, calculation of mean, mode, median and standard deviation, teachers tend to ignore the data analysis topics. There are several reasons leading to such an attitude:

1. In almost every text book, these topics have been put at the end of the book of every grade. On the one hand, such arrangement has been interpreted by some teachers to be unimportant topics. On the other hand, when teachers cannot finish teaching the whole book, they tend to ignore the last chapters.
2. Frequencies and data presentations are also introduced in the primary school. Some teachers regard these topics to be very elementary and do not prefer to spend time on them.
3. Data collection, interpretation of data display, etc. are not covered in the training of a lot of mathematics teachers who have not had sufficient statistical education. Such teachers would skip these topics and expect them to be taught by teachers of other subjects such as Geography, Economics and Public Affairs, etc.
4. A very important reason leading to ignoring these topics has been the format of the open examination which have been handled by mathematicians who tend to put little emphasis on statistical aspects. The problems set, therefore, require mathematical treatment such as calculation rather than interpretation. This point will be elaborated in the next section.

Even when data analysis topics are taught, they have been treated rather unsatisfactorily. The teaching, very often, emphasis too much on skill and have a very narrow concept of application. There are several important issues here:

### 1. *Focusing too much on calculation*

In the teaching of statistical measures, for example, teachers may concentrate on teaching the students how to calculate the mean, mode and median of a set of grouped data rather than discussing with the students the relative merits of these central tendency measures and under what situations each of which is recommended.

### 2. *Neglecting the technological advancement*

In the teaching of graphical presentation of frequencies, for example, teachers very often pay a lot of attention on how to group the ungrouped data and how to determine the boundaries of each group so that a bar chart can be constructed. They have completely forgotten that today's computer software are so advance that all these can be done in a fraction

of a second and that it is far more important for students to recognise the effect of using different number of bars and the choice of the most appropriate charts.

3. *Expecting a model answer*

Both text books and teachers tend to make sure that when a problem is set a unique answer will be arrived at. Teachers may find it convenient when marking students' scripts if the answer is unique. Such convenience, however, is attained at the expense of introducing to the students a serious misconception of the sure existence of a unique solution for every problem. Students are often uneasy when they face a real life problem where more than one solution is possible and argument will be needed to justify a solution.

4. *Allowing too little flexibility*

In order to arrive at the model answer, examples and problems are usually set very rigidly without allowing flexibility for students. An artificial set of data could be given, for example, and the students were asked to plot a specific graph. Students, therefore, lack the training of considering which graphical presentation would be most appropriate under different situations.

5. *Ignoring interpretation*

When a data set is given, questions on calculations and graphical presentation are usually set. The information conveyed, however, are usually ignored. The formula for calculating standard deviation, for example, is taught while the importance of this measure in terms of describing the variability of the set of data may be totally ignored. The chart and graph plotting technique are usually well taught while the distribution and trend displayed may not be mentioned at all.

6. *Lacking real life examples*

Text books usually provide artificial, small data sets such as the body height of a group of children. The skill of graphical presentation, frequencies and statistical measures calculation can all be tested using such a data set. It does not, however, demonstrate the usefulness of data analysis nor convince the students that different statistical measures are necessary under different situations. It also does not inspire the students nor stimulate any further thoughts on exploring further useful information that is contained in the data set.

### **Examination**

The School Leaving Certificate Examination is an open examination attended by all Grade 11 students (Hong Kong Examination Authority, 1995). To seek employment or to further study, the records on the certificate are

usually the only recognized assessment of a student's academic ability. Since the certificate only records the results of the open examination and nothing else, it is understandable that the whole education system becomes heavily examination oriented.

In the teaching and learning process, a long adopted criterion is that a topic will be taught or treated seriously if it will be examined. How a topic is taught also depends on how it has been examined.

Data collection, for example, is never examined. For teachers and students, therefore, this is an unimportant topic. Likewise, teachers skip also the chapter on use and misuse of statistics, a very interesting, applied topic which has not been examined.

Another example is statistical measures. Measures of central tendency and variability have been required to be calculated but seldom interpreted in the examination. Teachers therefore drilled the calculation without mentioning the relative merits of different measures or why one measure is more appropriate than the other under a certain circumstance.

Recruiting statisticians into the mathematics subject committee is a remedy to be adopted by the Hong Kong Examination Authority. The examination problems can then have more emphasis on statistics. It does not, however, solve all problems. Data collection, for example, is not a topic that can be examined in a three-hour written examination in an examination hall. Such norm of examination certainly does not serve the purpose of assessing students' overall ability in data analysis.

In the foreseeable future the existing examination format is not going to be changed due to lack of leadership in the Education Department, lack of training among teachers and lack of initiative to change the examination oriented system.

In view of this, the Secondary Statistical Project Competition launched by the Hong Kong Statistical Society is playing an important role to supplement the existing statistical education.

### **Projects**

Working on projects is not the main stream in Hong Kong's secondary education which is examination oriented. Statistical projects with emphasis on data analysis are even rarer. It was seldom, if not never, seen until the Hong Kong Statistical Society launched the first Statistical Project Competition for the secondary schools in 1986.

The competition requires a participating team to identify a theme of study, to collect the necessary and adequate data, to analyze and fully exploit the data, to interpret the analysis results, to provide logical arguments and valid conclusions. The team then has to prepare a written report presenting a good grasp of the topic of study, clear and concise definition of the topic, clear and neat presentation of results with proper use of graphs and tables

to illustrate findings.

Interviews with school teachers and participated students reflected that the advantages of taking part in the competition are:

1. *Exposing students to the use of data analysis*

For many students, this project could be the very first time that they realise information can be dug out from data using what they have learned in the data analysis class

2. *Gaining experience in data collection*

Although the competition does not allow for raw data collection, the collection of relevant compiled data is still a very useful experience. Students found that it is not easy to collect the data even when they know its existence. They might need data from different sources or data of a long time span which require a lot of effort. Through their participation they gain a feeling of the importance and the value of data.

3. *Understanding statistical concepts*

When carrying out the data analysis and presenting findings, students have to do a lot of decision making. Which statistical measure to be calculated, which chart or graph to be constructed, what scale to be used, what analysis to be presented, etc. To make each of these decisions, the students have to understand the concepts and consider very carefully the effect of such decision.

4. *Mastering communication technique*

Unlike mathematics where very neat and precise mathematical language and symbols are adequate. In a real life applied problem, human language has to be adopted to explain clearly the puzzle, interpretation, findings and conclusions. Writing up the report provides a good opportunity for training the students to write up a scientific report where all arguments have to be supported by data and data analysis.

## **Conclusions**

Data analysis in Hong Kong is treated dryly as one of the many topics in the secondary school mathematics curriculum. The emphasis has been in calculation rather than on concept, mathematical skills rather than interpretation, accuracy rather than appropriateness. Its interesting and strong applied nature has been largely ignored. Its importance, therefore, has also been down graded accordingly. One of the objectives stated in the Mathematics syllabus for secondary schools (1985) which says "to prepare students to understand everyday applications outside the classroom - for

example by teaching the fundamentals of statistics and probability” does not seem to have been fulfilled under the existing system. Some possible remedies which would shift the emphasis to the right track include:

1. Recruiting statisticians in the mathematics subject committee so that the format of examination problems would be changed,
2. Providing statistical education for mathematics teachers and
3. Introducing project element in the education and assessment system.

### **References**

- Curriculum Development Committee (1985). *Syllabuses for secondary schools: Mathematics (Forms I-V)*. Hong Kong: Education Department.
- Curriculum Development Council (1994). *Target oriented curriculum programme of study for mathematics*. Hong Kong: Education Department..
- Hong Kong Examination Authority (1995). *Hong Kong Certificate of Education Examination: Regulations and syllabuses - 1997*. Hong Kong: