# *Working Group Report on Statistics Curriculum: Content and Framing*

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## *Multiple Perspectives on the Content of the Statistics Curriculum*

Teachers and curriculum developers working at all levels are concerned with the content of courses, which has usually been described in terms of *what students should know*. Traditionally this has been listed in terms of factual and conceptual knowledge, and operational knowledge and procedural skills. More recently, some statistics (and mathematics) curricula have been structured in terms of both *knowing and doing*, with the emphasis on doing being related to holistic approaches and large-scale issues. Within this emphasis, what students "do" might be thought of in terms of problem solving (doing statistical investigations and statistical modelling), reasoning with uncertainty, communicating, and making connections.

We believe that there are other important perspectives that can be used to consider the statistics curriculum. The first of these is *statistical thinking*; what is known and done is only meaningful if underpinned by thinking; this includes thinking about data, investigations and modelling, variation, multiple representations, sampling, inference, and so on. For teachers a key concern is *learning activities*. What range of learning activities help students develop their ability to know, do and think statistically? We acknowledge that a curriculum may be written using a framework involving only one or two of these perspectives, but all four of them need to be considered and, ideally, all four will be made explicit either within a curriculum or within the supporting documentation.

## *Some Considerations Relating to Curriculum Framing*

The *aims* of any statistics curriculum need to be stated explicitly. The aims need to be coherent within the general aims of the educational programmes, the discipline itself (statistics), and those of stakeholder groups when the curriculum is for a service subject. In schools, the aims of the statistics curriculum also need to be aligned with the aims of the mathematics curriculum when statistics is taught as part of mathematics.

The *principles* guiding the construction of the curriculum will ideally be made explicit. These principles, together with the aims of the subject, will provide the rationale for the curriculum and help people with alternative views understand the basis of the curriculum. Any *assumptions* that are made should be made explicit so that those with alternative views can argue critically for their alternatives. Such assumptions might relate to the nature of statistics, the nature of knowledge (separated or connected, surface or deep, relative or absolute), pedagogy, the proposed audience, the historical development of preceding courses, available resources, the degree of choice left to the instructor, the assessment regimes (school and external), and the teachers' responsibility to empower learners to continue their exploration of the subject after any formal courses are finished.

Each statistics course or statistical component of a course needs to be aligned with associated courses, be they other statistical courses, mathematics courses, courses in other subjects (formal or informal) in which statistics plays a service role; and between courses taught at different levels (primary, secondary, undergraduate, and graduate levels). Part of this *alignment* involves making links between the subjects, seeing commonalities as well as differences, and considering how the balance of importance can swing from one to the other as particular topics are considered. As part of this alignment, teachers of statistics need to acknowledge their responsibilities as teachers in the general sense, and also as well as teachers of statistics, and realize how societal values can be incidentally learned because of the way the subject is taught and the activities used in the teaching.

Technology has a role in the teaching of statistics and is changing the nature of the subject, its role can be summarized by:

Some statistics becomes more important because technology requires it;
Some statistics becomes less important because technology replaces it;
Some statistics becomes possible because technology allows it; and
Some statistics can be taught using technology.[1]

For example, technology use has allowed earlier accessibility of complex investigations, exploratory data analysis and visualization, simulation, and re-sampling.

## *Further Considerations with Respect to Curriculum Design*

While there are many similarities between primary, secondary and post-secondary education, there are also some differences. Consequently, at each level of education, there are specific matters that deserve consideration.

### *Primary/Elementary School Statistics within Mathematics*

In some countries statistics is part of the school (mathematics) curriculum from the first years of schooling. In these circumstances notions of categorisation within mathematical reasoning provide some initial opportunities to discuss categorical data. Primary school teachers are usually teachers of all subjects, and statistics need not be seen as a separate subject but rather as a tool to be used in any/every subject, and thought of as numbers and data in context.

### *High School Statistics within Mathematics*

In some countries statistics is taught throughout high school as part of a mathematics course, while in other countries statistics is a stand-alone course in the senior year. In both circumstances the commonalities and the differences with mathematics need to be emphasised, and courses need to be structured with the aim of statistical literacy for citizenship for some and the likelihood of further study in statistics for others.

### *Post-Secondary Statistics Courses*

Initial tertiary-level statistics courses are designed for mathematics/statistics majors, for future statisticians, and for students who may not continue with statistics; and for students in a range of different universities and countries. We believe that such *introductory courses* should build on the students' backgrounds, be strongly related to data, contribute to the students' development in statistical thinking, take account of current educational and statistical practice, and provide a strong basis for future statistical learning.

Developing and implementing curriculum for tertiary *service courses* requires considerable understanding of statistical education and expertise in helping the serviced area identify and articulate what they want for their students. In developing curriculum collaboratively with serviced areas, and in designing learning and assessment experiences, the statistician should ensure that the interests of the students remain foremost.

In developing curriculum for courses beyond those at the introductory tertiary level it is important that each course be coherent within itself, structured around clear objectives, and clearly linked with other

[1] This statement has been adapted from one made by Engelbrecht & Harding (2001) by replacing the word mathematics with the word statistics, and originally adapted from a statement made by Seeley (1990) in reference to mathematics.

subjects that the student may take. As with service courses, the wishes of stakeholders must be interpreted and balanced with the educational development of the students, with the latter remaining foremost.

*Statistics as Part of General Adult Numeracy Courses*

We see a need to acknowledge statistics as an important strand of adult "numeracy" when considering literacy and numeracy programmes for citizenship and work. Statistical numeracy can rarely be taught adequately by literacy specialists with a minimal level of statistics or mathematics; statistics educators need to work with adult educators to help them develop courses and learn themselves.

*Special Purpose Short Courses and Workshops*

Statistical concepts taught in short courses targeted for professional development, such as certificate programs and training workshops for industry and government, should emphasize those aspects that are relevant to achieve the learning objectives of the particular program. These courses could focus on such topics as quality engineering/control, modeling and simulation, control systems, or teacher development. The students in these courses may not have been exposed to statistics before, and while it is important that they be well trained in the use of statistics, such courses may be dangerous in the sense that they only provide a partial picture and participants may try to extend this initial knowledge erroneously to other areas.

## Four Additional Matters

There are a number of other matters that relate to the curriculum and curriculum development that we did not discuss. These include: collaboration, assessment, resources, teachers' professional development (pre-service and in-service), and research.

## References

Engelbrecht, J. & Harding, A. (2001). *Mathematics is not for grown ups*. Seminar presented at the Mathematics Education Unit, University of Auckland.

Seeley, C. (1990). Address at Leading Mathematics Educators into the Twenty First Century conference for the release of the 1989 *Curriculum and Evaluation Standards for School Mathematics*. National Council of Teachers of Mathematics.