

# Curriculum Design: from an art towards science

S. WAKS\*

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## REVIEW

THIS book is an important contribution to the literature. Such a guideline for systematically developing a curriculum to fulfil defined teaching requirements is long overdue. That this book emphasizes data gathering as the first step, and thorough statistical analysis of the collected data as the second step is admirable.

In particular, the technique of setting up a multi-dimensional *mapping sentence* to describe the possible variations of conditions is powerful. The basic requirements for such a mapping sentence are stated as giving 'an exhaustive set of elements' that are 'mutually exclusive' (orthogonal, Cartesian) and 'exhaust the contents of concern'. Most elements that can be recognized are to some extent interactive, and to be exhaustive is almost impossible. Especially difficult is trying to include the elements of abilities and attitudes that are desired in graduates.

I have reservations, in part because the book is not completely consistent in its philosophies. It seems the author does not distinguish sufficiently well between (professional) engineers, technologists and technicians; the requirements for these three grades are different, but with some overlap. Another part is that historic data is gathered by a questionnaire, from practitioners who left their student days behind by several years. This has the same disadvantage as market research and benchmarking. Only historic trends can be discovered, and extrapolation into a future would need some insight into possible future trends that cannot be present in current practitioners. Even these historic trends can be distorted by failings in human memory—what is important to practitioners now, may not be the requirement for the same practitioners when they started their careers, and thus for starting practitioners in the near future. The results (details and structure) of any analysis can therefore easily reflect 'common knowledge', but fail to reveal new insights.

Using such data from historic sources also assumes that the market (in this case for engineering graduates) is stable and will find its own equilibrium—but that is just not true. As the time-to-market of new products decreases, a state of dynamic instability is more likely, leading to wild swings in trends. The complex market (for practitioners) is always changing, which implies that 'edge of chaos' theory (1) may be a better model of the future situation.

A major emphasis in this book is on statistical analysis of data obtained from questionnaires, to provide various forms of input to the design process for formulating a curriculum. In most of this book, the author advocates using non-parametric statistical techniques because they do not rely on assumption about the nature of the underlying statistical distribution. Yet Chapter 10 and Appendix C deal mainly with parametric statistics based on the normal distribution.

In Appendix C, the author states that in non-parametric statistics the median of a sample is a better estimator for the population mean  $\mu$ , than the sample mean  $\bar{x}$ . Yet in Chapter 4, in the (non-parametric) DISCO program that estimates whether 'perfect discrimination' (no overlap), partial overlap or coincidence (full overlap) between two populations exists, a calculated coincidence of the *sample means* indicate complete coincidence of the populations. But Fig. 4.1 shows *skewed* distributions. And 'perfect discrimination' still allows the two adjoining end values of each distribution to coincide, but reports 'no overlap'.

The data gathering as reported was (correctly) done by asking many people from several levels of activity involved and academia. The effort of data gathering seems to have been large—about 100 persons across 20 recognized job divisions, each spending about 45 minutes to answer the questionnaire for this trial alone. But the questionnaire seems to be one person's opinion about what needs to be asked. The selection and formulation of these questions is to me inadequate, especially for finding out about tasks for mechanical engineers. A much wider range of questions and respondents needs to be tapped to obtain a good view of the needs.

\* Available from: TEMPUS Publications, Dublin Institute of Technology, Bolton St., Dublin, Ireland.

The questionnaire in Appendix A (for electronics technologists) deals only with the design (the product) as assessed for quality, cost packaging, safety and 'design control'. The latter refers to checking and verifying the product. Any designed product has more properties than that. We recognize classes of *external properties* related to functioning (especially in space and time), functional parameters, operation, manufacturing, distribution (marketing, transport, etc.), delivery (deadlines, etc.), disposal (recycling, etc.), ergonomics, aesthetics, conformance to laws and social conditions, and economics (cost, price, etc.), and the *internal properties* of elements and assemblies directly designed or selected to establish the product. Quality is the appropriateness of the mix of these measured and perceived properties for the observer and/or the task to be performed—which includes 'cost, packaging and safety'. And in the electronics context, 'packaging' has a particular meaning. The designer of the electronic circuit usually is not concerned about the (2-D and 3-D) space configuration of real devices that implement the circuit—that is the task of electronic packaging.

Chapter 8 and 9 are somewhat dated in their

approach to teaching and learning, with many recent developments not considered. Especially, the component-to-system approach is *not* a Cartesian /non-interacting contrast to the system-to-component approach; any good teacher will use both of them to complement each other. The affective domain gets somewhat short shrift—there is no mention of the companion work to Bloom's taxonomy (2), edited by Krathwohl (3), and the development of student capability according to Perry (4) is not mentioned. A national curriculum, as advocated here, does not exist in most English-language countries; standards between institutions are maintained by short periodic review visits by an accreditation board.

In spite of all noted short-comings, this book is a valuable contribution. The volume should be required reading for all curriculum developers, especially in countries where 'planning' is regarded as a dirty word. Its treatment of data analysis and interpretation to assist curriculum design is a major step forward. I recommend this book, especially for those at the interface between teaching and administration.

E. Eder

#### REFERENCES

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3. D. R. Krathwohl, (ed) et al., *Taxonomy of Educational Objectives: Affective Domain*, New York: McKay, 1956.
4. W. G. Perry, *Forms of Intellectual and Ethical Development in the College Years: A Scheme*, New York: Holt, Rinehart, 1970.