Curriculum Innovation and the Teaching of Probability in South Australia—Colonial Echo, Mature Development or Muddling Through?

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Abstract

Some writers have argued that mathematics curriculum change in Australia has been a mimicking of overseas trends until recent times when a more mature approach been developed.

This claim is examined for the teaching of probability in South Australian schools from 1960 to the present. This recency and probability's distinctive requirements mean that the forces underlying its introduction are likely to be more accessible to the researcher than those for less radical changes.

It is argued that neither a "colonial echo" nor a "coming to maturity" model are adequate to describe what happened. The forces for change have often been idiosyncratic, poorly integrated and poorly justified. They have been concerned more with content than with research findings or pedagogical difficulties. "Muddling through" may well be the best way to describe the process of change.

Introduction

Some writers have argued that mathematics curriculum change in Australia has been a mimicking of overseas trends until recent times when a more mature approach been developed.[1] They claim that in the 1960s the School Mathematics Project (SMP) and the Nuffield Project, both from England, were the major inspirations for the introduction of the new mathematics into Australia,[2] that even the criticisms of the new mathematics made in Australia were copies of criticisms being made overseas,[3] and that

> it was the naive willingness of Australian educators to accept untested English ideas in the area of school mathematics which persuaded education authorities, in each Australian state, to commit schools to large-scale, but ill-fated, reconstructions of their primary and secondary mathematics curricula, through the Cuisenaire and "new Maths" movements.[4]

Probability first appeared in school syllabuses about 1960. Not only was it unfamiliar to most teachers but it differed markedly from traditional algebra and geometry, and required different pedagogic approaches. So a study of its introduction can provide a useful touchstone against which to test the generality of the claims made above.

To compress 35 years of history into eight pages is not easy. In this paper vignettes of some critical relevant events in South Australia are sketched to illustrate that the "colonial echo" explanation

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1 Clements, Grimison & Ellerton (1989, p. 51)

2 Clements *et al.* (1989, p. 69)

3 Clements *et al.* (1989, p. 70)

4 Clements *et al.* (1989, p. 68)

mentioned above is too simplistic and too general. Necessarily, conclusions drawn from such an approach can only be tentative, but it is argued that the vignettes suggest that there is a need for a more comprehensive theory than that of "colonial echo".

Probability as Part of the "New Mathematics"

There was no one "new mathematics" approach to probability in the 1960s. In the USA some argued for its inclusion because of its importance in the developing biological and social sciences[5] while others argued that it could be presented as

> ... an example of a small axiomatic system that has remarkably extensive consequences: it takes its place beside the deductive systems recommended for geometry and for algebra. Moreover, the theory of probability provides a natural use for the important notion of sets ... .[6]

Others saw it as a branch of applied mathematics which could provide "an antidote to the erroneous idea that 'in mathematics there is always one *exactly* right answer'" or which was amenable to an activity approach in primary school.[7] Indeed, some saw it as so important a part of a liberal education that it should be taught in primary school before children started to leave formal mathematical education.[8]

In Britain probability was initially justified because it was a useful application of elementary set theory which enabled conditional probabilities to be dealt with in a way acceptable to tertiary mathematicians[9] but later, it was advocated as a topic with wide application, one "that always goes down well in the classroom"[10] and one that "encourages the pupil to think clearly and logically".[11]

In general, the approach in the USA tended to be a "pure mathematics" approach, that in Britain an "applied" one. Both were known about by some in Australia as the teaching of probability developed, but neither approach provided a complete model for the Australian developments.

Probability Overshoots at the 1964 ACER Conference

It was the decision to change to a decimal currency in Australia which provided the opportunity for mathematics syllabus reform. Twenty people, mainly state curriculum officers and leaders in primary education, met in March 1964 under the auspices of the Australian Council for Educational Re-

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5 National Council of Teachers of Mathematics (1961, pp. 65 - 68)

6 College Entrance Examination Board (1959, p. 32)

7 Cambridge Conference on School Mathematics (1963, pp. 70 - 72)

8 Cambridge Conference on School Mathematics (1963, pp. 70 - 71)

9 School Mathematics Project (1965, p. 82)

10 School Mathematics Project (1970, p. 1)

11 School Mathematics Project (1970, p. 1)

search (ACER) to make suggestions about appropriate changes for primary schools in the light of "recent movements in the teaching of mathematics."[12] Its view of mathematics as "... a study of the relationships between selected sets. It is a study of structure"[13] was pitifully narrow, but it did include the "development of an intuitive idea of probability" in a statement of expected outcomes of a primary mathematics course.[14] This is probably the first time that probability is recommended for primary schools in Australia. It is not clear who advocated its inclusion or on what grounds. It just seems to have appeared.

In any case this recommendation did not get back to South Australia.[15] This was probably not entirely the fault of the local representatives. It did not even reach the Suggested Outline of Topics and Topic-Sequence drawn up in the official Conference report.[16] Only in 1966 when the book *Background in Mathematics* [17] was published to disseminate the ideas of the Conference was probability discussed in depth in a section which drew on overseas experience.[18]

The book had little influence in South Australia: "800 copies were distributed... but teachers found it difficult to read".[19] Furthermore, South Australia was still trying to accommodate itself to the experiments led by Dr ZP Dienes from the University of Adelaide who was concerned with structure and the use of concrete aids and not with probability.[20] For the mathematical leaders in South Australian at that time mathematical power came from knowledge of how to do things and control over the use of brackets.[21]

But *Background in Mathematics* had little influence on the teaching of probability in the rest of Australia either. The ACER sponsored a writing team lead by Mr J Izard who produced a card scheme entitled *Individual Mathematics Programme* to illustrate how the 1964 recommendations might be implemented.[22] Probability is not mentioned.

So it may be said that although overseas ideas on the teaching of probability did reach Australia, and were incorporated into critical documents by 1966 the topic failed to make a landing in South

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12 Australian Council for Educational Research (1964a, p. 34)

13 Australian Council for Educational Research (1964b, Annexure 3, p. 1)

14 Australian Council for Educational Research (1964b, Annexure 3)

15 *Education Gazette South Australia* 1 Jun 1964, pp. 187 - 188

16 Australian Council for Educational Research (1964b, Annexure 10)

17 ACER (1966) and lightly revised in 1972. Page references are to the 1972 edition.

18 Dr John Keeves, Curriculum Officer at ACER at that time (pers. comm.)

19 Brinkworth (1970, p. 39, text and footnote). Much of the book had been checked and corrected by the eleven-year old niece of the author! (Keeves, pers. comm.)

20 Dienes (1964)

21 Glastonbury (1966)

22 Izard *et al.* (1965, 1970)

Australian primary schools. Only in the 1990s did it start to be taken seriously as a subject suitable for study in these schools. It did, however, come into secondary schools, but for reasons quite different from those proposed overseas.

Probability Comes into the Secondary Syllabus

Early in 1965 a much larger conference for people concerned with secondary mathematics was convened in Sydney by the Commonwealth Office of Education and UNESCO. The major speakers, Professor Ed Begle from the USA and Professor Bryan Thwaites of SMP from the UK were specially chosen because it was felt that the mathematics which they were encouraging was rich and varied.[23] But while both mentioned probability, their discussion was superficial.

Australia was starting to experience the rapid growth of its secondary school population. Participants at the Conference were concerned to develop new syllabuses which were suitable for successful presentation by "all teachers to all children".[24] They did express "general support for the inclusion of [probability and statistics] and felt that work could be given at all levels".[25]

The reasons for this support seem to have been less the eloquence of the invited speakers than some participants' experience that statistics could be a suitable practical topic for less able students. The extent to which this pragmatic reason underlay much of the move to bring probability and statistics into school curricula is one which warrants further investigation. Certainly the fundamental principle underlying change in 1965 was that "if the general impression of teachers to syllabus change is favourable, then such a change should be acceptable."[26] The beginnings of the increasing role of the teacher, as opposed to the administration or the universities, in curriculum reform can be clearly seen in this conference.

The conference did lead mathematics educators in South Australia to decide that the time had come to develop new mathematics syllabuses in SA.[27] They did so at a time when schools were becoming more comprehensive and moving more to providing vocational and social developmental education.[28] It was decided in February 1965 to introduce changes on a trial basis immediately.[29] While SMP was initially used as the basis for the trials it was not long before locally produced materials

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23 Keeves (pers. comm.)
24 UNESCO (1965, p. 10)
25 UNESCO (1965, p. 21)
26 UNESCO (1965, p. 24)
27 Sumner (1969)
28 Hamann (1975)
29 Baxter (1972)

quite different in approach replaced it[30] and tended to define the new course in all schools. In 1969 a new mathematics syllabus for public examination at Year 11 was offered which included work on the sum and product laws of probability and binomial probability.[31] The algebra section of this course included permutations and combinations which it saw as a topic which could be applied to probability.[32] Soon after a new Year 12 course was offered.[33] These syllabuses were strongly in the "pure mathematics" tradition. For example, only the symmetric approach to probability was discussed. For neither course were textbooks recommended or prescribed.[34] This was clearly going to be a "do it yourself" syllabus development.

So by 1969 probability had found its way into secondary schools. Administrative reasons may well have delayed the introduction of probability into secondary courses until 1969. But it is still not clear why South Australians saw the topic as needing to be introduced at all.

Publications of the Mathematical Association of South Australia (MASA) at that time make it clear that South Australian mathematics teachers could easily have been aware that probability was being introduced in other parts of the world from at least 1967, but this does not explain who urged its introduction into South Australian schools or for what reasons.

There is some evidence that ES Barnes, professor of Pure Mathematics at the University of Adelaide was a important advocate. He had helped to found MASA in 1959 and had a significant influence on the 1969 revision of the Mathematics I syllabus at the University of Adelaide to include probability[35] at a time when neither Flinders University[36] nor the Institute of Technology[37] taught the topic to first year students. It has been suggested that the changes which Barnes introduced were mirrors of what was happening in other parts of the world.[38] Some of these may have been, but this in no way suggests that they were advocated uncritically, and it does not explain why the introduction of probability came first at the instigation of a pure mathematician at an older university.

There may well have been good reasons for introducing probability which will be discovered when reading private records, but these have not found their way into the public documents which I have so far examined and which would have been read by teachers. This in itself is significant. Not only

30 *Secondary Mathematics Series (SMS)* published by Rigby in Adelaide
31 Univesity of Adelaide. Public Examinations Board (1968, p. 41)
32 Univesity of Adelaide. Public Examinations Board (1968, p. 41)
33 Univesity of Adelaide. Public Examinations Board (1968, pp. 106 - 108)
34 Univesity of Adelaide. Public Examinations Board (1968, p. 40)
35 Barnes (1969)
36 Abrahamson (1969)
37 Duncan (1969)
38 Letter to author from Professor MA Clements 20 Jan 1994.

did the change just happen, but it seems to have happened with little attempt to explain why it happened.

Probability Starts to Leave the Secondary Syllabus

As a result of the changes started in 1965 probability gradually became an integral part of the secondary syllabus at all levels. By 1985 official documents of the Senior Secondary Assessment Board of South Australia (SSABSA) were claiming that probability was "a topic essential in interpreting the results of scientific research and handling much media information" and which would be of value in real life because a student would know how to "apply [it] to problems involving chance events".[39] Students preparing to attend university sat for either Mathematics 1 and 2 or Mathematics 1S, both of which contained a significant study of counting and probability, but no statistics.

At this time the increasing emphasis on applied mathematics in schools led to moves to incorporate a significant amount of statistics into Year 12 academic mathematics courses. SSABSA established a Mathematics Task Group under its Mathematics Curriculum Area Committee to examine the feasibility of making such a change.

There was significant opposition from some tertiary mathematicians who claimed that statistics was "not simply a branch of mathematics but a quite separate subject concerned with the logical interpretation of data."[40] or because of concern about the lack of confidence in probabilistic ideas which Year 12 students held at that time.[41] Others held the view that "a satisfactory introduction to statistical inference, including a discussion of sampling distributions, can be based almost entirely on the analysis of data sets".[42] This difference of opinion among authorities arose to some extent from different emphases placed on the balance of pure and applied approaches, on new ways of interpreting data which were being developed, and on the views of the purposes of a Year 12 examination in mathematics. These differences deserve more detailed examination than is possible here.

During 1987 and 1988 SSABSA conducted a survey of all Year 12 mathematics subjects among teachers, students, and other interested parties. Some felt that the survey was of a form which was

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39 SSABSA Subject Guide extant in 1987, but probably from an earlier date.

40 This view was expressed by a member of the University of Adelaide in late 1985 in correspondence with the Mathematics Curriculum Area Committee.

41 This view was expressed by a member of Flinders University in early 1986 in correspondence with the Mathematics Curriculum Area Committee.

42 This view was expressed by a member of the South Australian Institute of Technology in early 1986 in correspondence with the Mathematics Curriculum Area Committee.

biased towards the desires of those in power, but their objections were not heeded.[43] It was proposed *inter alia* that:

> Mathematics 1 and 2 remain in essentially in the same form with counting retained but probability omitted "to allow a more thorough study of a smaller number of topics and an increased range of associated applications",[44] and that
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> a new subject, Mathematics 3, be established, "designed for students wishing to take an applied study in mathematics"[45] containing significant study of both probability and statistics.[46]

It was intended that all three subjects should be "Publicly Examined Subjects" acceptable to the universities when allocating university places. In fact Mathematics 3 is still (April 1994) unacceptable to two of South Australia's three universities. Their refusal to accept the subject has led to acrimonious debates and unsuccessful attempts to mount a challenge to their decision in the courts.

Why, if probability was seen as so important, was it allowed to be removed from the course studied by academic students just at the time when the mathematics community was working towards the preparation of a *National Statement on Mathematics for Australian Schools* [47] which would recommend that probability be a key part of the mathematics curriculum from Reception to Year 12?

One reason was that teachers felt that the survey revealed that Counting & Probability was least enjoyable to teach and very difficult for students. These views were most strongly held by those teaching Mathematics 1S who were more likely to be the teachers less well qualified to teach the topic. The survey revealed that one out of six teachers of Year 12 mathematics had only one or two years of study of tertiary mathematics and about 10% of the teachers were teaching the subject because there was not other teacher available.[48] So a second reason might be that the topic was omitted because it was too hard for a significant minority of the teachers.

There were those on the Curriculum Area Committee who opposed the move. They quoted recommendations from the National Council of Teachers of Mathematics in the United States of America to argue that South Australia was moving against the tide. They argued that 10% of Mathematics 1 and 2 students had found probability the most useful topic they had studied in their mathematics

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43 This view was expressed by a member of Flinders University in 1987 in correspondence with the Mathematics Curriculum Area Committee.

44 Recommendation 16 of Mathematics Curriculum Area Committee to SSABSA 13 Feb 1989.

45 Recommendation 1 of Mathematics Curriculum Area Committee to SSABSA 13 Feb 1989.

46 The name of this new topic has changed many times; "Mathematics 3" will be used here.

47 AEC (1991)

48 SSABSA Evaluation Report

studies. They were told that probability's omission from Year 12 did not mean that it would not be taught lower down in the school. [49] They failed to stem the tide.

Probability was removed from the syllabus at the end of 1991, leaving behind counting which, it will be recalled, had been justified back in 1969 as a topic which could be applied to probability.

Discussion

There is clearly much more to this matter than can be discussed in a brief paper. But the vignettes presented do suggest that the reasons for the introduction and removal of probability are complex. They cannot be attributed merely to a process of "colonial echo". There were too many developments of different forms happening overseas for all of them to be echoed at once. Even when a deliberate decision was made to adopt an overseas course, this was quickly changed into the use of a locally produced quite different course. They cannot be attributed even to an echo of what was happening in other states. South Australia moved against the stream both in the way it treated the ACER 1964 conference and in the way it removed probability from the Year 12 syllabus in 1991.

It is also difficult to argue that a more mature approach has marked recent changes in South Australia. In a state which has had a reputation for maintaining good relationships between the various groups concerned with education, recent years have been marked by an acrimony and litigiousness which are scarcely the marks of mature development.

It is difficult to argue that the changes have been driven by internal logic. Reasons for change have been difficult to locate. Even if there have been good reasons, their absence from the easily available literature means that they have not been seen as critical in ensuring the support of teachers.

There is some evidence that curriculum decisions about probability have been made at the insistence of people holding considerable power at the time. There is some evidence that they have been made on the basis of what is likely to be well received in the classroom quite independently of its intrinsic value. There is some evidence that they have been influenced by the limited capacity of some teachers to teach probabilistic ideas. There is no evidence that I have been able to find that they are based on research findings about the teaching and learning of the topic or that the locally produced programmes were any better tested than the "untested English ideas" referred so derogatively at the beginning of this paper.

There is more research to be done, but at this stage "muddling through" does seem to be a better model for curriculum innovation than either "colonial echo" or "mature development".

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49 Minutes of Mathematics Curriculum Area Committee 1988

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