The Curriculum and Standards Framework: New Directions for Mathematics Curriculum.

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Background

In 1993, when the Victorian Board of Studies was established, replacing the Victorian Curriculum and Assessment Board, an important item in its charter was the development of a curriculum and standards framework for Years P to 10. The Board established eight "Key Learning Area Committees" (KLACs), reflecting a means of conceptualising the curriculum that had been established nationally for the development of the national statements and profiles. During the first half of 1994, each KLAC was charged with developing its contribution to the Curriculum and Standards Framework (CSF). The draft was completed in June and, at the time of writing, consultations with schools are being undertaken. Revision of the document to reflect results of the consultation and further advice from the Board is to be completed in October and the final document is to be ready for introduction into schools at the beginning of the school year in 1995.

The purpose of this article is to outline some of the major features of the Mathematics section of the CSF that are crucial to its practical use. It is important to understand how the CSF presents only one way of conceptualising the curriculum. For various reasons to do with its origins in the national curriculum movement of several years ago, the underlying structure focuses on student outcomes, rather than teaching inputs. Issues of how to develop a teaching program from the CSF are therefore taken up later in the article.

The origins of the CSF. The Draft CSF itself (Board of Studies, 1994) gives information about the purpose and intended use of the document and its structure in terms of levels and strands, which are adapted from the National Profiles (Curriculum Corporation, 1994). The Mathematics section of the CSF draws heavily on the national documents. This was partly due to Board of Studies policy of adopting the overall structure of the national profiles, partly due to the shortage of time for writing the document and partly due to shared values of what is important in a mathematics curriculum. These shared values have been described most fully in *A National Statement on Mathematics for Australian Schools* (Australian Education Council, 1990). Whilst the *National Statement* view of the characteristics of mathematical learning which are of most value to the various groups of students who study Mathematics in Years P to 10 has been subject to sharp criticism in the press from sections of the scientific and mathematics community, it has met with broad consensus in the educational community. The *National Statement* has, for example, been used as the basis for the development of the *Mathematics Course Advice (Primary)* published recently by the Victorian Directorate of School Education (DSE, 1992).

During 1993, the adequacy of the National Mathematics Profile (Curriculum Corporation, 1994) was subject to intense investigation, beginning with a Victorian Ministerial Advisory Committee and culminating in consultations with schools. In response to this investigation, plans for the development of the CSF were finalised. During the few months that were available for the preparation of the draft CSF, the National Mathematics Profile was altered in several ways:

(a) to meet the somewhat different size and format of the Victorian document;
(b) to adjust the learning outcomes in the light of the changed number of levels (reducing from 8 to 7) and to the stronger and different links between levels and years of schooling (in Victoria, levels were set in relation to stages expected to be reached at various grade levels; the national document was more open to describing levels which children reach in their own time);
(c) to remove the general process strand in the national document, removing generic processes of learning and investigating and instead identifying specific processes and procedures that students should be taught in mathematics;
(d) to simplify the language wherever possible;
(e) to reduce the number of substrands and learning outcomes where possible;and
(f) to adapt the content to reflect the advice of the Mathematics KLAC, which had decided that some aspects of the content had to be strengthened in order to adequately prepare students for careers involving high level quantitative thinking.

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The Theoretical Model

Outcomes based education. The structure of the National Profile and following it, the CSF, is based on curriculum inputs and learning outputs. It is an example of a world-wide movement towards outcomes-based accountability of schooling. Schools should be judged, it is believed, according to how much learning they produce in their students. Two things are required for this: a statement of what is important to be learned and a way of assessing it. The CSF is thus partly an attempt to delineate what is regarded as being of value in our society; to set out the "big ideas" which all schools should work on. In this sense it is indeed a curriculum framework and this purpose was upmost in the minds of the writing team and in the advice given by the Board to KLACs prior to the main writing phase.

However, the other side of outcomes-based accountability of schooling is the need to obtain some measure of the learning outcomes. In the near future, the quality of information that can be gained for this purpose and the impact of gathering it on schools, teachers and students may become critical issues for everyone in education to engage with. The experiences of other countries are sobering. The testing movement has for many years dominated teaching in the United States, with consequences that are widely condemned (National Council of Teachers of Mathematics, 1989). In Britain the assessment procedures introduced in support of their National Curriculum, took large slices of teachers' and students' time and produced information of dubious comparability, reliability, validity and utility (Hudson, Johnson, Routledge, Smith & Smith, 1993). In Victoria, the Learning Assessment Project, state-wide testing of every child in Victoria in grades 3 and 5 beginning in 1995, is one attempt to measure learning outcomes.

The levels and strands of the CSF and Profiles are also oriented to assessment, being based on a theoretical model of learning popular in educational measurement. The model proposes that as students grow and/or learn, they will exhibit increasing levels of competence in a given area. How well a student does on any item is assumed to depend on two things only: the student's competence in the area and the difficulty of the item. Statistical techniques are used to find points along the scale which in some sense represent equal amounts of growth. These equally spaced levels are then described verbally according to the nature of items which exhibit that degree of difficulty. Some "validation" of this nature was done with the National Mathematics Profile.

Both the national profiles and the CSF identify the substrand as the basic area of learning, along which student's progress. The assumption therefore is that each substrand is an internally consistent and cohesive whole representing a continuum along which development occurs. In identifying the 31 substrands, the National Mathematics Profile has therefore tried to describe the basic elements of competence. For practical reasons, the CSF has done it in less: 25 substrands in the draft.

Consequences of the theoretical model. The idea that a substrand is a set of learning outcomes (and not teaching inputs) leads to the large amount of apparent duplication across substrands. Ideas about grouping statistical data, for example, are in three of the four statistics substrands. This is because teaching this topic (and most others) results in a variety of different learning outcomes. Students, for example, will learn how to "plan class intervals for continuous data using a sensible number of intervals for the purpose" (Collection and Organisation Substrand, p 64[2]); they will "represent grouped univariate data in histograms (with equal interval widths)" (Visual Representation and Summary Statistics Substrand, p 67) and will "interpret information in tables and bar graphs where data is grouped into simple intervals" (Interpretation and Inference Substrand, p 70). When a teacher teaches a topic there are inevitably and desirably a variety of goals and outcomes, but this makes the CSF a heavy-handed approach to designing a teaching program.

Perhaps the prime example of over-emphasis is the topic of computations. Since they can be done mentally, by written methods or with a calculator they pervade the Number Strand and also appear in Mathematical Tools and Procedures Strand. Most "topics" of a traditional curriculum are spread in this way, making it a challenge to infer a teaching program from the set of learning outcomes. Support material which translates the CSF into detailed teaching programs will need to be provided. An example of how information from the various components of the CSF needs to be assembled together to develop a program is given later in this article.

Not everything fits the model. The assumption that substrands generally represent abilities which begin to develop at the beginning of schooling and continue, is modified in the Algebra strand, which begins in the CSF at level 5. However, there are other patterns. Some abilities which begin to develop may simply be achieved and then maintained over time. Other important aspects of mathematics do not seem to fit the model at all. One example is the awareness of the need to check the results of calculations of all descriptions, from 2 + 3 = 5 to finding a minimum value of a function. This awareness implies a sensitivity to the conditions of a problem, an ability to work cognisant of the whole context and constraints of a situation. I contend that although our students vary markedly in the degree to which they exhibit this important ability, it does not of itself develop with age. A child just beginning school can show this characteristic on the problems he or she is solving as much as a student of Specialist Maths in Year 12. Yet the strand/level model would have us characterise the level 1 child (a typical 5 year old) as insensitive to context, getting ridiculous answers without concern and a year 10 student as having advanced checking skills. This simply is not the case. The complexity of the problems where the ability is

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[2]All page references, unless otherwise specified are to the Mathematics section of the Draft CSF (Board of Studies, 1994)

demonstrated varies over the years, but students of all ages can demonstrate excellent awareness. All teachers will be striving to improve students' skills here. It is clearly an important goal but it does not fit in with the developmental basis of the document.

It is for reasons such as this that the CSF in its curriculum focus statements and learning outcomes cannot express all that is important for students in Mathematics. The Introduction (p. 1 - 6) which specifies the goals, the varieties of mathematical behaviour and the limitations of the structure is therefore critically important when it comes to judging the adequacy of the ways in which the CSF learning outcomes might be used for assessment and reporting.

Making a teaching program from the CSF

The body of the CSF for Mathematics is written in terms of curriculum focus statements, each of which is associated with a string of learning outcomes, spaced two years apart. One immediate problem for teachers is to design a program for teaching a year's work. Teachers will not use only the CSF in this task: course advice being prepared by the Directorate of School Education and textbook series will assist, and further support material may be made available by the Board of Studies during 1995. However, to successfully use the CSF to plan a year's work requires looking at the curriculum focus statements across a strand, delving into the learning outcomes for more detail and examining adjacent levels to see new emphases and what foundations need to be prepared for the future. Finally, checking across other strands will suggest other avenues for re-inforcement and looking ahead. As an example, some preliminary thinking for redesigning a schools' program in the Number Strand for Years 5 and 6 will be illustrated.

Numbers, counting and numeration	Counting, ordering and estimating and describing with large numbers and common and decimal fractions Using positive whole number powers Using place value (thousandths to millions and beyond) (p. 35)
Mental computation and estimation	Estimation and mental calculation involving the four processes, money and other quantities (p. 37)
Written computation	Adding, subtracting, multiplying and dividing whole numbers, money and measures to two decimal places (two digit multipliers and single digit divisors) (p. 39)
Applying numbers	Choosing and using appropriate operations to solve problems involving whole and fractional numbers where more than one operation may be needed (whole number multipliers and divisors only) Selecting information relevant to a particular problem (p. 42)
Number patterns and relationships	Identifying, continuing and devising whole and fractional number patterns, including those where successive terms are linked by a multiplication or division strategy Constructing and completing number sentences not involving pronumerals Prime numbers Properties of operations

Figure 1. Curriculum focus statements: level 4 of Number (Board of Studies, 1994, p. 34 - 45)

From curriculum focus to learning outcomes. The first guide is the curriculum focus statements, shown here in Figure 1. The Numbers, Counting and Numeration Substrand entry shows that students in Grades 5 and 6 (i.e. level 4) will deal with a full range of positive numbers, from very small to very large. Consulting the level 4 learning outcomes shows that simple percentages will also be introduced, but not as a main focus of the curriculum. Looking at level 3 shows how the range of numbers is extended in level 4, so that children will be working with numbers in the hundreds of thousands and greater and with more than one decimal place. This work will naturally provide opportunities for teachers to provide consolidation work for children (e.g. in understanding tenths as decimals) and to identify those children who believe that the place value column immediately after the thousands is millions. The CSF does not specify any contexts for teaching this large number work. However, the Introduction stresses how mathematics will be motivated by real world problems and intriguing situations (p. 2) and how using and applying mathematics is central to the curriculum (p. 5), whilst the choice of the areas of applications is left to the teacher. The work with large numbers at Grades 5 and 6 would easily fit with a unit on world population or on the resources required for living in cities where vast amounts of water must be provided on a daily basis. In Science (Earth and Beyond Strand, level 4) children may be making scale models of the earth and solar system which require them to consider the relative sizes of large numbers.

Looking across the levels. In planning a program, it will be important to look across the levels, to see how ideas develop and where they are heading. This is one of the strengths of the format of the mathematics section. By comparing level 3 learning outcomes with those at level 4, we see that the representation of fractions extends from representing a fraction as part of a whole (block of chocolate etc) to representing a fractional part of a collection (e.g. 3/5 of a class of 20 students). Clearly, level 4 teachers will need to frequently re-visit the representation of fractions as part of a whole, even though this is not a level 4 learning outcome. As well as looking back to level 3, level 4 teachers will need to look ahead to level 5, thinking about the preparation for the important ideas linking fractions, decimal, percentages and ratios that come to fruition later.

Linking up the substrands. The entry in the Mental Computation and Estimation Substrand for level 4 suggests children will learn their tables and be able to use a variety of strategies for mental whole number arithmetic. The learning outcomes illustrate the suggested level of difficulty and, at least by implication, a variety of practical contexts. These number facts will be used in work for the Written Computation outcomes when students learn multiplication, division and fraction algorithms. This is another example of the duplication across some substrands. Mathematics cannot be broken up logically into separate sections, which have nothing to do with each other. Fortunately, it also means that for most purposes, when children are near to mastering a topic, assessment items will be able to check out several learning outcomes at once. On the other hand when children show difficulty, further investigation will be needed to home in on what the actual cause of the trouble is, looking at individual learning outcomes or even their constituent parts (where the CSF one-liners will be too gross).

Looking ahead to level 5 shows that it is suggested that students learn to divide by a larger divisors and multiply by larger multiplicands in level 5. My personal opinion is that this is a waste of time: I would go beyond the CSF in level 4 and give the harder examples to children who learn the algorithms easily and enjoy the challenge in primary school. In level 5, I would provide practice, again giving the harder examples to those who found it easy but expect all children to use a calculator (sensibly!) for long questions. The chance that most children will carry out the long process by hand accurately seems too small to justify its place in the curriculum. It is likely that this will be altered in the revised document.

The abilities described in the substrand Applying Numbers are critical to giving students' mathematical power. Although it cannot clearly come in the learning outcomes (as discussed on p. 5), the intention of the CSF is that using and applying mathematics is central to the curriculum (p. 2, 5) and so mathematics will be taught from practical contexts. Students will therefore have learned the arithmetic operations in context and have used them to solve problems at every level. In the Applying Numbers Substrand, however, the emphasis is on whether students can recognise when to apply the operations. This is a difficult thing for many students, and there will be a wide spread of ability. Some students will show considerable insight into the contexts in which operations can be used, displaying strong connections between mathematics topics and an intuitive understanding of the situations where they applicable. These students may well reach level 5 in this substrand considerably before Year 8, the designated time for achievement. For many students though, an understanding of when to use multiplication and division comes only slowly. For several years in problem-solving they will rely on repeated addition, for both multiplication and division. (For examples, see Stacey, Groves, Bourke and Doig, 1993.) These children need constant class discussion of a rich variety of examples so that they can recognise when all four operations are appropriate. This is particularly difficult when non-integral multiplicands and divisors are involved which is why these are designated as level 5 outcomes. Although it is very important for a student's confidence that he or she should be able to successfully tackle a problem by any means he or she know how, it is also important that teachers persistently try to move tthe student on to more sophisticated methods of greater generality. This is particularly important for learning algebra (MacGregor, Stacey, Pegg, and Redden, 1994) as well as for using a calculator effectively.

Looking across the strands. Also critical for learning algebra and therefore leading directly into the Algebra Strand are the outcomes in the Number Patterns and Relationships Substrand. Number pattern work has a triple purpose; to build a real feel for numbers and the properties that they have individually and together, to establish looking for patterns as a problem solving heuristic, and to firmly establish patterns and rules that algebraic notation will later be used to describe. By choosing challenging problems which lead to the creation of interesting number sequences, students will be able to work on both this strand and aspects of the Mathematical Tools and Procedures Strand, such as the learning outcomes in the Strategies Substrand which refer to using pattern to investigate a mathematical situation and systematically recording work (p. 86).

Although this completes the tour of the Number Strand in level 4, building a program for a Grade 5 or 6 class requires looking across other strands for areas of application and things that will be taught together. In the Measurement Strand at level 4, for example, students will be using their number knowledge from earlier levels for reading scales by interpolating between labelled marks (p. 51), estimating (p. 53) and finding areas and perimeters (p. 56). These will provide good contexts for re-inforcement of level 3 number skills and understanding of numeration. In contrast, the Mathematical Tools Substrand (p. 81) is, naturally, ahead of the Number Strand. The written calculations allocated to level 4 are met earlier on the calculator, at level 3. Also at level 4, students will learn to interpret negative numbers which appear in calculations, although there is no explicit number work on negative numbers. Using the constant function to count backwards is a common source of negative numbers, which can be readily interpreted by students at level 4. It is hoped that students who have this exposure to the counting aspects of negative numbers, further supported in many environments by everyday occurrences such as negative temperatures, will be able to slowly build a firm concept of negative numbers which will stand them in good stead when they begin to calculate with them in level 5. Finally, with the aim of developing techniques for Mathematical Reasoning (p 87), many problem solving situations involving number will be included in the program.

The example above illustrates how the ingredients for curriculum planning are embedded in the CSF. On the one hand it can be used as a checklist, against which existing courses can be measured up, with an eye to more adequately covering some areas or changing an emphasis in line with current thinking. On the other hand, the learning outcomes from a particular topic or unit of work are often spread across the substrands and even the strands. The creation of a coherent program requires looking at all aspects of the CSF; (a) the introduction, (b) the curriculum focus statements; and (c) the learning outcomes and up and down the levels.

Future Developments of the CSF

At the time of writing this article, the final draft of the CSF is being prepared for approval by the Board of Studies in November. Useful and constructive criticism of the first draft was obtained from written responses and also from a group of 25 schools who were visited specifically to obtain feedback on the Mathematics section. Most of the comments were on the detail of the document and these points are being re-considered. There have been relatively few suggestions about changes to be made to the substrand breakdown and at this stage it seems that only the Statistics Strand will be reorganised. In the future the Mathematics KLAC hopes to be able to revise the CSF on a cyclic strand by strand basis, in the light of information from practical implementation. It also hopes that resources will be made available in 1995 for the preparation of advice which bridges the gap between the assessment-oriented structure of the CSF and syllabus planning for teachers and schools.

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