Specifying a National Curriculum:
reflections on the English experience

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Introduction

The general issues of the dynamics of curriculum change have been discussed elsewhere in this volume.[1] Here I want to consider a problem of current concern in both the U.S. and England – that of specifying a national curriculum.[2] In the U.S. the work of the National Council of Teachers of Mathematics to define Standards and that of the Mathematical Sciences Education Board to establish a Curriculum Framework come into that category; in England, to the surprise of many of us, the Government has decided to institute a National Curriculum for students from age 5—16, with Mathematics as one of the three "core subjects". I have been taking part as a member of the Working Group whose task is to make recommendations within a framework defined in its terms of reference. (One year has been allowed for this enterprise, with no full-time staff support!)

In looking at the model we were given, I was naturally led to consider the general problem of specifying a curriculum in ways that will lead to reasonably faithful implementation of the designers' intentions in most classrooms of the educational system. As far as I can see, in cases where the changes sought are substantial, this central problem does not seem to have been solved anywhere worldwide; in terms of the patterns of classroom learning activity and student performance, a qualitative mismatch between stated intentions and outcomes is the norm. Could we do better? What models are available, and what seem to be their strengths and weaknesses?

This paper is but a commentary on these matters, with a particular focus on the model put forward by the Department of Education and Science (DES) in Britain. Serious empirical research and development needs to be done, though there is little sign of it yet – or even of active recognition of the need for it. This arises partly because it is not yet routine practice to observe classroom activity and performance in detail and, as a result, the picture is unclear.

Principles of Curriculum Specification

It seems sensible to aim for specification that:

- is tight enough to ensure reasonably faithful implementation, in particular avoiding corruption by:
  textbook designers, assessment designers, in-service trainers, teachers in the classroom, their students;
- does not impose arbitrary curriculum elements where a broader range of possibilities of equal validity would allow the creative abilities of developers, teachers and students to provide better learning environments;
- allows and encourages innovations to explore and develop new elements that may form the basis for more widespread curriculum change in the future;
- eliminates error in the form of inappropriate or inaccessible targets for the students and teachers.

It is clear that, as usual with aims, perfection on all counts is unlikely to be achievable, but it is well to seek mechanisms that at least keep these factors in focus.

The Current British Model

There are three key elements in the framework defined by the DES in England for specifying the new National Curriculum—attainment targets, programs of study, and assessment and testing. Their definitions were far from unambiguous, but they seem to have the following characteristics, strengths and weaknesses.

Attainment Targets are supposed to be "clearly specified objectives for what pupils should know, understand, and be able to do." They seem to be intended to provide a set of detailed behavioral objectives in each subject at each stage or level as targets for students and teachers to focus on. The value of such targets is clear. The limitations of such objectives, however, are well-recognized internationally. They include the following:

- To be sufficiently specific, the criteria of attainment have to be defined in great detail (e.g., can count up to 20—when the objects are stationary, can be touched and moved, and there are no other elements to the task) so that the number of such targets becomes very large ($\sim10^3 - 10^4$).

- The resultant picture of attainment is a granulate or fragmented one and, on its own, misleading (imagine specifying historical ability in terms of lists of detailed facts and perceived connections to be known at each level), because it has not yet proved possible to specify the integrative aspects of attainment in levels in unambiguous behavioral terms.

- As a result, detailed attainment targets on their own can well provoke a conflict with broad curriculum objectives.

Equally important, attainment targets alone do not specify a curriculum – the targets could be approached in many ways (e.g., taught and tested separately or through extended integrative tasks). General descriptions of strands of attainment, on the other hand, while valuable and free from some of the above defects, lack specificity; almost any curriculum can, and usually does, claim to satisfy them.

The DES appears to regard the Attainment Targets as the key to the specification, from which the two other aspects described below follow. For the reasons just mentioned, I think it is obvious that the targets alone do *not* provide an adequate basis for a curriculum specification, but the other two elements can function in complementary fashion to yield a model that is much clearer.

Programs of Study are "intended to provide a detailed description of the skills and processes which all pupils need to be taught so they can develop the knowledge and understanding.....". They provide a different perspective on attainment—in addition to describing how best to prepare for the attainment targets, they provide a further opportunity to meet the specification requirements above. For example, specifying the range and balance of learning activities in the curriculum provides additional elements in curriculum specification, precluding, for example, an approach which focuses on each detailed attainment target separately, and requiring a substantial curriculum focus on extended tasks and learning activities. In many systems, this aspect of curriculum specification includes provision or approval of selected textbooks which give a detailed realization of the intended curriculum. However, it should not be assumed that the curriculum followed in most classrooms is a faithful realization of the curriculum specification, or even of the intentions of the textbook writers ("the textbooks determine what *may* be taught" is a common view which seems soundly based).

Assessment and Testing whose main purpose "will be to show what a pupil has learned/mastered," will have an influence on what is taught and learned that increases with the importance attached by society to students' achievement on the tests. It is now widely accepted that the nature, quality and balance of "public" assessment provide at least a limitation on what will be achieved in curriculum terms, and perhaps a controlling influence on the implemented curriculum. (It seems, at least, that most British teachers of mathematics in secondary schools have long taken this view; many leaders in mathematical education reject it because, I believe, they find it so unpalatable) Though many people regret this influence, it seems to be a fact of life. It does provide an opportunity to use the assessment system as an encouragement to beneficial change. This presents a challenge to the designers of the assessment process, who have tended in the past to measure what can easily be measured, and to rely on hoped-for correlations of performance rather than the educational validity of the assessment. There is widespread recognition now that the quality of assessment needs to be vastly improved in terms of educational validity if we are to make progress with the curriculum. Work in recent years in the U.K. is recognized as providing leads in this endeavor, in which other countries are also much involved.

In terms of curriculum specification, the definition of assessment and testing can naturally provide a third dimension—the range and balance of the types of tasks the students should be able to tackle and a specific realization (through marking schemes) of the values placed on different aspects of performance. This dimension communicates vividly and without distortion what is intended, provided that the assessment is of high enough quality. It does not, of course, describe the constituent ingredients of mathematical attainment nor the balance and sequences of classroom learning activities through which progress can best be realized—these are provided respectively by the previous two elements.

Thus, these three elements are complementary and *together* offer a hope of a reasonably effective method of curriculum specification (see figure 1).

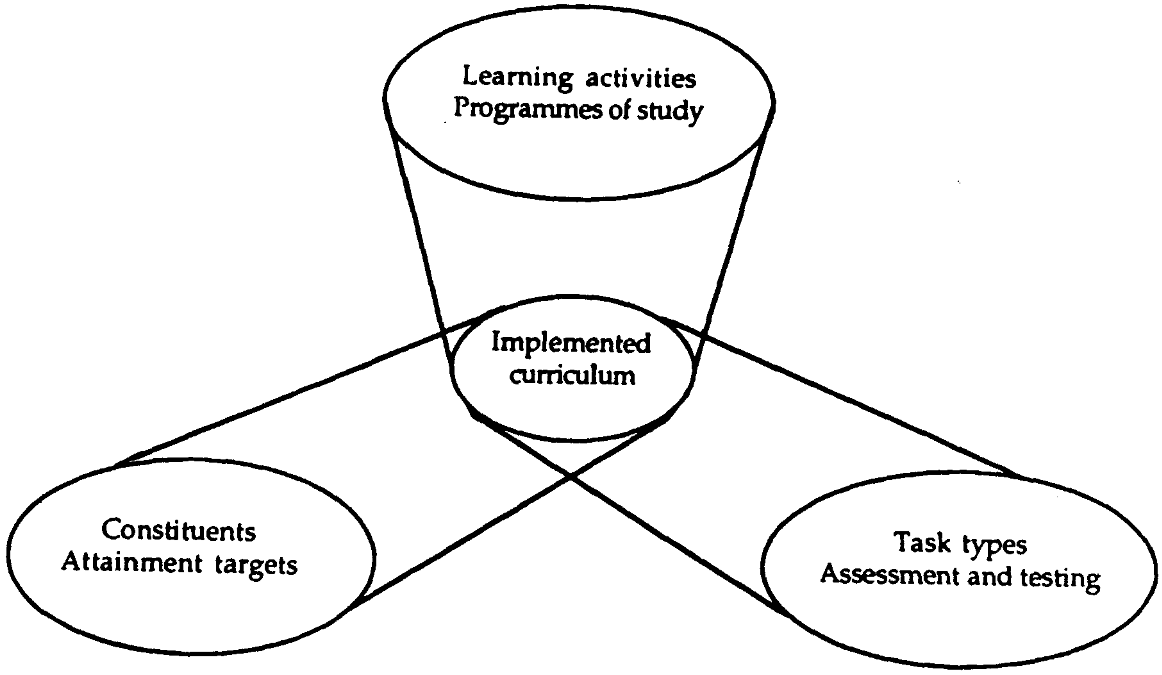
Other dimensions are, of course, also important. These include:

- definitions, which are strong on generality and in establishing boundaries;
- exemplification, which helps communication enormously;
- a rough quantification, which is essential to avoid "rabbit and elephant pie" (equal parts – one of each).

Now let us look in more detail at a structural relationship among these elements that seems able to 'hold water." First we will look at the relationship between attainment targets and assessment and testing. This is illustrated in Figure 2. The attainment targets are represented in the left column; the levels in "profile components," which constitute the reported output of the testing procedure, are at the right. The crucial links are provided by the set of assessment tasks, with their mark schemes, and by the aggregation procedure for combining levels on individual tasks into those one the profile component.

The set of types of tasks and their balance. represent a statement of one key aspect of the definition of mathematical attainment. The mark scheme of

Figure 1. Three dimensions in specifying a curriculum



each task links it to the attainment targets, assigning credit for those constituent aspects of attainment that these targets identify. The result is a level on the task. Some tasks (such as Task 1 in Figure 2) will relate almost entirely to one attainment target; the mark scheme will be such that the level awarded on that task to a student's response (F) matches the level for that attainment target. The majority of tasks (Tasks 2 and 3), like most actual mathematics, will involve the integration of various aspects of mathematics to a particular purpose, pure or practical. A number of a attainment targets will thus be represented in the marking scheme of such tasks. The task level will be determined by the overall difficulty of the task, which bears no simple relation to the levels of the separate attainment targets involved.

An aggregation procedure is required to produce a single level for each profile component in terms of the levels on the tasks that contribute to that component. This aggregation scheme also represents a statement of values in the balance of tasks included and their weightings. A further aggregation scheme is required to integrate profile component levels into an overall mathematics level, though this is not shown on the diagram.

The coherence of this structure depends on a clear distinction between profile components, which refer to the assessment of student performance on a set of task types, and attainment targets, which are the constituent

Figure 2. Attainment targets and assessment.

This figure shows how, although each task is focused on a particular profile component, only very simple tasks, such as Task 1, will involve a single attainment target related to that component. Richer and more interesting tasks will involve a range of attainment targets covering more than one profile component. The attainment targets provide the basis for the marking schemes which determine the level of a student' performance in the task.

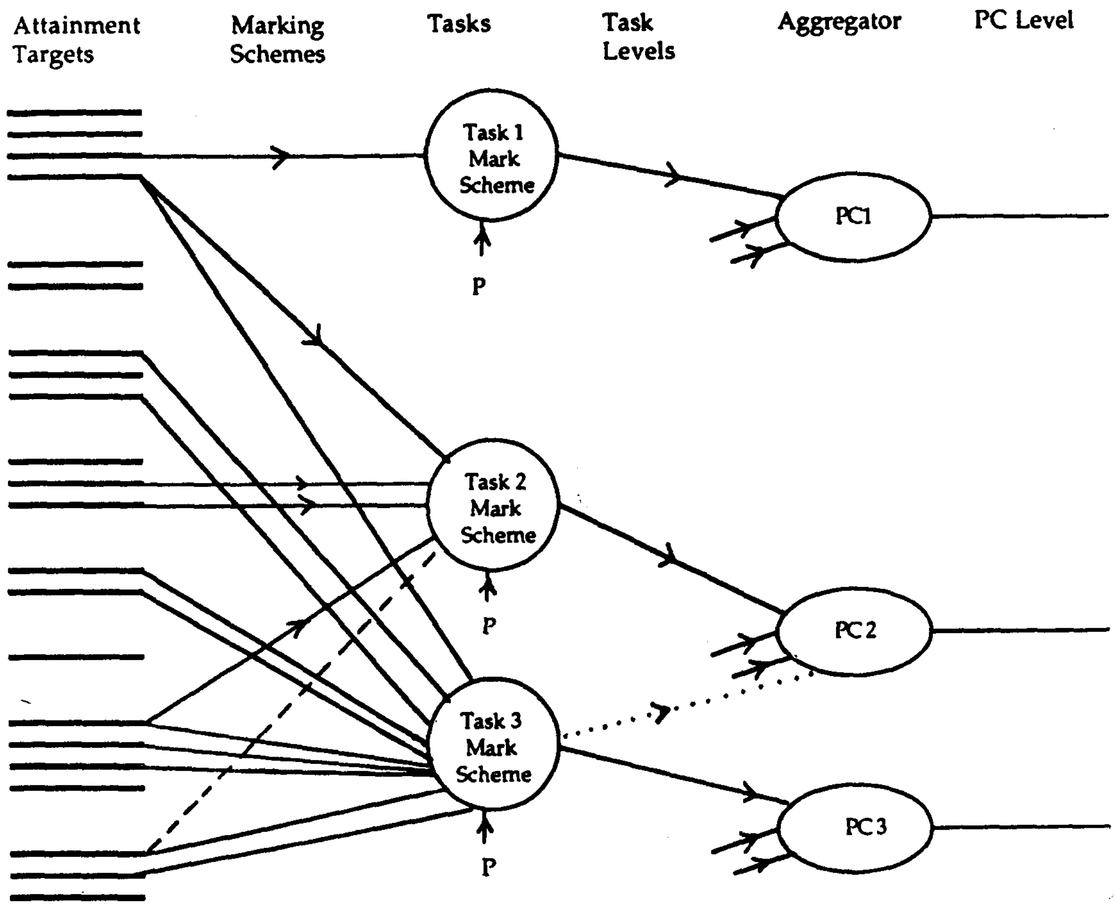
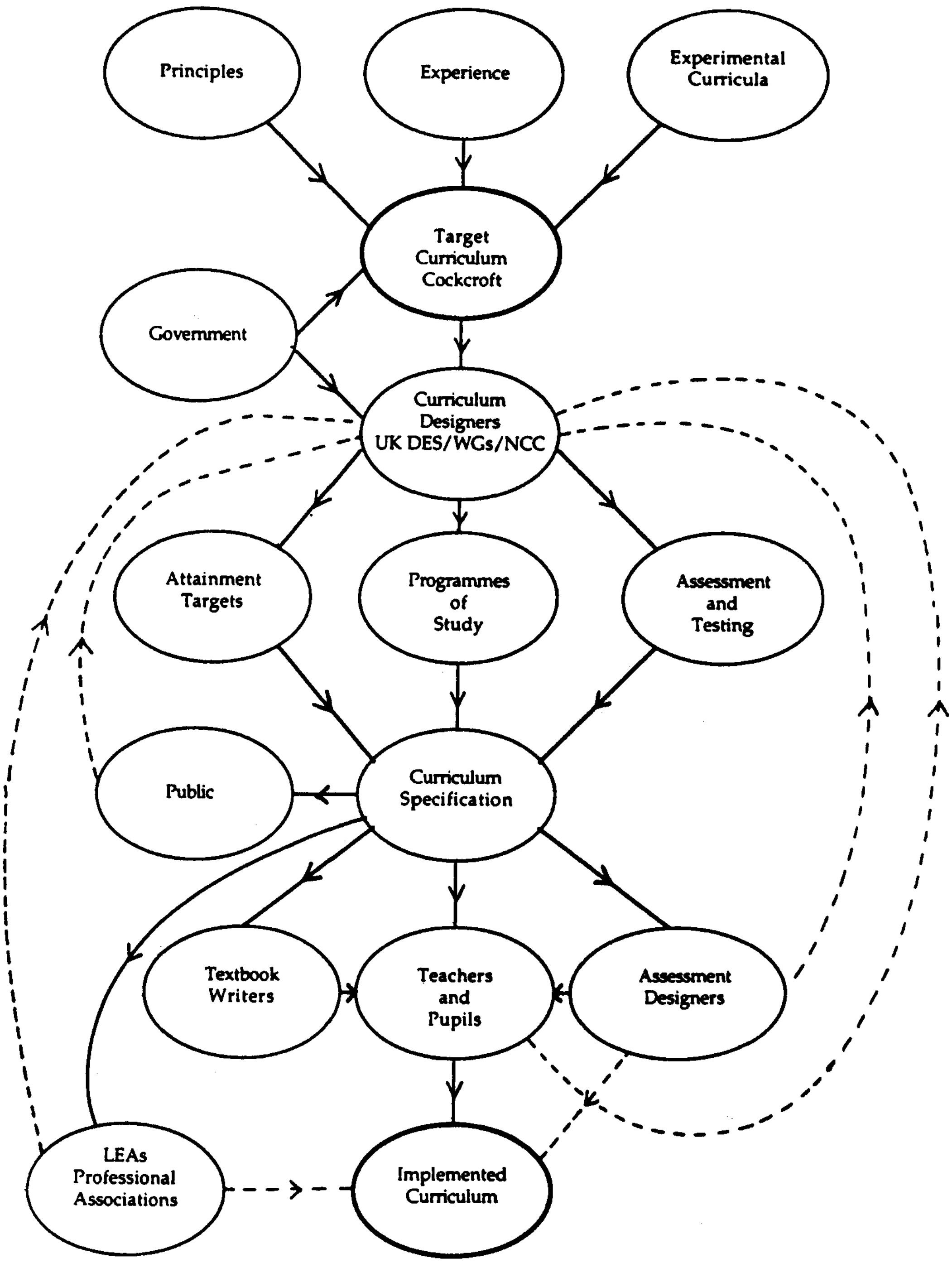


Figure 3. A view of curriculum specification.

This schematic diagram illustrates the main flows of influence on the implemented curriculum – that is ultimately delivered in the classroom.



ingredients of mathematical attainment for which credit is given in that assessment process. Thus, *all* the constituents for which such credit may be accrued must be included in the attainment targets, explicitly or implicitly. This includes not only the full range of *knowledge* and *skills* in different areas of mathematics but also the *strategic and tactical skills* that are integral to effective problem solving, and the personal qualities required to *control* all those skills and carry the processes through successfully. Thus, if credit is going to be given for "understanding the problem" or for "exploring a sensible set of simple cases," then those things should be included in the attainment targets.

Finally, in Figure 3 we give a view of the whole process of moving from ideal "target curriculum" to an "implemented curriculum" as seems to be envisaged in the current National Curriculum initiative in England and Wales.

National Curriculum Recommendations in Mathematics

Though the specific recommendations of the Mathematics Working Group to the Secretary of State for education (MWG 1988) are not the focus this paper, a short description of what has been recommended will help illustrate the points made above. The spirit of the recommendations relates closely to those of the Cockcroft Report (1982), updated to account for advances in various areas, particularly applications and information technology.

Fifteen broad attainment targets are set down. Twelve of them cover areas of mathematics – number, algebra, measures, shape and space, and handling data. Each target represents a strand of mathematical development such as "understand number and number notation" or "recognize and use functions, formulae, equations and inequalities." Within each of these targets, ten levels of performance are defined, as required by the terms of reference. For example, Level 4 of the target "recognize locations and use transformations in the study of space" specifies that, in addition to attaining the requirements for Levels 1, 2 and 3 students should be able to "describe a journey in a familiar environment" (such as sketching a map showing a visitor how to find the head teacher's office), "specify location by means of coordinates (in first quadrant)" (such as locating features on a map given by their grid reference), and "recognize rotational symmetry" (such as turning shapes using tracing paper). In addition to meeting the requirements for Levels 1, 2 and 3, Level 4 is supposed to represent the performance of a typical 11-year-old student.

The last three attainment targets relate to “using mathematics,” “communication skills” and “personal qualities.” The first is concerned with strategies for problem solving, the second with all aspects of communication during and after work on the problem, and the third with qualities of perssonnal organisation in tackling problems alone or in a group. The report does not claim to have solved the problem of describing levels in each of these domains; indeed, it is only possible for the content areas because specific skills *can* be tested in isolation (though, of course, the student’s ability to deploy them in practice will be sensitively dependent on the complexity and context of the task). Strategic skills come seriously into play only in substantial tasks where many attainment targets are involved. This problem has not been very clearly recognized, let alone solved, in the report.

The *programs of study* are set out in terms of general principles on the kind and balance of classroom activities that should be involved, and are illustrated by outlines of exemplary programs at four different ages in the range concerned.

The *assessment and testing* framework provided by another working group (TGAT 1988) required the reporting of student performance in mathematics in “profile components”; the Mathematics Working Group recommended that there be three – two related to “knowledge, skills and understanding” in distinct areas of mathematics and one concerned with “practical applications of mathematics”. This third component also covers pure mathematical problem solving, though it is envisaged that there should be some of this, related to specific areas, in the first two profile components. The assessment and testing is to be based on a combination of “standard assessment tasks” and “teacher assessment” throughout the child’s development (the reporting ages are to be 7, 11, 14, and 16). The Mathematics Group strongly recommends that the standard assessment tasks, rather than simply measuring what is simply measurable, be balanced in curriculum terms. A substantial proportion of the report is devoted to illustrative examples of the kinds of tasks that should be involved. One dimension is length: short tasks, which may take anywhere from seconds up to twenty minutes, focus on a narrow range of attainment targets; long tasks, occupying from twenty minutes to two hours, test flexibility and enterprise in choosing and using appropriate knowledge and skills to tackle mathematical and practical problems. Extended tasks, occupying up to about ten hours of class time, assess the ability of students to use their skills and knowledge in practical applications. These cover a broad range of attainment targets. For example, an extended task for age 14 (Shell Centre 1988) might require the students to work as a class to plan and carry through a day-trip from the school to some place of interest. In the course of this work they will be faced with specific sub-tasks to ensure that each member is in touch with the work, while at the end there will be a written examination testing their ability to transfer the skills they have learned to other more or less closely related planning and scheduling situations.

The following list identifies five general principles that the assessment must satisfy:

1. It must be faithful to the aims of the mathematics curriculum as defined in the report.
2. It must give all students the opportunity to show what they can do.
3. It must encourage teachers to implement the intended curriculum.
4. It must command the confidence of the public, parents, teachers, employers and students that the assessment results are a fair reflection of achievement.
5. It must be capable of being organized economically.

Although the performance in each profile component is to be reported separately, the group was asked to suggest a weighting for aggregation. They recommended broadly equal weights—30:30:40. (In putting forward the report for comment and discussion, the Secretary of State said he believed there should be more weight on the knowledge and skills elements, and asked whether practical applications could be developed and tested in that context, disregarding the multiplicity of aspects of mathematics that these elements tend to bring together.)

The report takes a firm, positive line on the role of technology, seeing a need for greater fluency in mental arithmetic but regarding the calculator as the appropriate tool for heavy calculation. Fluency in most pencil and paper algorithms is regarded as obsolete—exceptions include the ability to add up a column of figures and to subtract one number from another. (The Minister expresses reservations on this point too.) The report also points to the gradual takeover of all heavy manipulation by computers, handheld or otherwise, but recognizes that the automation of manipulation in graphical, algebraic, and statistical procedures is not yet as universally available as for arithmetic.

The report recognizes the great uncertainties that such radical change involves—not least in the appropriateness and accessibility of the attainment targets as written. The need to begin immediately on the process of validation and review is emphasized, as is the need for providing effective and appropriate teacher support.

The details of the implementation process are still far from clear, so no attempt will be made to discuss them here (see also Burkhardt et al. in this volume). It seems that there are three features which an implementation model will need if it is to have any chance of success:

- pressure on all participants to change in the intended directions;

- support to enable them to make those changes;
- dynamic "learning" capability within the model itself, so that departures from the intended outcomes can be detected and corrective action taken.

What actually happens will add interest, and perhaps anguish, to the future.

Endnotes

1. See "The Dynamics of Curriculum Change" in this volume.

2. This paper arises from the experience of the National Curriculum Mathematics Working Group in England, and from discussions with those responsible for curriculum specification in a number of other countries – particularly Germany, Japan, Sweden, the United States, and Australia. I am especially grateful to the National Council of Teachers of Mathematics and the University of Chicago School Mathematics Project for the timely invitation to their April 1988 International Conference which addressed these issues.

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