A comparative curriculum study

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Abstract

My intention with this research was to compare mathematics curricula from five countries with populations and areas similar to those in New Zealand but with different languages and cultural backgrounds. After explaining the school systems, the paper discusses the differences between the curricula and looks at them from constructivist and post-structuralist perspectives. Finally some conclusions are presented.

Introduction

New Zealand has a tradition of national curriculum (Department of Education, 1969, 1972, 1985, 1987; Ministry of Education, 1992). This is different to the situations in England, Australia and the United States of America. New Zealand is also different from these countries in terms of population, ours might be compared to that of a city or state in Australia, England or the States.

I decided to spend time in the Netherlands and Scandinavia looking at their curricula and comparing them with that of New Zealand. I chose them because English is not their first language yet they are similar to New Zealand in terms of size, and population and have similar political environments.

Theoretical perspectives

Curriculum has largely been dominated by behaviourism. The emerging paradigm in mathematics education is now constructivism. Critiques of constructivism that focus on its limitations are emerging in post-structuralist literature. Behaviourism resulted in the subject being broken into small objectives, these were ordered according to ideas of progression and taught without considering the learners' prior ideas. The intention was that all learners should understand the body of knowledge known as mathematics.

The two principles of radical constructivism (Von Glasersfeld's, 1992) are:

1 *Knowledge is not passively received either through the senses or by ways of communication, Knowledge is actively built up by the cognizing subject*

2 a *The function of cognition is adaptive, in the biological sense of the term, tending towards fit or viability.*

b *Cognition serves the subject's organization of the experiential world, not the discovery of an ontological reality. (p. 23)*

A constructivist curriculum should recognize learners' prior ideas about topics, make use of meaningful contexts, and allow for curriculum negotiation. Constructivism questions ideas of progression and specificity of objectives.

Many radical constructivists find no conflict with two ideas that are often referred to as part of social constructivism: firstly that communication is important in learning even though knowledge is not passively received through communication; and secondly that the body of knowledge to be learned has been socially negotiated and named by mathematicians. The implications of these are to emphasise the role of communication, and to value the idea that mathematics is both what mathematicians know and do.

Post structuralist criticisms of constructivism have been enunciated by Zevenbergen (1994). These are not denunciations of constructivism but

highlight its limitations. In particular the fact that constructivism 'does not take account of the process by which a significant proportion of students come to be marginalised as a consequence of their exposure to mathematics.'

She argues that the dominance of the structural aspects of teaching and teachers' understanding of what is legitimate institutionalised mathematics conflicts with the purported right of students to construct their own legitimate (although alternative) understandings of the subject. She is concerned that the lack of understanding of the students' culture (background, language, class and experiences) means that teachers continue to interpret alternative conceptions as misconceptions and construct assumptions about ineffective learning to describe these differences. Post-structuralist concerns suggest that a diversity of opinions needs to be valued; a curriculum should focus on developing students rather than on the aims of mathematicians; and the way knowledge is partitioned in schools may be inappropriate for many learners.

Thus, in looking at the national curricula of the countries mentioned in the introduction, I wanted to see if they were moving from the behaviourist paradigm; if they were influenced by constructivism, and if any consideration was given to the post-structuralist concerns.

Methodology

With restricted time I aimed to meet and discuss the situation in each country with a ministry official and a mathematics educator. I used an open-ended interview schedule to ensure that relevant aspects were discussed. My sample was biased because of vacations and the ministry officials varied as some agencies only have responsibility for some levels of schooling.

Schooling systems

Table 1: School systems

Age	*Netherlands*	*Denmark*	*Finland*	*Norway*	*Sweden*
5	*Primary*				
6	*School*	*Folkeskole*			
7	*Grades*	*Grades*	*Primary school*	*Folk*	*Compulsory*
8	*1-8*	*K-9*	*Gr 1-6, age7-12*	*or*	*School*
9	*Ages*	*Ages*	*(or part of*	*Primary*	*Grades*
10	*5-12*	*6-16*	*comprehensive*	*School*	*1-9*
11			*school*	*Grades 1-6*	*Age*
12			*Grades 1-9*	*Age 7-12*	*7-16*
13	*Secondary*		*Lower Sec*	*Youth or*	
14	*(various*		*School*	*Lower Sec*	
15	*tracks)*		*Gr 7-9)*	*Gr 7-9*	
16		*Gymnasia*	*Non comp*	*Non comp*	
17		*and others*	*Gymnasia*	*Gen. & Voc.*	*Non comp*
18			*Voc. schools*	*Streams*	*Upper Sec*
19					*Acad./Voc.*

The different school systems are summarized in table 1. In all the countries early childhood education was available and many students went on to tertiary education. The Netherlands system was similar to that in New Zealand apart from the choice of high schools. The differences between Scandinavia and

New Zealand included starting ages, the age at which a change of school occurs, and the gap between academic and the vocational courses.

National curriculum

Like New Zealand, each country had recently developed national curriculum for their schools. In Sweden, Norway and Finland there was a bringing together of courses for students in the Gymnasia and in Vocational schools, and a rationalisation of course options.

The most notable difference between the curricula was to do with compulsion. The Netherlands one was not binding on schools, and the Scandinavian ones were broad statements of intent which emphasised change and did not give content details. This was evident from their size. For example, in Sweden the curriculum comprised three pages for maths during compulsory education and one page each for the five non-compulsory courses; and in Finland an older detailed version had been replaced by one of eight pages. All claimed that exams and textbooks played a major role in defining the curricula although these were based on interpretations of the official statements. These brief curricula reflected a philosophy of educational devolution. Interviewees reported that the lack of prescription was part of being democratic and not dictating to teachers. They assumed that teachers were professionals, that choice was desirable, and that the government should not make the curriculum decisions.

The contrasts between these short curricula and the longer ones from English-speaking countries raises important issues regarding the desirable level of national directives into professional and curriculum decisions that can be decided locally. It can be argued that our curriculum could fit in five pages if repetition and suggestions were omitted, however these seem to be included because of a belief that teachers need assistance and are not expected to make significant decisions rather than the belief that they are professionals.

Curriculum Frameworks

Traditionally mathematics curricula have been developed with little reference to other subjects. This began to change in 1993 with the production of the *New Zealand Curriculum Framework* that outlines learning areas and essential skills for all students (Ministry of Education, 1993a). But, with the exception of technology, (Ministry of Education, 1993b) the curricula written off this framework relate to the traditional school subjects rather than learning areas, indeed the relationship between subjects and learning areas is not made explicit, and links with other subjects are virtually non-existent. Similar frameworks have been developed in Finland, Sweden (Ministry of Education and Science, 1994a, b) and Norway (Royal Ministry of Church, Education and Research, 1993). While these suggest close and coherent links between subjects, none of them suggest an integration of subjects. On the other hand they do not stop an integrated interpretation and some evidence for this exists with thematic teaching. In New Zealand we have a multiplicity of documents, the framework, the curricula, and teacher guides. The curriculum details much more than what is said in the framework. In the Scandinavian countries the short curriculum statements related to each area or subject are all published in the same document as the broader framework statements. From the point of view of national educational administrators the short single document approach means that curriculum development is not such a complex process.

Curriculum components

In a mathematics curriculum it is possible to include details regarding:

i the philosophy and learning theory that underpin the curriculum,

ii lists of content topics (with or without options),

iii other aspects of the subject (the mathematical processes),

iv calculators and computers,

v learning and assessment activities that link with teaching styles, and

vi mathematics in other subjects.

Philosophy and theory

All the documents had introductions that outlined general educational aims and objectives. The people involved all claimed to be influenced by constructivism but specific assumptions about philosophy or learning theory were not in the Scandinavian documents except implicitly through the aspects. The curricula from the Netherlands and New Zealand, being more detailed, also made these assumptions implicit through exemplars

Content topics

All the countries listed content to be taught. In Scandinavia the topics are general and related to the goals of the curriculum. In the Netherlands more detail is given but the curriculum was not seen as prescriptive and teachers had freedom to make content decisions. In Denmark there is room to interpret, modify and add topics.

In all the countries statistics was getting an increasing emphasis although by New Zealand standards there was comparatively little taught at primary school level. In the Netherlands statistics was linked with aspects of discrete mathematics and embedded in contexts such as circuits, train timetables, sports draws, trees, flow charts, system structures, and the media.

The approaches to geometry varied. In the Netherlands the introduction was based on what one sees in the environment and what one can draw. In the upper levels in Denmark the curriculum included analytic, solid and vector geometry while in Norway vector geometry was taught with an algebraic approach. The move in Norway was to introduce more descriptive and intuitive approaches by using ideas of symmetry but not by introducing a formal transformation approach. In Sweden and Finland the syllabus statements were general and no approach was signalled as preferred.

With algebra the Netherlands was the only country that departed from tradition. They had virtually no emphasis on quadratics and factorisation, but included general work about graphs and functions related to the world of the students. This started with practical topics (eg. clothes sizes) and often moved to spreadsheets and non-standard graphs.

The emphasis in the Netherlands on realistic mathematics meant that teaching often used themes rather than traditional topics and this had the effect of making connections between topics. Examples of themes included: flying (timetables, time zones, exchange rates, maps); maps (topological, topographical, sea level and negative numbers); water (needs); and weather.

Other aspects

All the curricula addressed the redefinition of mathematics to include aspects that relate to what mathematicians do. In New Zealand these aspects refer explicitly to problem solving, reasoning and communication and implicitly to making connections. The aspects varied slightly from place to place, the ones given most emphasis were problem-solving and modelling, reasoning, communication, and culture and history. In Denmark an additional aspect was an emphasis on structure. The responses from the Netherlands stressed that these aspects need to be seen as implicit in the curriculum and taught throughout—not treated as separate topics.

Calculators and computers

The use of calculators and computers was assumed in all countries. Numerous trials were being done with young children and calculators. In the senior school the students were expected to have scientific calculators, while graphics calculators

were needed by Grade 12 students in three countries. There were concerns about programmable calculators in examinations and about the costs of graphics calculators on top of the high cost to students of texts. The impact of computers was acknowledged by all and familiarity with packages such as those for graphing, spreadsheets and statistics was expected. However difficulties related to the costs were causing concern.

Learning and assessment activities, teaching styles

The four documents from Scandinavia did not include examples of learning or assessment activities. This lack of exemplars was seen to be within the spirit of devolution to schools and the assumption regarding the professionalism of teachers. It was evidence of a freedom from directives with respect to teaching styles in the Scandinavian countries and the Netherlands.

More thematic or contextualised problems were done in the Netherlands and oral work was more accepted as part of the teaching-learning repertoire in Denmark because of the emphasis on these in examinations. The general view of teaching was summarised by a response from Finland that recognised that teachers were slowly starting to move to more open approaches but the rhetoric that preceded a change was more evident than the change itself.

The New Zealand curriculum offers one curriculum for all students although it is acknowledged that different students within a class achieve at different levels. In the European countries there was less emphasis on differences at the junior level but more options in the post-16 sector because of the separation between Gymnasia and the vocational schools. The existence of multiple tracks was particularly evident in the Netherlands while the new initiatives in Sweden and Norway were trying to reduce the number of courses and the difference between the alternative tracks.

Mathematics in other subjects

All the curricula were dominated by views of mathematicians, statisticians, and teachers. Links with other subjects were implied but no curricula suggested a restructuring of schooling to make integrated learning a reality. No recognition was given to the teaching of mathematics within other subjects.

Limitations of study

The influences of national assessment, textbooks, teacher development and inspectors were acknowledged as having an influence on change. These are discussed in a fuller report of this research (Begg, 1995).

Many levels of curricula exist and while the comparisons in this paper are between the official documents it is impossible to divorce a national curriculum from the sense people make of them as they construct their school schemes and lesson plans, and teach and assess.

The methodology used in this project was limited in terms of time, the sample size and my reliance on the English of respondents. The responses need to be considered in terms of both the different systems of schooling and the traditions that have influenced their development.

General conclusions

Whether a curriculum with a few pages on each subject is preferable to a framework document and separate subject documents is debatable. If devolution is taken seriously and the rights of communities to be involved in curricula decisions is respected then a one-document approach has much to commend it. Other reasons for this approach include being able to afford regular reviews; the empowerment of teachers by allowing them to control their planning, a manageable change scenario for primary teachers who have to change all their programmes, and a negotiated common philosophy across all learning areas. The dangers are that exams and textbooks may continue to dominate and possibly

misinterpret the curriculum. Alternatives between 5 and 160-page curricula need to be considered as possibilities for the future.

All the curricula were written with ideas of constructivism but this was not made explicit because of the desire by the writers to respect teacher choice and the concern by bureaucrats to avoid conflict. Unfortunately this allows the assessment to be based on behaviourism which undermines the intent.

From a post-structuralist point of view I saw no evidence of contributions from people other than mathematicians, statisticians and teachers. The emphasis was on the mathematics rather than on developing the students' ideas. Culture was mentioned in terms of making connections, but there were no suggestions about recognising students backgrounds and their alternative ideas and it is probable that the same groups of students will continue to be marginalised as have been historically. The general form of the Scandinavian curricula and the non-compulsory nature of the one from the Netherlands means that teachers in these countries are not bound by structures and have the freedom to do what they can in providing for the multiplicity of voices in their classes. The draft syllabus in New Zealand (Department of Education, 1989) seems to be the only one that gave assistance to teachers yet made some of the differences explicit and forced teachers to consider them.

Specific conclusions

The content and approaches from the Netherlands are worth looking to in the future as their work has been carefully researched. It is now being modified and translated to English by an American group so will become accessible.

The challenges that arise with calculators and computers have been faced to a greater extent in some of the European countries compared to New Zealand, but this remains a major area for work in the future.

Curriculum in Denmark which allows for approved deviations from the national curriculum and the non-binding nature of the curriculum in the Netherlands have much to commend them. These are reminiscent of the New Zealand draft curriculum (Department of Education, 1989) which allowed choice, and the exploratory curriculum studies done in the eighties which encouraged experimentation and variation. Such mechanisms help the development process remain dynamic rather than stop-start as at present.

Overall the intention of this study was to ensure that questions are asked, it was not to provide answers. In doing this there seems to be a need to look beyond the traditional influences from the English speaking world and consider other possibilities. Hopefully this work will be continued with studies from other different cultures such as Russia, Hungary, Germany and Japan so that we can learn from the advances in these countries.

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