A COMPARISON OF PRIMARY MATHEMATICS CURRICULUM IN ENGLAND AND QATAR: THE SOLO TAXONOMY

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The study reported here is part of a wider study, which aims to compare the primary mathematics curriculum in England and Qatar. This paper focuses on the analysis of the expected standards set through educational policy in national curricula in both countries using the SOLO taxonomy. The results suggested that the expectations from English pupils aged 7 and 11 were higher than those from Qatari pupils. This raises important issues related to classroom practice in teaching mathematics.

INTRODUCTION

The comparison of one curriculum with that of another country's provides background information about how to understand and study these curricula. Through comparison, the strengths and weaknesses of the two curricula may be highlighted. Several comparative studies of mathematics curriculum have been conducted all over the world (see, for example Bierhoff 1996; Harris et al 1997a, 1997b; Campbell and Kyriakides 2000).

In Qatar, five lessons a week (45 minutes each) are devoted to mathematics in the first four years of the primary level and six lessons a week in the final two years of the primary level. The percentage of time devoted to mathematics is about 16.7 %. The mathematics curriculum in Qatar encounters many problems such as the poor mathematical attainment, the negative attitudes of pupils toward mathematics and the great reliance on memorizing and rote learning (Al-Bagir, 1994).

Concern about low standards in mathematics especially in arithmetic skills was evident in England (Brown, 1999) and the primary mathematics is revised regularly. The National Numeracy Strategy (NNS) was introduced in order to raise standards in mathematics, especially number and arithmetic. It offers detailed objectives for planning and teaching all aspects of the mathematics programmes of study for primary pupils (DfEE, 1999). A comparison study of the primary mathematics curriculum in England and Qatar was carried out using content analysis of the two curricula, classroom observations and interviews with teachers. This paper focuses on the analysis of the expected standards set through educational policy in national curricula in both countries using the SOLO (Structure of the Observed Learning Outcome) taxonomy (Biggs and Collis, 1982).

THEORETICAL BACKGROUND

The SOLO taxonomy provides an approach to both categorising cognitive performance in different content areas and defining curriculum objectives, which contain criteria for the levels of learning required (Biggs and Collis, 1989; Biggs, 1999). This model incorporates five modes of functioning parallel to a large extent the Piagetian stages of cognitive development. These modes are: sensorimotor (from

birth), ikonic (from around 18 months), concrete-symbolic (from around 6 years), formal (from around 16 years) and post formal (from about 20 years).

Each mode is associated with a series of cumulative levels of response reflecting increasing complexity, ranging from prestructural to extended abstract; these are described below (adapted from Biggs and Collis 1982, 1989)

Prestructural: an incorrect datum is used in order to answer a question or respond to a problem, which may lead to an irrelevant aspect belonging to a previous stage of mode. The learner may even fail to engage in the problem, so he closes (or come to a conclusion of some kind) without even seeing the problem.

Unistructural: one relevant datum or feature is used and focused on to link the cue and response logically. The learner closes too quickly.

Multistructural: a number of relevant isolated data are used, but the learner doesn't integrate them.

Relational: the integration and synthesis of information is achieved. The relational response gives an overall concept or principle that accounts for the various isolated data, but it is still tied to concrete experience.

Extended abstract: all the relevant data and their interrelations are taken up and subsumed under a hypothetical abstract structure that can enable deductions to apply to data or situations not experienced. Extended abstract responses are at a level of abstraction that is extended into the next mode.

Biggs and Collis (1989) define the mode as "the level of abstraction that a learner uses when handling the elements of a task" (p.152). It is assumed that pupils in primary and secondary schools usually function in concrete-symbolic mode. This mode of operating is characterized by using symbolic systems that apply to the experienced world. The above five levels of SOLO are cumulative and reflect increasing complexity throughout each mode. The focus of learning is the target mode which encompasses the middle three levels: unistructural, multistructural and relational abstract (see Biggs and Collis, 1989, p. 152).

The SOLO taxonomy has been applied to a variety of areas of mathematics (see, for example, Davey and Pegg 1989; Watson and Moritz 1998; and Chick 1998). Most of the earlier research on SOLO used the taxonomy to evaluate and classify learners' performance in terms of their exhibited structure into a hierarchy of levels of abstraction. However, SOLO can be used in other aspects of learning. In his recent work, Biggs (1999) argued that SOLO can be used to define curriculum objectives, which contain criteria for levels of understanding applied to the content in question (p. 37).

PROCEDURE AND SAMPLE

The SOLO taxonomy was employed in order to analyse the cognitive objectives of teaching mathematics in the two countries in terms of the three levels which form the

target mode; unistructural, multistructural and relational. The documents analysed were the statutory National Curriculum (NC) for Key Stage (KS) 1 and 2 in England (DfEE and QCA, 1999) and the Qatari mathematics curriculum framework (Department of Curriculum and Textbooks, 1997).

RESULTS AND DISCUSSION

The analysis of the English and Qatari curriculum policies exposed not only shared characteristics, but also different aspects which will be reported under the following headings:

- Organisation of the curriculum
- Expected standards
- Levels of objectives

Organisation of the curriculum

The mathematics curriculum in Qatar is organised on the basis of year groups rather than levels and the content to be taught to each age group of pupils is specified. This is unlike the English situation where the NC allows for a differentiation in terms of pupils' attainment Additionally, each individual school in England is responsible for planning the organisation of the curriculum and pedagogy despite the fact that the content is prescribed nationally. However, teachers in Qatar depend heavily on textbooks published by the Ministry of Education, which are the most important tools that guide their teaching. Moreover, pupils in Qatar start primary education at age six and finish at about age twelve. In England Primary education covers key stages 1 and 2 for children aged 5 to 11.

Levels of objectives

The comparisons of the two curricula using the SOLO taxonomy suggested that the curriculum standards in both countries expected primary pupils to work to some extent within all three levels of understanding: unistructural, multistructural and relational. The main difference between the two curricula was in the relational level of understanding. It was stressed more in the English curriculum than in the Qatari curriculum.

Expected Standards

Primary pupils in both countries are expected to achieve various objectives across the different curriculum areas. Because the age of pupils in each year group in England is different from the parallel year group in Qatar, the comparison was made on the basis of the expected standards at the end of each Key Stage namely for pupils aged 7 and 11. For organisational purposes, the main findings arising from the comparison in this category will be presented as follows:

- Number and Algebra at age 7
- Shape, space and measures at age 7
- Handling data at age 11
- Number and Algebra at age 11
- Shape, space and measures at age 11

- Communicating, problem solving and reasoning
- Using information and communication technology (ICT)

Number and Algebra at age 7. The major differences between what 7-year-old Qatari pupils and average 7-year-old English pupils are expected to do in relation to number are concerned with mathematical concepts and skills and the range of numbers, which they have to be able to know and use. The concepts and skills that are only expected from English pupils at this age are: recognise odd and even numbers, estimate and approximate, recall of the multiples of 2 and 10 (expanded to multiples of 3, 4 and 5 in the case of high achievers), use mental strategies to add and subtract numbers mentally as well as handle larger numbers (up to 1000).

Number and Algebra at age 11. English pupils are expected to use a wider range of mental methods of computation with the four operations; recognise, order, add and subtract negative numbers in appropriate contexts; and plot and interpret coordinates. Qatari pupils are expected to handle very large numbers such as 7 to 9 digit numbers in pencil and paper calculations. In contrast, English pupils are expected to use calculators for calculations involving several digits.

Shape, space and measures at age 7. The analysis and the comparisons exposed that the standards expected for Qatari pupils at this age are lower than those for their English counterparts. Qatari pupils are expected to recognise familiar 3-D and 2-D shapes; use language such as longer or shorter to compare objects; read o'clock time and name days of the week. In addition to this, English pupils are expected to use language related to position, direction and movement; recognise right angles in turns; and use non-standard units to measure length, mass and capacity.

Shape, space and measures at age 11. At this age English pupils are expected to achieve most objectives set for Qatari pupils in the area of shape, space and measures. Additionally, English pupils are expected to develop further concepts and skills related to geometrical transformations and symmetry. This is an aspect of geometry that is included in the Qatari curriculum in the preparatory stage (at age 12-15). Another aspect which is found only in the Qatari curriculum is the type of year (solar and leap) and type of month (lunar and calendar) as they relate to the Arabic calendar.

Handling data at age 11. The expectations for English pupils in this area are higher than those for their Qatari counterparts. English pupils are expected to collect and record data; construct and interpret tables, graphs and diagrams; use the mode and range to describe sets of data (extended to the median and mode with high-achievers). English high-achievers (at level 5) are expected to be involved not only in the above activities, but also in activities which give them the opportunity to begin to understand the concept of probability. On the other hand, the single form of representation that Qatari pupils are expected to handle at this age is the Venn diagram for union and intersection of sets.

Communicating, problem solving and reasoning. The English NC places considerable emphasis on these processes that constitute the essence of the attainment target 'using and applying mathematics' (AT1). Teaching requirements relating to this attainment target are integrated throughout the programmes of study. However, communication is seemingly not addressed strongly in the Qatari framework except for a few objectives, which are related to understanding data in pictures and using Venn diagrams. Problem solving and reasoning are emphasised in the Qatari curriculum to a lesser degree than that in the English curriculum.

Using information and communication technology (ICT). English teachers are expected to use calculators and computers to support and enrich children's experience of mathematics.. On the other hand, there is no indication in the Qatari curriculum of any use of either calculators or computers.

Overall Summary and Discussion. The comparisons of primary mathematics curriculum in England and Qatar revealed that the expectations from English pupils aged 7 and 11 are higher than those from Qatari pupils.

These results are in line with the findings of Harries and Sutherland (1999) which found that English pupils are introduced to a much broader curriculum than pupils in the other countries are studied. Further, Bierhoff (1996) has found that English pupils in primary schools are expected to study a wider range of topics, which has an influence on the consolidation of basic concepts and creates pressure for coverage at the expense of understanding.

Another issue that emerges from the comparison is the emphasis on mental calculation. Thompson (1999) suggests four aspects that promote children's ability to do mental calculations successfully, these aspects are: "a secure knowledge of number facts; a good understanding of the number system; the ability to perform accurately the skills underpinned by these understandings; and the confidence to use what they know in their own way to find solutions" (p.155). The English curriculum expects pupils to use different strategies in order to consolidate mental computation skills. On the contrary, mental methods are not explicitly referred to in the Qatari framework; priority is given to the use of written strategies and algorithms.

Communicating mathematics is an important aspect of AT1 of the English NC. The Qatari curriculum includes a small number of objectives related to this aspect, but there is no explicit treatment of the role of language and social interaction in teaching mathematics in the Qatari documents. The other aspects of AT1 namely, problem solving and reasoning are emphasised to a greater degree in the English curriculum as well. However, there have been concerns in England (see Johnson and Millett, 1996; Hughes et al, 2000) that 'Using and Applying Mathematics' has been interpreted by teachers in ways that do not correspond to the meaning intended by the national curriculum policy-makers.

Finally, the use of ICT is recommended in the English NC. This has its consequences for the competencies English teachers need. In fact, all courses of ITT (Initial

Teacher Training) must cover a curriculum for the use of ICT in subject teaching (DfEE, 1998). The Qatari framework has no explicit policy for using any source of technology.

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