

Maths in Primary School

Including Results of an INTO Survey

Irish National Teachers' Organisation
35 Parnell Square
Dublin 1

Telephone: 01 8047700

Fax: 01 872 2462

Email: info@into.ie

Web: <http://www.into.ie>

General Secretary: John Carr

Cumann Múinteoirí Éireann
35 Cearnóg Pharnell
Baile Atha Cliath 1

Guthán: 01 8047700

Fax: 01 872 2462

Ríomhphost: info@into.ie

Gréasán: <http://www.into.ie>

Árd Rúnai: John Carr



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Foreword

It is generally accepted that mathematics education is an important dimension of a general education. It is perceived as a core area of learning in probably most education systems throughout the world. However, we may well question how well mathematics are taught in the primary school. Ireland has participated in a number of national and international assessments in the area of mathematics, the main findings of which are summarised in this report. Though Ireland performs reasonably well in overall terms, there is no doubt that there is room for improvement, particularly in some aspects of the mathematics programme. The most recent international research, conducted by the OECD among fifteen year old pupils, indicates Ireland's performance in mathematics to be in the average range. Mathematical questions in real-world contexts were set to assess not only mathematical skills and knowledge but also problem-solving strategies. The evidence from OECD countries shows that the greater the social inclusion in schools the better the pupil performance in mathematics overall. Ireland's performance in the OECD PISA study (Programme for International Student Assessment) raises issues which warrant further discussion in relation to the approach to teaching mathematics and the content of the curriculum at both primary and second level.

The primary maths curriculum of 1999 has incorporated a number of concerns that were identified by the INTO in its previous research on mathematics, and which were raised at the consultative conference on education in 1990. It is heartening to know that many of the recommendations the Education Committee made in 1990, particularly in relation to problem solving, overloading of content, estimation, mental and oral maths and use of mathematical games, have been incorporated into the revised curriculum. Initial responses from teachers to the revised curriculum are included in this report.

Both the Department of Education and Science and the National Council for Curriculum and Assessment carried out evaluations and reviews of the implementation of the mathematics curriculum in primary schools during the school year 2003–2004. The quality of the mathematics curriculum was found to be good in the majority of schools. However, a number of issues were identified which require addressing if the teaching of mathematics is to improve further. The INTO calls for additional materials and resources and enhanced opportunities for professional development for teachers as key elements in supporting mathematics teaching in primary schools.

I would like to acknowledge the work of the INTO Education Committee in preparing this report. It is a further contribution to education research carried out by teachers. The Committee carried out quantitative research, by issuing questionnaires to members seeking their views on the revised Maths curriculum and I would like to thank all the members who completed the questionnaire, which informs this report. I would also like to take this opportunity to thank members of the Head Office team who prepared the report for publication, under the general direction of Deirbhile Nic Craith, Senior Official.

John Carr, MA (Ed)
General Secretary
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Mathematics in the Primary School

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INTRODUCTION

There is a general acceptance of the importance of mathematics education. It is perceived as a core area of learning in probably most educational systems throughout the world. Indeed many international studies have sought to compare achievement in mathematics between various countries. Its inclusion as a curricular area in schools reflects its value in providing pupils with knowledge, skills and procedures which are necessary tools in understanding the physical environment and in exploring patterns and relationships. Mathematics, though enjoyable and valid in its own right, is also relevant to learning in many other curricular areas.

The INTO, in its report on *Mathematics in the Primary School* (1990) highlighted a number of areas where changes were required in the primary curriculum. Many of the Education Committee's recommendations, particularly in relation to problem solving, overloading of content, estimation, mental and oral maths and the use of mathematical games have been incorporated into the revised mathematics programme in the Primary Curriculum (1999). The proposal to develop a continuous curriculum for the compulsory school years, as is common in most European countries, has not materialised, as primary and post-primary curricula tend to be developed separately, an issue which merits addressing by the National Council for Curriculum and Assessment (NCCA). The INTO argued strongly that the needs of pupils in compulsory schooling should not be subordinated by assessment. It was also

argued that the mathematics curriculum should not be designed for pupils who would need applied mathematics for future careers in engineering, accountancy or the sciences, but should instead focus on pupils' needs in preparation for life as adults capable of dealing with practical mathematics in real-life situations (INTO, 1990, p.64). In addition to its economic utility and intrinsic social value, mathematics education is an intellectual pursuit in its own right, a source of fascination, challenge and enjoyment, (DES, 1999, p.3) and this is reflected in the current mathematics curriculum in primary schools.

It is too early to assess fully the impact of the revised mathematics curriculum. Teachers were given an opportunity during the school year 2003–2004, to review their implementation of the mathematics curriculum, in addition to the English and Visual Arts curriculum. The NCCA, in order to assist schools with this process, designed review templates. A number of schools were invited to return their templates to the NCCA for inclusion in a general review and evaluation of the curriculum. The NCCA has compiled a report arising from the curriculum review process. The Inspectorate, as part of their ongoing work on school evaluation, also considered the implementation of the mathematics curriculum¹. The INTO carried out a survey of members to ascertain their views in relation to the current mathematics programme, and these findings are included in this report.

Mathematics is recognised as one of the sciences and is used in everyday life. Achievement in mathematics is regularly monitored by both teachers in classrooms as an integral part of the teaching learning process and by the Department of Education and Science (DES), who on behalf of the State, gathers information on the general performance of the educational system. Ireland, therefore, has participated in many international assessments of mathematics learning, in addition to national assessments. A brief overview of Ireland's achievements are included in this report, highlighting the areas in which Irish pupils achieve well and the areas where Irish pupils achieve poorly by international comparison. Information from such assessments is useful in guiding future curriculum development in mathematics education and in informing the needs of teacher education, both initial teacher education and ongoing professional development.

MATHEMATICS IN THE PRIMARY CURRICULUM

The Primary School Curriculum (1999) contains a number of revisions to the mathematics curriculum of 1971. The implementation process for the revised Primary School Mathematics Curriculum began in September 2002 following an inservice

¹ The Department's report 'An Evaluation of Curriculum Implementation in Primary Schools' was published in May 2005

programme provided by the Primary Curriculum Support Programme (PCSP). The aims of this curriculum are as follows:

- 1 To develop a positive attitude towards mathematics and an appreciation of both its practical and its aesthetic aspects.
- 1 To develop problem-solving abilities and a facility for the application of mathematics to everyday life.
- 1 To enable the child to use mathematical language effectively and accurately.
- 1 To enable the child to acquire an understanding of mathematical concepts and processes to his/her appropriate level of development and ability.
- 1 To enable the child to acquire proficiency in fundamental mathematical skills and in recalling basic number facts.

(Primary School Curriculum, 1999 , p.12)

Mathematics should be portrayed to children as being practical and relevant in their everyday lives. It should be integrated with other areas of the curriculum, such as social, environmental and scientific education (SESE), music and physical education. Whenever possible it should be linked to the children's environment and their own experiences. Through the mathematics curriculum, children are being prepared to deal effectively with the varied transactions of everyday life and to make sense of the mass of information and data available through the media. It is essential, therefore, that children see mathematics as relevant to their own lives. As stated in the teacher guidelines for mathematics, the curriculum will be a key factor in preparing children to meet the demands of the 21st century (p. 2). Children should enjoy mathematics and be catered for according to their ability. They should look forward to the challenges of mathematics learning and be fully equipped to face them with confidence and enthusiasm in order to experience the satisfaction of a job well done.

There is a great emphasis on children being the instruments of their own learning. The constructivist approach is central to the mathematics programme, where children must construct their own internal structures. They are encouraged to develop their own mathematical strategies for solving problems by using their knowledge of one area to explore another and enhance their growth of reasoning. Access to concrete materials is considered necessary for pupils at all class levels from infants through to sixth class. Language also plays an important role. Children need to develop the ability to listen, question and discuss as well as to read and record. Discussion can be in pairs, groups or among the class as a whole. The teacher supplies mathematical language when necessary to enable children to build up an appropriate mathematical vocabulary. Concepts need to be adequately developed orally before children record them in writing, using symbols and mathematical expressions.

STRUCTURE OF THE CURRICULUM

The curriculum comprises five strands:

- 1 Number.
- 1 Algebra.
- 1 Shape and space.
- 1 Measures.
- 1 Data.

The strands form a network of related and interdependent units which are further developed as strand units. An overview of the strands, and the main differences introduced to the curriculum in 1999 are outlined below.

Number

A ceiling has been placed on number work to allow for more extensive treatment of the mathematics programme as a whole and to allow more time for concept development. It places less emphasis than heretofore on long, complex pen-and-paper calculations and a greater emphasis on mental calculations, estimation and problem-solving skills. Recording can be concrete, oral, pictorial or diagrammatic, or can include model-making. Work on fractions and decimals, in general, will place more emphasis on understanding the relationships between them.

Algebra

Algebra has always been part of the curriculum. It includes patterns, sequences and statements such as $2 + _ = 5$. It is, now, formally recognised at all levels. Positive and negative numbers are introduced in senior classes. It is expected that numbers used will be kept small so that the children can understand the concepts presented.

Shape and space

This strand explores spatial awareness and its application to real-life situations. It is particularly suited to integration.

Measures

This strand has six strand units – length, area, weight, capacity, time and money. Problems should be mainly practical with the totals easily verified by measuring. As with the previous curriculum children should be taught from an early age to estimate. Children will need to handle materials, investigate them and then to discuss and

compare their findings. The reasons for using standard measuring instruments should be explored in a practical way.

Data

Graphical representation and interpretation has always been part of the curriculum, but data handling is, now, a separate strand. Interpreting and understanding visual representation is essential, as the child needs to be enabled to interpret data in an increasingly technological world. It is hoped that, where available, information technology will be used by children in data-handling exercises. Children must understand how important it is to enter relevant data and ask clear questions if the information to be extracted from the database is to be of any use. The concept of chance is of great importance. It represents real-life mathematics and promotes thinking and discussion. Topics can be introduced through problems, practical experiments and simulations that help to develop intuitive foundations for future work and are fun for the child.

Linkage

Strands can be taught in parallel rather than one after the other. Children will use their knowledge of one area to explore another. This facilitates the use of number throughout the mathematics curriculum.

Calculators

Calculators have been introduced to schools for the first time from fourth to sixth classes. They help the development of problem-solving skills by allowing the child to focus on the structure of a problem and possible means of solution. They can be used to check estimates, to perform long and complex computations and to provide exact results to difficult problems. However, the calculator cannot be a substitute for practical activity with materials.

Assessment

Assessment should provide information that will enable the teacher to cater for individual differences in ability, to assess previous learning, to address learning styles, and to resist pressure to push the child to premature mechanical mastery of computational facts and procedures.

ALTERNATIVE APPROACHES TO TEACHING MATHEMATICS

In addition to traditional approaches to the teaching of mathematics, a variety of alternative approaches are used by teachers to support the teaching and learning of mathematics – a selection of which are outlined below.

The Mathematics Recovery Programme

The Mathematics Recovery Programme draws on research into the learning and teaching of early mathematics undertaken by Professor Leslie Steffe and his colleagues at the University of Georgia in the US and by Professor Bob Wright who worked with him as a doctoral student. Research has shown that there are already vast differences in the mathematical knowledge of students when they begin school initially (Aubrey, 1993; Young-Loveridge, 1989; Wright, 1991, 1994). This gap tends to remain and increase throughout their schooling. Strong negative attitudes to mathematics can develop along the way. The Mathematics Recovery Programme is directed towards early intervention.

ASSESSMENT

Children are assessed by way of an 'Interview Schedule'. This is an oral assessment seeking to find out what the child knows, what strategies, if any, s/he is using and getting to the core of the concept problem. The assessment is concerned, primarily, with number, addressing the following topics

- 1 facility with number words and number word sequences;
- 1 ability to recognise, identify and write numerals;
- 1 emerging strategies for adding and subtraction;
- 1 knowledge of the tens and units aspect of the numeration system;
- 1 emerging methods of notating in arithmetic; and
- 1 ability to ascribe number to spatial and temporal patterns.

FOCUS AND KEY FEATURES OF PROGRAMME

The focus of the programme is to identify low-attaining students at an early stage and, subsequently, to provide a programme of intensive, individualised teaching. The aim of the programme is to raise the student to a level where s/he can return and learn successfully in the mainstream class. Instruction takes place on a one-to-one basis and in conjunction with the class teacher.

The 'Interview Schedule' (ie, the assessment that is done) is used to develop an individual teaching framework for each student involved in the Mathematics Recovery Programme. The programme deals with early number - counting on/back, counting in 2s, 3s and so on, counting in tens for place value, visualising and manipulating number. The instruction is problem-based and from a constructivist perspective. It is mainly oral – extending the child's current thinking. It should be challenging but with a good possibility of success, thus, increasing self-esteem. Children are encouraged to reflect on their own mathematical thinking.

The programme involves teaching cycles of 10-15 weeks duration. Students are taught for 30 minutes daily, four or five days a week. In Ireland, at present, learning support and special needs resource teachers are using the programme. Those participating in the programme are finding it very successful. There is great demand for the limited number of in-service places available. Pilot projects, supported by the Department of Education and Science, are planned for a number of schools in Limerick.

Regrouping for Mathematics

Regrouping is a form of grouping where children remain in their normal teaching unit for most of the day and are assigned to groups, according to ability, for certain subjects eg, mathematics. Assignment to groups is made on the basis of actual performance in the subject and there is mobility between levels so that students can move from one to another according to their achievements. Instruction is adapted to the specific needs of the students.

There are many advantages to grouping children according to ability. For example, there is a greater challenge to brighter students as they can progress faster and children with difficulties in learning mathematics will gain more confidence and perform better if the class work is aimed at their level. In addition, teachers may find it easier and more productive working with groups of children of similar ability. There are various forms of grouping – mixed-ability grouping where children of different abilities are placed in the one class and streaming, where children are placed in classes according to ability. With regrouping children spend most of the day in a mixed-ability setting and are regrouped for certain subjects such as mathematics. Therefore, the original class remains the primary reference group.

Lyons (1999) in her research on regrouping sought "to ascertain whether a regrouping system for mathematics at fifth and sixth class level contributed to the development of a more positive attitude towards mathematics and an increased level of confidence in approaching study of the subject". For the purpose of her research she chose an all-girls, largely middle-class, convent school situated in an expanding urban area. There were three classes of each level from second class upwards. The

system of regrouping pupils of both fifth and sixth classes for mathematics had been in operation in the school for the previous five years. Teachers of the fifth and sixth classes moved from one maths group to another each term. Pupils were not told the ability level to which they were assigned although it became clear in the course of the study that they succeeded in working that out for themselves. The three mixed-ability classes in both fifth and sixth were regrouped according to ability – TOP MIDDLE WEAK – for the teaching of mathematics. For the purpose of the investigation pupils were chosen at random from each level and both pupils and their parents were interviewed.

RESULTS OF INVESTIGATION

Almost all pupils were happy with their placement and understood the importance of ability as a criterion for the formation of the groups, and that they were being regrouped in an effort to assist them. The majority of the students understood that it was possible to change groups. A minority in the weak-ability group did not seem to be aware of this, possibly, because flexibility only existed in this particular study between high-ability and medium-ability groups. According to Lyons, it is very important that those in the weak ability group are aware of the possibility of upward mobility.

The majority of pupils and parents from sixth class were quite happy changing teachers for instruction during the year, whereas, on the whole, they were unhappy with this arrangement in fifth class.

There were more children in sixth class than in fifth class who rated mathematics among their favourite subjects, leading to the conclusion that the overall attitude towards the subject was becoming more positive since regrouping. Half of fifth class compared to 87.5% of sixth considered the work easier than the previous year. Most of sixth class pupils commented that learning mathematics was more enjoyable and over half of fifth class reported an improved attitude. These comments were generally supported by the parents of both classes.

Pupils and parents, alike, from both fifth and sixth classes were agreed on the positive effects of regrouping on the nightly ritual of homework. This was most evident in the weaker ability pupils. It was thought that “the relatively new feelings of success for weaker ability students would, hopefully, help to break the cycle of repeated failure and lead to an increase in confidence and improved attitude towards maths”. The majority of pupils and parents from both fifth and sixth classes considered that their confidence in approaching mathematics had increased and no child reported a reduction in confidence levels.

Pupils in the middle and weaker groups were more sensitive to comments made about placements. Those in fifth class were more affected than those in sixth class. It was perceived by the author that by the time pupils reached sixth class, having been in the system for a year, they generally tended to accept the process as the norm and,

therefore, major discussion concerning it ceased. The majority of the parents and pupils of both fifth and sixth expressed a preference for continuing with the practice of regrouping.

A regrouping system in any school would need to be continuously monitored and evaluated. The focus of the system is on the development of confidence and the growth of a more positive attitude towards the subject. The correct assignment of pupils to the different groups is essential, and such assignments must be flexible. There is a need also to outline the philosophy underlying the system to both pupils and their parents when introduced initially. According to Lyons “a regrouping programme may offer pupils the support to develop mathematical skills at their own pace, to experience success where they had previously known only failure and to work at an appropriate individual level”.

Parental Involvement in Maths in Primary School

(A) SHARED MATHS / MATHS FOR FUN

Shared Maths/Maths for Fun is a teaching strategy where parents are involved in the classroom. The children in the class are divided into groups. One parent works with each group for a period of 40 minutes. The equipment is stored in crates, baskets or boxes. The groups move from one game/activity to another. A timer is set to buzz after 10 minutes signalling the end. Children tidy up before moving on to the next game/activity. To encourage ease of movement and a low noise level Merit Stickers may be given to groups who leave everything in its place and move quietly from table to table. The group with the highest number of stickers (every group!) receive a Maths Bookmark at the end of the session, which lasts six weeks. Suggested games and activities include: Tangrams; Relational Attribute Blocks; Pattern Blocks; Pentominoes; BINGO; Bank Balance; Snakes And Ladders; Dienes Blocks; My Computer and Time Games. See Appendix 1 for a description.

(B) PAIRED MATHS

Paired Maths is where parents are involved in playing mathematically-based games with their children at home. The parents of the children involved attend a school-based meeting. They are given instruction on how the system works. Each child in the class will be given a game to take home for a period of one week. The whole process lasts six weeks.

ASSESSMENTS OF MATHEMATICAL ACHIEVEMENT

Irish primary schools have participated in a small number of national and international assessments of mathematics achievement since the introduction of *Curaclam na Bunscoile* (DES 1971). Ireland has also participated in international assessments at second-level. This section of the report highlights the main findings of both national and international assessment in relation to mathematics, in addition to giving an overview of the main findings of a recent study on mathematics teaching and learning at junior cycle at second level. The latter study raises some issues of relevance regarding the approach to mathematics teaching at primary level.

National Assessments

The Department of Education tested a national sample of second and fourth classes in 1977 and sixth classes in 1979. Sixth classes were retested in 1984 and reports were issued by the DES in 1977, 1980 and 1985.

The tests for second and fourth classes included items in seven content areas: Operations with Whole Numbers, Whole Number Structure, Measurement, Fractions and Decimals, Geometry, Graphs and Problems. At second class level, 85% achieved mastery in Operations with Whole Numbers and 55% to 65% achieved mastery over six content areas. Items which caused most problems at second class related to subtraction and the commutative and distributive properties of addition. Girls slightly outperformed boys in all areas with a marked difference on a few items.

At fourth class, mastery levels were lower across the board with 75% mastery at Operations with Whole Numbers and a 40% - 60% range in the other areas. Items of Unitary method, adding and subtracting decimals, interpreting graphs and timetables, problems, relating fractions and decimals, symmetry, perimeter and long division all achieved less than 50% mastery. Again girls outperformed boys in most areas of the tests.

The achievement tests for sixth classes covered 10 content areas in mathematics: Operations with Whole Numbers, Whole Number Structures, Fractional Number Structure, Operations with Fractions, Decimals and Percentages, Metric Measure, Algebra, Geometry, Charts and Graphs and Problems. Geometry, Measurement, Problem Solving, Whole Number Structure and Algebra were the areas of lowest mastery and boys, on average, outperformed girls.

In 1999, the Educational Research Centre (ERC) tested national mathematical achievement in 4th classes in 5 areas: Number, Algebra, Shape and Space, Measures and Data. These correspond to the strand units in the Revised Primary School Curriculum (NCCA 1999). Pupils performed best on Data (69% correct), Number (60%) and Algebra (58%) and poorest on Measures (54%) and Shape and Space

(46%). No significant gender differences arose but a much higher proportion of boys scored at or below the 10th percentile.

International Assessments

Ireland took part in a number of international surveys of mathematical achievement since the introduction of the 1971 Primary School Curriculum. The Second International Mathematics Study (SIMS) in 1980–82 targeted 13 year olds, some in sixth class and some in first year, at post-primary level. The International Assessment of Educational Progress (IAEP) conducted studies of 13 year olds in 1988 and both nine year olds and 13 year olds in 1991. The Third International Maths and Science Study (TIMSS) took place in 1995 and targeted third and fourth classes in primary schools and first and second year pupils in post-primary schools.

IAEP I (1988)

IAEP I (1988) carried out tests in five countries: Ireland, UK, USA, Korea, Spain and seven Canadian Provinces, in six content areas: Number and Operations; Algebra; Relation and Functions; Geometry; Measurement; Data Organisation and Interpretation and Logic and Problem Solving. Ireland, UK, Spain and French Canadians performed at the mean level of all participants. English Canadians performed above the mean, while Korea achieved well above the mean. The USA performed below the mean. Ireland scored particularly badly in Data Organisation and Interpretation and relatively badly in Geometry and Measurement. The remaining three areas showed a much stronger performance. No significant gender differences were reported. However, a correlation between a greater amount of time spent watching television and a lower maths achievement score was noted.

IAEP II (1991)

IAEP II (1991) tested 20 countries for 13 year olds and 14 countries for nine year olds. The international average for 13 year olds was 58% and Ireland scored 61%. At nine year old level, the average score was 63% and Ireland's mean score was 60%. IAEP II covered five content areas: Number and Operations; Measurement; Geometry; Data Analysis; Statistics and Probability; and Algebra and Functions. Ireland scored significantly below the mean in both geometry and measurement and at about the mean in the other areas. Girls scored higher than boys in third and fourth classes but not significantly higher.

TIMSS (1995)

The TIMSS (1995) included 45 countries over two age groups – nine year olds and

13 year olds. The average score for the older age group was 484 for first year students and 513 for second year students. The Irish pupils scored 500 for first year students and 527 for second year students. In third class the international average was 470 and Irish pupils scored 476. In fourth class Ireland scored 550 over a mean score of 529.

The TIMSS (1995) tested six content areas: Whole Numbers; Fractions and Proportionality, Measure, Estimation and Number Sense, Data Representation, Analysis and Probability, Geometry and Patterns, Relationships and Functions. Pupils in 4th class scored at the mean in two areas: Measure, Estimation and Number Sense and Geometry. They scored significantly above the mean in the other four areas.

No significant differences showed up between boys and girls. Fourth class pupils reporting more than 100 books at home scored significantly higher than those reporting less than 25 books and fourth class pupils reporting a positive attitude to maths scored significantly higher than those who did not. Irish pupils in smaller classes scored higher than those in larger classes but not significant so.

PISA 2000

The OECD Programme for International Student Assessment (PISA) assesses the knowledge and skills achieved by students near the end of compulsory schooling (ie, 15 year olds). In PISA 2000 Ireland scored just above the country average of 500 (502.9). Boys scored significantly higher than girls at this age which correlated with that of most other countries tested. The number of books in the home was noted as an indicator of success in maths achievement.

PISA 2003

PISA 2003 focused on mathematics and two reports were published – *Learning for Tomorrow's World* and *Problem Solving for Tomorrow's World*.

Mathematics was assessed in four domains, Shape and Space, Change and Relationships, Quantity and Uncertainty. Mathematical questions in real-world contexts were set to assess not only mathematical skills and knowledge but also problem-solving strategies. Ireland finished within the OECD average range and 17th out of the 29 countries taking part. In the domains assessed, Ireland was significantly above the average in both Uncertainty and Change and Relationships; was on the average for Quantity, and below average for Shape and Space.

Males outscored females in all four domains of mathematics assessed but the overall difference was not large except in *Shape* and *Space* which was significant. These results seem at variance with Junior Certificate results in Ireland where females consistently outperform male students. The types of real-world problems posed in the PISA 2003 survey may provide the answer to this variance in gender results. Pupil opinions

amongst Irish students showed a more positive attitude to mathematics as a factor for improving education and life skills than the OECD average.

In relation to variation between both students and schools, PISA found that Ireland had one of the lowest ranges of student performance variation amongst OECD countries. Low achievers in Ireland performed stronger than many OECD countries but conversely high achievers did not perform as well as their counterparts. PISA also reported that Ireland is one of the few countries with little performance differences between schools. This prompted the remark that “parents can be confident of high and consistent performance standards across schools in the entire education system.” The variation of performance between schools and between students, although small, was best explained by socio-economic factors.

The initial recommendations of the PISA 2003 Report relate to the education system and schools rather than pupils. The evidence from OECD countries shows that the greater the social inclusion in schools the better the pupil performance in mathematics overall. The first recommendation, therefore, is to develop social inclusion in schools across the education system. Since there is little variation in pupil performance between schools, the second recommendation is that policies aimed at improving the performance of low achievers are likely to be the most effective.

PISA 2003 also included a section on cross-curricular problem solving which again placed Ireland within the OECD average similar to that achieved in general maths performance. A small portion of PISA 2003 was also given over to reading and science. First indicators were that Ireland was well above the OECD average in reading with only three countries scoring higher than Ireland. In science, Ireland was again well above the OECD average but still some way behind the highest rated countries. PISA 2006 will be a major assessment of science in the OECD. The full data for PISA 2003 remains to be completely interpreted and further reports will be produced in due course.

Summary

Ireland has consistently scored at about or just above the mean in the international studies in which it has participated. Items relating to number and data have been the most successful, while those relating to geometry, measurement and algebra have been less so. Little or no difference between the performance of boys and girls was detected except at 15 year old level (PISA 2000). Pupils’ attitude to mathematics and socio-economic backgrounds seems to have some significance relating to mathematical achievement.

JUNIOR CYCLE MATHEMATICS IN POST PRIMARY SCHOOLS

The Gender Equality Committee of the Department of Education and Science initiated and funded a study related to Junior Certificate Maths. The study is based on Exam Results (1992–1996) and case studies of ten different second-level schools around the country. With the co-operation of teachers and students an intensive video study of twenty mathematics lessons and six English lessons involving second year students was undertaken. The video studies were complemented by interviews with students, teachers and parents in order to examine the relationship between teaching practices and attitudes to learning.

The study was designed to explore co-educational and single-sex schools across different types of school background to gain understanding about pedagogical styles and priorities and their impact on the teaching and learning of mathematics. The impact of gender and social class on outcomes was a related objective.

The study outlined two epistemological approaches to mathematics teaching. These contrasting perspectives are the absolutist and the relativist. The former is objective, consistent and knowledge based and favours a didactic approach to transmission. The latter is based on interaction between individuals, society and knowledge and is culturally situated. This lends itself more to problem based and constructivist learning.

Second-level teachers, who are preparing students for public examinations, are inclined to favour didactic teaching where it is known to be rewarded with good examination results. In preparation for the main video study, an analysis of Junior Certificate Mathematics examination results for 1992 – 1996 was carried out. Students have a choice between three levels: Foundation, Ordinary and Higher. The uptake of each level is approximately in the ratio 1 : 3 : 2 respectively. Mathematics has a low take-up at the Higher level (36%) in comparison to Irish (40%) and English (61%). It is conjectured that this may relate to a static syllabus that is perceived to be difficult.

Gender differences vary widely with regard to type of school and social background. Girls in general tend to reject maths or under perform in maths more and this is more pronounced in disadvantaged schools. However, it is shown that this cannot be explained by teaching or school-specific variables alone. The wider socio-cultural context where gender identities are created and reinforced is the prevailing basis for gender differences in both participation and performance. However, the number of girls taking Higher level papers has risen significantly over the last fifteen years.

Where major differences exist in performance they are, increasingly, linked to social class background rather than gender. It would appear that differences in take-up rates of different levels of mathematics between co-educational and single-sex schools is

not so much related to their coeducational status as it is to the social class composition of their school population and the tradition of the school. The schools with the most disadvantaged students are the ones in which there is the highest take-up of Foundation and Ordinary levels. The most socially selective schools, fee-paying secondary, have the highest take-up rates at Higher level. The analysis also suggests that teacher expectations and perspectives on students were influenced by the students' social class and background. The track, set, stream or band into which a student is placed influences his/her experience of learning mathematics. Top tracks experience a more intense, work-focused and competitive learning environment than the lower tracks.

Review of Case Studies

There was a high level of uniformity in how the lessons were organised and presented. The didactic approach, teacher demonstration and student practice, was the preferred choice of teachers. Learning was most often equated with the memorisation of formulae and procedures. There was little time devoted to problem-solving, to the practical application of mathematics in the physical world or to alternative methods of solving problems. Teachers were more likely to use lower-level and drill questioning with the emphasis on giving the 'right' answer. It was clear from the video that students were not encouraged to ask questions. Interaction was for the most part teacher-initiated with only 4% student-initiated. In general, boys received more teacher attention than girls did. The classes that were most gender-balanced were those in which the teachers were gender aware. There was a tendency for a small number of boys to dominate classes in both coeducational and in single-sex boys' schools. Praise was limited, although girls in all types of classes received somewhat more praise than boys did.

Teachers' Perspectives

Teachers, generally, attributed students' improvements to having an innate ability and to being encouraged and supported by the teacher. They did not hold themselves responsible for any observed deterioration in students' performance. Students' own attitudes, behaviour or lack of ability were deemed to be the main reasons. All of the teachers adhered to the essentialist view about mathematical ability ie, that some students have a natural talent for the subject while others do not. Six of the ten teachers claimed that students from "poor" backgrounds were disadvantaged in learning mathematics by their parents' lack of knowledge of, and especially interest in, education. Most of the teachers assigned homework in each lesson and corrected it in the next. A number of teachers observed that certain students entered second level schools educationally disadvantaged in mathematics, raising questions as to why this

was the case, and why the problems had not been addressed at primary level.

Student Perspectives

For pupils, mathematics, as a subject, seemed to be defined and interpreted in terms of the person who taught it. They rejected the essentialist view of mathematics (innate ability). Pupils were more likely to state that what was required for success in school mathematics was having a good teacher and studying at home. They also thought that good memorisation was important but not necessarily “learning the text book by heart”. They were quite positive about the value and importance of mathematics required for everyday life, for employment and for further education purposes. They recognised it as an important subject that had both a short and long term value. However, the study also highlighted that students were reluctant, even fearful, to ask for help in mathematics class. In discussing their experience of learning mathematics throughout their primary and post-primary education, students said they, generally, preferred to ask their parents and/or other siblings for help at home or, alternatively, to ask one of their friends or classmates. Students spoke about finding it “unnerving” when questioned in class and feeling under pressure to “get it right”. For students, teacher attitudes appear to have a big bearing on outcomes. Students related their attitudes to mathematics in terms of their teacher. If the teacher was perceived as positive and supportive, they were labelled “good”. Teachers were criticised for being negative or “going too fast”.

Parent Perspectives

Parents from all types of social backgrounds held the essentialist view on children’s “innate ability” for successful learning in mathematics. While very few parents actively avoided co-educational schools there were those who actively chose single-sex schools as these were reported to be strong academically and/or were prestigious because of their socially selective intake. Parental expectations were a significant influence on student/teacher attitudes and performance.

Possible Implications for Primary School Maths Teaching

As evidenced from the above study, didactic teaching is the norm at second level. However, while constructivist teaching is the basis of the revised primary curriculum (1999) and was also implicit in the 1971 curriculum, there is still a lot of didactic teaching at primary level. If primary teaching in the future evolves to a constructivist approach as is envisaged, the students should be transferring to second level with greater knowledge and more positive attitudes to mathematics. However, they may

well be less suitably equipped to cope with a didactic approach, if such practices remain at second level.

Students are often streamed at entry to second-level. Students who leave primary with low attainment levels, irrespective of ability, will be unable to enter the higher streams at second level. This raises the question of the quality of mathematics education at primary level. Disadvantaged schools and disadvantaged students are being discriminated against both socially and educationally. In second level schools where streaming takes place, there is no real mechanism for the disadvantaged pupil to change streams. This places a burden on primary level to bring children to a sufficiently high level to give them the option to enter the highest stream on entry to second level.

Gender differences are small in comparison to social differences. Parental values and student and teacher attitudes have a major effect on mathematics achievements. Attitudes to mathematics and resulting teaching styles and practices at primary level need to be tailored to develop support and positiveness towards mathematics and to reduce pupil anxiety. Parents also need to be informed about how the system works as well as encouraged to develop positive attitudes to mathematics and education in general.

Student attitudes appear to be very dependent on their concept of what a 'good' teacher is, in that teaching styles that incorporate positive reinforcement, supportive and steady progress through topics and an emphasis on 'anxiety-free' environments need to be encouraged for maximum effect. Teachers also need to be aware of gender differences between boys and girls and also between dominant and non-dominant boys in making classes more inclusive for all students.

Results of INTO Survey on Mathematics (2004)

INTRODUCTION

The Education Committee of INTO conducted a national survey on the teaching of mathematics in the primary school in March 2004. A total of 505 (51%) questionnaires were returned and processed. Where responses were made by all or most participants, results are given in percentages. Questions that required opinions or a variety of responses are reported by giving the actual number of teacher replies. It was decided to include some opinions that were expressed by relatively few respondents since they provide additional information and illustrate practice in some instances.

School Details

Surveys were returned from 505 teachers of whom 20% taught infant classes, 15% taught junior classes, 20% were in middle classes and 24% were in senior classes. The remaining 20% taught in multiclassrooms. Respondents reported that 23% were in one to four teacher schools, 44% were in five to 16 teacher schools and 33% were in larger schools. Describing their location, 32% of teachers said they were in rural schools, while 35% were in small towns and 29% were in city schools. Three-quarters of teachers replying taught in co-educational schools, 13% taught in boys' schools and 10% taught in girls' schools. One-quarter of respondents were working in schools designated disadvantaged and 6% were teaching through the medium of Irish. Teachers reported a variety of class sizes. One-tenth of teachers had classes of up to 15 pupils, one-fifth had 16–20 pupils, one-quarter had 21–25 pupils, one-third had 26–30 pupils and one-eighth taught classes of over 30 pupils.

Learning Support

Regarding the provision of Learning Support in Mathematics (LSM), 58% of teachers

reported that their schools provided LSM, while 39% teachers reported that they did not. However, relatively little time out of total learning support time is allocated to maths by most of those schools providing LSM. In total 184 (36%) teachers reported children in their classes receiving LSM, as follows:

Table 1: Numbers of Pupils per Class receiving LSM/Number of Teachers with Pupils receiving LSM

Number of Pupils in Class receiving Learning Support in Maths	Number of teachers who reported pupils in their class receiving learning support in Maths
1 pupil	34 teachers
2 pupils	42 teachers
3 pupils	35 teachers
4 pupils	29 teachers
5 pupils	21 teachers
6 pupils	13 teachers
More than 6 pupils	10 teachers

When respondents were asked how many should be receiving LSM, they reported as follows: 48% felt up to 4 pupils needed LSM, 31% reported five to eight pupils in need and 6% felt even more pupils required assistance. A total of 218 (43%) teachers reported that children received support in maths from the special needs resource teacher. Eighty six teachers reported one such pupil, 63 teachers had two pupils, 31 had three pupils, 20 had four pupils and 17 had more than four pupils receiving such help.

Details of Respondents

Four-fifths of respondents were female and one-fifth of respondents were male, which corresponds with the general representation of male and female teachers in the profession. Only 16% of respondents had mathematics as a degree subject while 82% reported that they had not. Regarding the number of years spent teaching, 31% had less than 10 years teaching experience, 23% had 11–20 years experience, 29% had 21–30 years experience and 18% had more than 30 years experience as a teacher.

Professional Development /Inservice

Apart from PCSP inservice seminars in Mathematics Teaching, 30% had attended

INTO Maths courses and 2.2% had attended Education Centre Maths courses. A small number had attended other Maths courses, while 25% reported not having attended any other inservice courses. Three-fifths of teachers reported that their school had availed of the *cuiditheoireacht* service for Mathematics, while one-third had not.

TEACHING AND LEARNING MATHEMATICS

Mathematical Activities

Teachers were asked how often they used six different mathematical activities. The results are outlined in Table 2 below. There was liberal use of estimation, mental maths, memorisation and problem solving, especially in the older classes. However, less than one-fifth made much use of alternative algorithms or computerised procedures, and this was mostly in the senior classes.

Table
2:
How
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Methodologies	Very Often	Often	Sometimes	Never
Alternative algorithms	4%	16%	27.6%	33.0%
Computerised procedures	4%	12%	41.8%	38.8%
Estimation	25%	48%	21.0%	0.8%
Memorisation of facts/formulae	33%	37%	20.0%	7.0%
Mental maths	48%	40%	10.6%	1.4%
Problem solving	35%	51%	12.2%	1.4%

Teaching Methodologies

Teachers indicated how often they used eight particular teaching methodologies in mathematics. The results are outlined in Table 3 below. The environment was regularly used by less than one-fifth of respondents but its most frequent use was in infant classes. Active and collaborative learning, talk and discussion, oral computation and linkage within the maths programme were very frequently used by teachers. Integration and investigation were also used frequently. Integration was practised twice as often in infant classes as in more senior classes. As expected, early learning activities

are reported mostly in infant classes with some continuity into first and second classes.

Methodologies	Very Often	Often	Sometimes	Never
Active and collaborative learning	35%	43%	19%	1%
Early learning activities	24%	18%	31%	23%
Integration with other subjects	17%	40%	39%	4%
Investigation	11%	39%	44%	5%
Linkage within Maths programme	24%	50%	24%	1%
Oral computation	40%	49%	10%	1%
Talk and discussion	53%	40%	7%	1%
Use of the environment	7%	17%	42%	32%

Activity learning was also reported as slightly more frequent in infant classes.

Table 3: How often teachers used eight teaching methodologies in mathematics

Teaching Resources

Teachers reported their use of teaching resources. Table 4 below outlines their

Resources	Very Often	Often	Sometimes	Never
Calculators	6%	18%	21%	53%
Concrete materials	41%	38%	20%	1%
ICT games	5%	13%	29%	52%
ICT programmes	8%	17%	45%	30%
Maths games	12%	30%	51%	8%
Resource books	30%	42%	24%	5%
Textbooks	74%	21%	3%	2%

responses. Textbooks, resource books and concrete materials were the most used resources. Maths games were also used quite often. ICT games and programmes and calculators were the least used resources.

Table 4: How often respondents report using teaching resources

Organisation	Very Often	Often	Sometimes	Never
Group work on tasks	16%	39%	37%	8%
Homework	64%	24%	6%	6%
Individual work	70%	25%	5%	0%
Pair work	16%	45%	33%	5%
Whole class presentation	48%	21%	14%	13%

Organisational Structures in Mathematics

Teachers were asked how often they used five organisational structures in the maths classroom. Their responses are outlined in Table 5 below. Group work and paired work were used quite often, but homework, individual work and whole class presentation were the most frequently used.

Table 5: How often teachers used five organisational structures in mathematics

Textbooks

Two-thirds of teachers reported that schools were using one particular textbook series throughout the school. Ten different texts were in use. Among reasons given by the one-third not using one textbook were – series not complete yet, undecided which series to choose, preference for a variety of texts or unavailability of Irish texts. Almost half of the respondents use workbooks and more than a quarter use additional textbooks to provide supplementary mathematics material.

Materials	Percentage of teachers citing availability of materials
Unifix cubes	51%
Sorting materials	62%
Counting equipment	45%
Place value materials	43%
Fraction/decimal/ percentage materials	27%
Measure (length)	64%
Measure (weight)	35%
Measure (capacity)	22%
Measure (time)	38%

**ICT
and**

Calculators

A small number of respondents use ICT for specific areas of mathematics. Some 71 teachers use computers for tables drills and practice, 21 teachers use ICT for graphs and logo activities, while 27 use ICT for problem solving. However, as many as 315 (62%) teachers use a variety of commercial games packages that cover wider aspects of the curriculum.

Reporting on the success of the introduction of calculators in teaching and learning mathematics, 9% of teachers said that the use of calculators was very successful, 30% said it was successful, 29% reported moderate success and 6% said the intro-

duction of the use of calculators was not successful. A total of 92 teachers said that

Equipment desired by teachers	Number of teachers desiring equipment
Measuring apparatus	79
Sorting and counting materials	48
Teaching and learning number	36
ICT hardware or software	70
Measure (time)	55
Shape and space materials	13
Fraction/decimal/ percentage materials	24
Maths games	22
All types of resources	61

they use calculators for number operations, 86 use them for estimation and 45 use them for money, percentages and place value. Some 32 respondents reported using calculators for checking answers, while another 38 use them for maths games. Only 15 respondents use calculators for exploring patterns and sequences, while six make use of them for problem solving and three teachers use calculators for supporting weaker pupils. Most of the take-up on the use of calculators was reported in fifth and sixth class. However, even in these classes, only 50% of respondents use calculators often or very often.

Materials and Equipment

Respondents reported that Shape and Space was the strand of the curriculum best supported by concrete materials. The majority (79%) of teachers had some form of suitable materials available, although only 15% had access to large geometric equipment. Early Mathematical Activities and Number were also fairly well supported by available concrete materials. A variety of equipment was cited by teachers as outlined in the following table:

Table 6: Materials used by teachers

Algebra and Data were poorly represented in the survey with little or no equipment cited to support these strands.

Teachers were asked what types of maths materials they would like in their classrooms. Additional equipment desired by teachers is outlined in the following table.

Types of Questioning	Very Often	Often	Sometimes	Never
Discussion/ Higher order	37%	47%	15%	1%
Drills/Fast paced review	26%	44%	24%	6%
Recitation/Activity	25%	46%	25%	4%

Seeking Assistance	Very Often	Often	Sometimes	Never
From peers	15%	44%	37%	2%
From teachers	63%	35%	3%	0%
From home	9%	38%	41%	4%

Table 7: Equipment desired by teachers

Indicators for Success	Indicators of Limited Progress	The challenges faced by teachers in using maths materials in the classroom were predominantly organi-
Intelligence	innate ability	
Innate ability	intelligence	
Pupil effort	pupil attitude	
Pupil attitude	pupil effort	
Teaching methodologies	pupil self-esteem	
Pupil self-esteem	teaching methodologies	
Pupil behaviour	pupil behaviour	
Resources	parental attitude	
Parental attitude	parental involvement	
Parental involvement	resources	
Social class	social class	
Gender	gender	

sational. A total of 176 teachers reported problems with storage, maintenance and retention of materials; 152 stated that large classes, supervision, explanation, suitability and divergence of abilities were problematic in using equipment and 58 teachers cited lack of resources and lack of space as detrimental to the use of materials.

Classroom Interaction

Regarding the percentage of classroom interaction that is pupil led, 45% reported that less than 25% of classroom interaction was pupil led, 36% said that such interaction ranged between 26% - 50% and only 15% stated that pupil led interaction was greater than 50%. Almost identical results were recorded for the percentage of questioning initiated by pupils – 54% reported that less than 25% of questioning was pupil led, 32% reported that between 26% and 50% of questioning was pupil led, and only 11% stated that pupil questioning was greater than 50%. Only 2% of respondents stated that children were not encouraged to ask questions related to maths topics, while 98% stated that they were. Regarding frequency, 41% were encouraged to ask questions very often, 42% were often encouraged and 15% were sometimes encouraged.

Respondents were asked about the frequency of three types of teacher questioning in the classroom. Their responses are outlined in Table 8 below. It is clear from the table that teachers are slightly more likely to use discussion and higher order questions.

Table 8: The frequency of types of teacher questioning in the classroom

Assistance

Respondents were asked from where did their pupils seek assistance in mathematics. It is evident from the table below that pupils were most likely to seek assistance from their teacher.

Table 9: Teacher opinion as to where pupils seek assistance in mathematics

Challenges Posed	Number of Respondents
Measures	47
Algebra	41
Decimals	22
Time	17
Number	9
Fractions	7
Shape and Space	7
Place Value	6
Estimation	5
Patterns	5
Probability	4
Subtraction	4
Problem Solving	3
Tables	3
Language	1

Indicators for Successful Learning in Mathematics

Teachers were asked to rank twelve indicators for successful learning in mathematics. Respondents then placed the same indicators in order of significance in relation to making limited progress in mathematics. The results are outlined in Table 10 next page. It should be noted that the rankings reflect similar opinions between indicators for success or failure. However, while their opinions show a clear pattern, there was relatively little difference overall in teachers' preferences between the highest and lowest ranked indicators. A handful of opinions separate each indicator in the ranking tables, although there was a clearer gap between the top and bottom of each table.

Table 10: Indicators for successful learning and for limited progress in Maths

Teachers' opinions on reasons for constant failure at maths by some children were elicited. Two fifths (40%) of respondents blamed failure on lack of interest, lack of attention and lack of effort; 18% felt it was due to lack of ability and poor intelligence.

Teacher observation	98%
Teacher designed tests	90%
Standardised tests	81%
Diagnostic tests	30%
Portfolios	15%
Curriculum profiles	12%

Another 14% of teachers considered poor early learning experiences due to lack of concrete materials and too little oral work had failed to lay a good foundation. A small minority (4%) put it down to curriculum overload or to lack of parental support (37%). Only 3% of teachers blamed a lack of self-esteem for constant failure, while large classes and lack of individual attention were blamed by 4% of respondents.

Junior/Senior Infants	1st/2nd class	3rd/4th class	5th/6th class	Multiclass
43%	88%	90%	95%	90%

Relating to the ability of children, two-thirds of teachers expressed the view that catering to the average was most important in teaching mathematics. Almost one-quarter felt that devoting time to low ability children was most pressing, while only one in twenty considered providing for high ability children as paramount. Responses to the query on which of these three groups consume most time during maths lessons, elicited almost identical results.

Problem Solving

A large majority of teachers (83%) reported that they present many methods to children for the solving of problems. Only 14% of teachers concentrate on using only one method for problem solving. A resounding 93% of teachers responded that children are encouraged to develop their own methods of problem solving and 92% reported that they encourage pupils to think creatively and that children were encouraged to provide reasons for their conclusions. The largest majority (96%) encourage the children to use mathematics in everyday life.

CURRICULUM AND ASSESSMENT

Curricular Changes

Teachers were asked what aspects of the new strands of the mathematics curriculum posed particular challenges for them. A small number reported the following problems as outlined in Table 11 below.

Table 11: The challenges posed to teachers by the revised curriculum.

However, 56 teachers stated that it was too early to assess the impact of the revised curriculum in the classroom to date. Three fifths (61%) of the teachers who responded were happy with content changes in the mathematics curriculum. They welcomed the emphasis on problem solving and relevance to everyday life, as well as the opportunity to revitalise their approaches and methodologies. Though, 17% felt there was little if any real change in content, a significant minority of respondents, 9%, expressed the view that changes were detrimental to the curriculum, citing poor texts in maths and a possible lowering of standards.

Assessment

Teachers were asked what forms of assessment they used in mathematics. Their responses are outlined in Table 12 below.

Table 12: The forms of assessment used by teachers in mathematics

When analysed by class level, it emerges that over 90% of teachers use standardised tests in senior classes, as evident in Table 13 below.

Table 13: Use of Standardised Tests

Two thirds of teachers expressed satisfaction with the assessment resources and materials available to them. The other third were not satisfied. When asked what influence assessment had on their teaching of mathematics, 45% of teachers replied that it helped them to plan for their pupils' progress through the maths curriculum. Another 17% of teachers found that it is a useful diagnostic tool and 9% felt it gave an indicator for reinforcement and revision. A small percentage (4%) of teachers have responded to assessment by teaching pupils how to tackle tests. In relation to standardised tests, 16% of respondents find them useful diagnostically, 21% find them useful in comparing results with their own assessments and with a national average. Only 10% do not find them helpful and 16% of respondents are critical of the wording and out of date nature of standardised tests.

Planning

Over a quarter (28%) of respondents reported that their schools had completed their planning in mathematics. Two thirds (68%) stated that planning was ongoing, while only 2% had not yet begun. Seventy-eight teachers would welcome the sharing of ideas and innovations and 11 cited the need for more collaborative planning. Thirty-four respondents wanted more PCSP support, while 31 felt they would benefit from inservice courses. Thirty teachers would particularly appreciate increased access to learning support.

More than two-fifths of respondents (43%) reported a significant build up of resources to implement the mathematics curriculum, more than half (55%) said that the build up was in progress, and only 2% had not begun the process. 56 teachers felt that increased access to mathematical resources and concrete materials would be the greatest support in developing their teaching of mathematics.

Teacher Concerns

Teachers expressed many concerns in relation to teaching mathematics. Seventy-two respondents were concerned with the progress of children of both low and high ability through the maths curriculum and the provision of adequate learning support for those in need. Sixty-three respondents felt worried that children would not learn concepts or be able to develop abstractions of their previous work with concrete materials. Sixty-nine teachers felt constrained by a lack of concrete materials and other resources. Sixty-two respondents were concerned that pupils would have positive attitudes and develop confidence in their mathematical ability. Forty-six teachers expressed a concern that numeracy would not be neglected in the face of new emphases. Seventeen respondents had a difficulty with textbooks, especially the lack of texts in Irish. A smaller number expressed concerns with the following areas: mathematical language (8), continuity between schools or classes (10), discipline (8), class size (12), lack of time (9) and curriculum overload (9).

Curriculum Continuity

Continuity of curriculum between primary and post-primary school was an issue for 40 of the responding teachers. Thirty-eight felt that communication or the lack of it was a problem, while 36 felt primary assessments were ignored. Forty-three saw the awareness by second level teachers of the primary curriculum as being paramount. Eighteen teachers worried about levels of learning support at second level and 13 worried about the lack of concrete materials for low ability pupils. Fifty-eight teachers saw problem solving skills as the single most important ability that needed to be acquired before transfer to post-primary.

Referring to issues concerned with pupil transfer within the primary school, teachers cited progress reports (50), curriculum continuity (37), good school planning (39) and the need to develop similar methodologies (69) as being the major prerequisites to success. In addition, 138 placed great emphasis on revision, while 16 highlighted the importance of individual needs.

DISCUSSION

Introduction

Responses to the present survey reflect the opinions of a broad cross-section of the teaching cohort across all class groups, single and multi-class, advantaged and disadvantaged, urban and rural. The vast majority of teachers are embracing the philosophy of the revised curriculum, although it is a little early to assess implementation. There were some reservations expressed and these are highlighted below. In general,

teachers seem happy with the way mathematics is progressing but give pointers as to how the situation could be improved.

Learning Support

The only disturbing factor uncovered in the first section of the survey relates to the level of learning support provided for mathematics. Less than 60% of those polled have access to mathematical learning support in their schools, yet almost half felt they had up to four pupils in need of support and almost a third felt they had up to eight such needy pupils. The amount of time allocated to mathematics for those children receiving learning support is very little compared to language support. Access to learning support in mathematics for all those children who require it must be made a priority in any programme for special needs provision.

Teaching and Learning Mathematics

The survey has ascertained that estimation and problem solving are regularly used by three-quarters of teachers and that mental arithmetic and memorisation of facts is used by even more. This appears to show that teachers are embracing the new order without the abandonment of the old! Both discussion and oral computation are highly used in classrooms, as well as active and co-operative learning. This indicates a commitment to constructivism as envisaged in the revised curriculum. However, the poor use of the environment is a cause for concern. Reasons for only one quarter of teachers using the environment are unclear from the survey, although informal discussion has indicated that safety issues may be a major contributory factor. In organising the maths classroom, teachers make much use of individual work and whole class presentation. Teachers also use pair work and group work but less often. A great emphasis is placed on homework

There is still a large dependence on texts and workbooks, with most schools using one text series throughout the school. About half of the respondents use workbooks and many also use additional texts.

There has not been a huge take up in the use of calculators and computers, although most teachers use ICT on a limited basis. It is perhaps too early to expect the introduction of calculators to have made an impact in schools. However, it is a little disappointing to see computers so little used for specific areas of the mathematics curriculum.

While some schools have made a good start in the collection of mathematical materials, it is obvious that teachers are not yet satisfied with the amount of resource materials available to them. There is a large wish list of equipment desired by teachers to implement the revised curriculum. It is acknowledged, however, that equipment

brings problems of storage, maintenance and organisation.

Classroom Interaction

Interaction in the classroom that is led by pupils is comparatively high as is the amount of questioning initiated by pupils. Children are actively encouraged to raise queries and teachers use a lot of discussion and higher order questioning. Over 60% of children seek assistance from their teacher and respondents felt that there was little reluctance to seek such assistance. However, a substantial number also seek assistance from peers or home.

When asked to rate indicators to successful learning in mathematics, the highest indicators to success in the eyes of teachers were in the hands of the pupils themselves – their abilities, their efforts and their attitudes. Respondents placed teaching methodologies at number five and resources at number eight. The perceived indicators in relation to making only limited progress in mathematics were almost identical. Likewise the lowest considered indicators – social class and gender – were the same in both sets of ratings. These indicators were reiterated in the reasons given by teachers for constant failure, although a minority blamed such failure on poor early learning experiences in maths.

Two-thirds of teachers considered that catering to the average pupil was most important in their teaching and this was reflected in the amount of time given to this group of children. The majority of the remaining respondents give their greatest attention to pupils of below average ability. Little time is given to high achievers.

In relation to one of the newer emphases of the revised curriculum, teachers seem to have taken on board an enlightened approach to problem solving. Pupils are encouraged to develop their own solutions and teachers strive to present many methods for solving problems. They are also encouraged to define their reasoning and to use mathematics in everyday life. This is a welcome development and shows a commitment to the aspirations of the revised maths curriculum.

Curricular Changes

Over 60% were happy with content changes, especially in the areas of problem solving and the emphasis on relevance to everyday life. While it may well be a little early to assess the impact of the revised mathematics curriculum, remarkably few teachers reported difficulties with the new strands. Algebra, because of its abstractions, and measures, mainly in terms of large classes and insufficient resources, were the greatest concerns. Other problematic areas that were highlighted were only done so by an insignificant number of respondents.

Assessment

It is significant to see that almost all respondents use teacher observation as part of their assessment procedures. A large majority (90%) also use teacher designed tests, while more than 80% use standardised tests, though this rises to over 90% in senior classes. This shows an increase in the use of assessment procedures from previous surveys and shows that almost all schools are developing their assessment plans and putting them into operation. Just under one third (30%) use diagnostic tests, usually for the identification of learning difficulties. It is important that having identified pupils with difficulties that such pupils would then have access to the learning support that they require.

While two-thirds of teachers are satisfied with assessment resources, it is significant that one-third are not. Concerns of teachers need to be addressed, especially in the provision of up-to-date and reliable tests and education in their administration and interpretation.

The greatest influence assessment had on teachers was that assessment was seen as a resource to help them plan their maths programmes. Standardised tests were said to be most useful in providing a baseline for how pupils are progressing. However, there was criticism of the fact that tests based on the revised curriculum have not been standardised and made available to date.

School Planning

Just over a quarter of schools have prepared a school plan in mathematics and over two-thirds are in the process. This means that only a small minority of schools have yet to begin their planning for mathematics. Similarly, more than two-fifths of schools have built up a significant resource of mathematics equipment and well over half of schools are proceeding towards their goal. These two facts alone point to a highly successful introduction for the revised mathematics curriculum. Many teachers felt that access to resources and materials would be their greatest support for implementation. Other teachers would welcome the collaboration with colleagues to share ideas, learn of innovations, develop plans and observe best practice.

Concerns

While a large number of concerns were raised in relation to teaching mathematics, they were only alluded to by a small number of respondents. The greatest concerns related to learning support, an issue that appeared, again and again, throughout the survey and the development of confidence and positive attitudes to mathematics. It can be assumed that the lack of concern shown by the vast majority of respondents shows a general satisfaction with the revised maths curriculum. This assumption is

borne out by other sections of the survey.

Teachers in senior classes continue to find issues related to the transfer of pupils to post-primary schools. Lack of communication with second level teachers, lack of awareness of the primary curriculum by second level teachers and lack of continuity between the two curricula were seen as the major concerns.

Transfer within primary school itself raises some issues, although for relatively few respondents. These issues mainly relate to better planning and progress reporting. Again it must be assumed that the lack of concern expressed by most respondents indicates a general satisfaction with the ongoing state of affairs in the schools.

CONCLUSIONS AND RECOMMENDATIONS

The level of concerns in relation to learning support in mathematics and the still relatively low provision of that support must be addressed, if mathematics is not to remain the poor relation of the basic skills.

The take up of ICT in mathematics is disappointing and reflects the poor support in training and resources given by DES to date. There has been a dearth of initial training for teachers which has only been filled by individuals. ICT training needs to be universal and skills updating needs to be introduced on an ongoing basis. There also needs to be constant updating of hardware and software and access to adequate technical support.

There is still a need for in-service for teachers in mathematics teaching and learning, as well as a forum for the exchange of ideas and best practice.

While there has been a marked improvement in the provision of teaching materials, there is still some way to go. The excellent start teachers have made to the revised curriculum must not be allowed to falter from a lack of resources. An annual grant for the maintenance and replacement of maths equipment should be available to all schools.

Teachers appear to have embraced the revised curriculum for the most part, albeit with some constraints and considerations. An enthusiasm for a change is evidently there to be built on. It would be unfortunate if that enthusiasm were diminished by not addressing teachers' needs and requirements.

There is still a large emphasis on textbooks but when the maths curriculum is embedded in the primary school system this dependence may well decrease substantially.

The information on pupil interaction in the classroom indicates a swing towards constructivist teaching as envisaged in the revised curriculum. This is particularly visible in approaches to problem solving.

The low emphasis placed by teachers on their teaching methodologies as indicators of success and failure appears to be at odds with their acceptance of constructivist views.

The use of teacher designed and standardised tests is almost universal. There is a pressing need for the most up-to-date and constantly revised standardised tests based on the revised curriculum to be readily available for primary schools.

The development of planning in mathematics is very encouraging. It is vital that all schools complete the process in the near future.

There remains some disquiet and problems over transfer of pupils to post-primary schools. These need to be addressed as a matter of urgency while the revised curriculum is in its infancy.

Overall the teaching cohort is happy with the revised curriculum and teachers are

doing their best to implement it. They must be given the support and resources to continue that development so that the standard of mathematics learning can be raised to new heights and successes.

3

Report from the Maths Discussion Groups at INTO Education Conference 2004

QUESTION 1:

INDICATORS OF SUCCESS/FAILURE IN LEARNING MATHEMATICS

Many indicators of mathematics success/failure were suggested during this discussion. The following indicators for success were among those that emerged:

- 1 Receptivity to the subject.
- 1 Enjoyment of maths.
- 1 Accuracy in estimating and ability to solve problems.
- 1 Understanding and ability to master concepts.
- 1 Positive attitude.
- 1 Confidence in performance.

From this discussion, delegates went on to debate the factors that contribute to success in mathematics. These included:

- 1 Teacher and teaching styles.
- 1 Good teaching methodologies.
- 1 Teachers being aware of children's learning styles.
- 1 Ability.
- 1 Effective and differentiated group work and close monitoring.
- 1 Reward given for use of correct method – answer not sole important factor.
- 1 Language that accompanies free play extremely beneficial to early childhood mathematical concepts.
- 1 Attitude of parents.

The discussion then moved on to focus on failure in learning mathematics, which included a discussion on some of the indicators outlined below:

- 1 Fear of failure.
- 1 Inability to transfer maths concepts learned to everyday life.
- 1 Forgetting the concepts.
- 1 Having a poor knowledge of number facts.
- 1 Frustration.
- 1 Constant struggle and dislike of subject.

It was agreed that there were many factors that influence mathematical failure, chief among which were:

- 1 Lack of parental involvement and knowledge of the language of maths.
- 1 Language deficit especially in children from disadvantaged homes.
- 1 Emphasis on 'getting it right'.
- 1 Textbooks geared to good readers.
- 1 Over reliance on textbooks.
- 1 Lack of suitable tests.
- 1 Teachers not willing to embrace new methodologies.
- 1 Too much concentration on number.
- 1 Attitude of both teachers and pupils.

It was generally agreed that success indicators would vary depending on the individual child. A child who is weak at maths can succeed at a level which would be regarded as below the norm for a brighter child. It was considered important to have consistent approaches and methodologies throughout the school regarding maths teaching.

QUESTION 2:

SOME TEACHERS HAVE CRITICIZED THE REVISED CURRICULUM IN MATHEMATICS AS BEING TOO FOCUSED ON NUMBER AND AS NOT BEING CHALLENGING ENOUGH TO ALL PUPILS. IS THIS THE CASE? -

Delegates agreed that the Revised Curriculum for maths was very positive as it allowed the teachers to mediate the approach to maths teaching according to the level of the children. However, one group felt that it was not challenging enough for bright children at the upper end of the scale whose special needs were not being catered for. One group felt that more learning support in maths was urgently needed to allow the classroom teacher extend and challenge the more gifted children in the class. One group disagreed that the curriculum was too focused on number. They felt it focused on other areas – some to too great an extent, eg, geometry. They welcomed the focus on estimation, which, they felt gave a better sense of number. Another group agreed that the curriculum is very focused on number but felt that this was a good thing. They expressed the view that number underpins all areas of maths and that the focus could not be too much.

QUESTION 3:

TO WHAT EXTENT HAVE TEACHERS EMBRACED THE USE OF CONCRETE MATERIALS IN ALL CLASSES?

Concrete materials were viewed as an essential tool in the development of abstract thought particularly in today's world where children do not have opportunities available to previous generations eg, going to the shop on their own. They are being widely used in the junior end of primary schools but not so much in the senior classes. There was a call for more suitable and age-appropriate materials to be made available in senior classes. Not all teachers recognise that mathematics is part of everyday existence and should be taught using the environment and concrete materials at all ages. It was suggested that the idea that maths could be fun needed to be investigated through maths games. However, there was also a view that maths was an abstract subject and that therefore, teachers should not become over reliant on concrete materials – including pen and paper. While teachers urged widespread use of concrete materials it was thought necessary to make the vital connection between the concrete and the symbolic. One group had problems with time management in relation to distributing/collecting and storage of materials. Another group reported that large classes were one of the major inhibitors to maths learning. They claimed that it was impossible to use maths equipment satisfactorily when teaching classes of up to 30 or more children. There was a strong view that class size matters. There was some disagreement in one group with regard to multi-classes. Some members were of the opinion that multi-grade classes militate against the use of concrete materials whereas one teacher claimed that they work well in multi-grade classes. One group felt that sharing materials among classes was not appropriate.

QUESTION 4:

MATHS IS A SCIENCE, THEREFORE, TRIAL AND ERROR SHOULD BE CENTRAL TO THE PROCESS OF MATHS LEARNING. HOW, THEN, CAN WE SEPARATE GETTING THE ANSWER WRONG FROM AN ASSOCIATION OF FAILURE IN MATHS?

Delegates were of the view that maths should be a partnership where pupils become aware that others also have problems and fears in relation to the subject. There was agreement that the concept of the 'wrong answer' must go and that the emphasis should be on understanding, on the process rather than the product and on creating efficient learners. It was thought that there should be much more emphasis on estimation at all levels and the idea that it was okay to make a guess and test the result needed to be reinforced. Children need to be encouraged and made to realize that the answer was not the sole important factor. Number, especially in the early years, had been regarded as what maths was all about but had to be seen as much broader. Another view put forward was that reward should be given for use of the correct method and that how children's maths was corrected needed to be re-examined – posi-

tively mark what is good. In one group the most important aspect was felt to be the development of a logical thought process. Children needed to be encouraged to ask questions that advance them. To combat the feeling of failure, it was suggested that more time should be spent playing maths games to allow maths concepts and language to be developed – leading to more enjoyment. Delegates thought that maths could and should be fun and suggested that as Book Fairs were held regularly in schools, why not Maths Fairs?

QUESTION 5 :

TO WHAT EXTENT SHOULD TEACHERS RELY ON THE USE OF TEXTBOOKS IN THE TEACHING OF MATHEMATICS?

In one group it was unanimously agreed that teachers should not be relying on textbooks in a maths class. However, there was general agreement that classroom situations often dictate otherwise. In multi-grade class situations textbooks were considered vital and in large class sizes teachers needed to work with textbooks. Where children needed to advance to a level of understanding using abstract thought processes, then it was thought that textbooks were invaluable, particularly in preparing pupils for transfer to second level. One group stated that changes needed to take place within textbooks in order for them to be more user friendly. The recommended changes include:

- 1 Less written work to be more inclusive of weaker children.
- 1 Less emphasis on number.
- 1 More fun elements.
- 1 More opportunities for constructivist approaches.
- 1 More emphasis on estimation.

Some teachers urged that maths textbooks should not be used at all as they were thought to be too restrictive. Workbooks could be encouraged but the revised curriculum should be the guide for teachers. One teacher tried to go without using a textbook for a year and she reported finding it very difficult. Some teachers expressed the opinion that textbooks were a crutch for “traditional teachers”, others felt that parents lead the drive for textbooks. Completion of a book could be seen as a sign of good teaching. It was thought that schools needed to resist pressure for texts and should seek to re-educate parents in this area. It was also noted that the development of mathematical language was vital before pupils use textbooks.

QUESTION 6 :

HOW ARE SCHOOLS PROVIDING FOR LEARNING SUPPORT IN MATHEMATICS? IS THERE ROOM FOR IMPROVEMENT?

Delegates felt that very limited provision was being made at present for learning

support in maths as the learning support guidelines give priority to language and literacy. In relation to shared learning support teachers, it was considered very difficult to have any continuity, something that was vital for children with maths difficulties, when those same children were only seen by a learning support teacher twice weekly. There was a strong call for extra, separately appointed, numeracy support teachers. It was pointed out that there were many children in schools requiring support who were not receiving it, and that early intervention was vital. The timing of this support also caused concern, as pupils could miss other subject areas. Some teachers stated that much could be done in the classroom with the help of the learning support/resource teachers or indeed with outside helpers. Many teachers thought that the Maths Recovery Programme was a great idea and should be actively supported. Use of equipment was cited as a great help in maths and it was also seen as bringing more enjoyment to maths learning. It was felt that a greater emphasis needed to be placed on the enjoyment of maths and much work needed to be done on inservice for teachers in maths – particularly in the area of maths games and fun maths. Resources were not there from the DES to put learning support in place for maths. One group indicated that schools would supply the support if the resources were in place. It was thought that much of the difficulty with standard maths tests was that they were literacy-based – tests were too text-based. The difficulties experienced in getting good diagnostic tests was frustrating for teachers, and in some cases Sigma Ts were being used as diagnostic tools. There was a consensus that there was a great need for improvement.

QUESTION 7:

TO WHAT EXTENT AND FOR WHAT PURPOSE ARE (A) CONCRETE MATERIALS (B) ICT AND (C) CALCULATORS USED IN THE TEACHING OF MATHEMATICS?

- (a) Concrete materials were considered very important. The expense and scant availability of materials in relation to maths frustrated teachers. A strong call was made for concerted professional development for teachers in relation to the effective use of a wide range of concrete materials from Infants right through to sixth class. Teachers needed to be guided through programmes.
- (b) Teachers did not trust ICT enough to include it into their teaching styles to a large degree. There is a great need for ICT maths programmes for Infants to sixth class.
- (c) There was a consensus that teachers needed to move away from the traditional way of teaching maths and that children should be taught how to use calculators. In one group the majority of teachers thought that it was essential that first and second class children should be allowed play with calculators. They felt that children should have fully grasped the concept in question before using calculators seriously. If they get the answer using calculators they must be encouraged to make stories using the numbers involved. Weaker children need help manipulat-

ing and using calculators. One group, while acknowledging that they were necessary tools, claimed that they should be used only to teach children their use. In another group the consensus was that children must continue to learn tables. Memorising was considered training in itself. It was thought that children had difficulties with memorisation because of lack of practice and that they would not have difficulties if they were 'built' properly – tables should not be a failure experience and by the end of primary school children should have a good concept of tables.

QUESTION 8:

TO WHAT EXTENT ARE TEACHING APPROACHES SUCH AS:

- (A) SHARED/PAIRED MATHS
- (B) MATHS RECOVERY AND
- (C) REGROUPING USED IN CLASSROOMS?

ARE THERE OTHER APPROACHES TO MATHS TEACHING THAT ARE USED BY TEACHERS?

Some teachers were involved in Paired Maths and thought it was a very good idea but felt that it required the teacher to be very organized in the checking and storing of equipment. Some teachers involved parents in Shared Maths in the classroom. One delegate raised a point about homework and its usefulness and stated that parents do not always understand what the child was being asked to do. It was thought that programmes such as 'Maths for Fun', which is structured over a five-six week period helped to bring parents (or grandparents) up to speed with the maths programme and how they can help at home. It was felt this reinforcement had shown spectacular improvement in the work of low achievers. In another group it was noted that only one teacher had heard of the Maths Recovery Programme. During a discussion on learning support one group reported that many teachers thought that the Maths Recovery Programme was a great idea and should be actively supported. Regrouping based on ability was being implemented in some classes. In one school the Principal (who was an administrative principal), the learning support teacher and the class teachers were involved in the regrouped classes.

QUESTION 9:

HOW BEST CAN ASSESSMENT BE USED TO IMPROVE CHILDREN'S LEARNING IN MATHEMATICS?

Most comments on assessment related to standardized testing. There was no mention of formative assessment apart from the comment that assessment in maths needed to be ongoing in order for the teacher to employ new strategies to help the less able child. One group felt that the Sigma T was demoralizing and inappropriate for many pupils. It was thought that assessment should be appropriate to the level of the pupils. It was

agreed that there was a need for a new type of maths assessment, which would measure a child's grasp of mathematical concepts and abilities. Maths was an everyday life skill but not always taught or assessed accordingly. Another group claimed that new improved assessment tests that could show that a child has potential and that could indicate a child's learning style were needed. In yet another group it was stated that teachers felt that assessments were a waste of time as they elicited no Departmental response in terms of providing additional support for pupils who were identified as requiring same. They were seen as useful for diagnostic purposes and for the teacher's own information.

Other points raised during group discussions:

TRANSITION BETWEEN PRIMARY AND SECONDARY SCHOOL

There was general agreement that there was a need for more continuity between primary and second level. Some fifth/sixth class pupils still have to prepare for entrance exams. It was argued that the primary approach was holistic while the approach at second level was exam-driven. It was felt that there was no link between the curriculum in sixth class primary and that of post primary although it was explained that fifth/sixth class maths programme was similar to the Junior Certificate maths programme (ordinary level). A representative from the post primary sector advised primary teachers to teach to the integrity of the primary school curriculum and not to distort because of pressure of entrance exams. Many students were intimidated out of higher level maths at second level because of elitist assumptions in relation to higher level maths.

TIME ALLOCATION

There was general concern about the amount of time required for maths in the context of all the other subjects in the primary school. This was a particular issue for small schools with multi-grade and large classes. Concern was expressed in relation to the shortening of the allocated time for maths in the Revised Curriculum and it was thought that this could lead to a dilution of standards.

TEACHER EDUCATION

Concern was raised regarding the standard of mathematical ability in student teachers. High points in the Leaving Certificate were not necessarily an indicator of maths ability. In addition, it was thought that the constructivist approach posed challenges for classroom management. It was noted that mental maths was very beneficial for children and that teachers needed to 'talk' maths more and do more visualizing with the subject. It was also suggested that there should be a national move to standardize

terminology, eg, 'units' or 'ones', 'away' or 'minus'.

EQUALITY

Children do not start from the same base. Many children have no pre-school experience with Lego, jigsaws puzzles or other such materials and were therefore, disadvantaged before they even begun. There was general agreement that children should be taken from where they were at on the learning continuum and their concept of development facilitated. Children with high levels of absenteeism, including travellers and non-nationals students were more likely to have gaps in their knowledge due to the lack of continuity in maths.

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Appendix I

SHARED MATHS/MATHS FOR FUN ACTIVITIES

Tangrams

- 1 Infants – sixth class.
- 1 Graded.
- 1 One set per pupil in group.
- 1 Develops spatial awareness, concepts of shape and area, visualising skills, problem-solving skills.

Relational Attribute Blocks

- 1 Size: large, small.
- 1 Colour: red, yellow, blue.
- 1 Shape: triangle, circle, square, rectangle, hexagon.
- 1 Thickness: thick, thin.
- 1 First upwards.
- 1 One set shared between two.
- 1 Development of oral maths vocabulary/logical thinking/problem-solving skills through listening, relating, identifying, matching, classifying, comparing, contrasting, sequencing.
- 1 A lot of concentration required.

Pattern Blocks

- 1 Shape: triangle, square, hexagon, trapezium, parallelogram, rhombus.
- 1 Infants – sixth class.
- 1 One set shared between two.
- 1 Use pattern blocks to make pictures.
- 1 Estimate number of blocks needed.
- 1 Transfer or reconstruct design on blank page.

Pentominoes

- 1 Develop full concept of shape: flat surfaces, faces, edges, shape of object – remains constant even though its location or position may change.
- 1 Identify the motions SLIDE, FLIP, TURN.
- 1 Develop spatial awareness, concept of tessellation, problem-solving skills involving visualising, combining and manipulation of shapes.
- 1 Line/rotational symmetry, perimeter, area.

Bingo

- 1 Infants – sixth class.
- 1 Individual Bingo cards and counters.
- 1 Develops mental computational skills.
- 1 Flash cards based on:
 - Addition/subtraction Senior Infants – second class.
 - Addition/subtraction/multiplication/division third – fourth class.
 - Fractions/decimals/percentages fifth – sixth class.

Bank Balance

- 1 Group board game with parent/teacher as ‘Banker’.
- 1 Dice and large counters.
- 1 Enables children to perform basic addition and subtraction leading to more complex calculations as they accumulate their answers.
- 1 Multiplication and division (senior classes).

Snakes And Ladders

- 1 Using large board and one or two dice – especially good for first/second classes.

Dienes Blocks: My Computer

- 1 Th.H.T.U.
- 1 Place value and regrouping.
- 1 Laminated sheets – A3 – one shared between two.
- 1 Large dice and a box for the person (‘Cashier’) changing the blocks from Units to Tens, Hundreds and Thousands and back again.

