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KASSEL Project

An international comparative project in
the teaching and learning of mathematics

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An international comparative project in the
teaching and learning of mathematics

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The KASSEL project is an example of collaborative effort which reflects the conference theme "Educational research: Building new partnerships". The project began in September 1993 in England, Scotland and Germany. It was originally designed to compare the mathematical progress made by secondary school pupils in England, Scotland and Germany and consequently to determine the factors that give rise to enhanced progress and make recommendations for good practice in mathematics teaching and learning in the United Kingdom.

Over the years, the project has grown and at present 18 countries (Australia, Brazil, Czech Republic, England, Finland, Germany, Greece, Holland, Hong Kong, Hungary, Japan, Malaysia, Norway, Poland, Scotland, Singapore, Thailand and Florida State (USA)) are participating in it. The main aim of the KASSEL project is now to carry out research into the teaching and learning of Mathematics in different countries, and ultimately to make recommendations about good practice in helping pupils achieve their mathematical potential.

As well as achieving the main aim, it is hoped that this project will provide relevant data for

- .the comparison of the progress in a variety of mathematical topics;
- .the comparison of mathematics curricula in participating countries;
- .the comparison of correlation of the ability to solve problems in context and apply mathematical concepts to real situations, with mathematical attainment;

- .the evaluation of the effectiveness of different approaches to teaching;
- .the use of calculators, computers and other resources;
- .the evaluation of self-based schemes of work compared with traditional teacher-led methods;
- .effect of setting/streaming;
- .the comparison of "expectations" at all levels of ability in different countries;
- .recommendations for a mathematics curriculum for the 21st century.

The paper will share with conference participants

- .the methodology of this research;
- .Singapore's contribution to the project;
- .recommendations for mathematics teaching and learning in the United Kingdom;
- .the MEP Demonstration project in United Kingdom.

Methodology of the KASSEL Project (Burghes & Blum, 1995; Burghes, 1996a)

The methodology of this research is characterised by the use of qualitative and quantitative methods. It is based on regular testing of pupils from age 13+ for a period of 2-3 years, monitoring the progress made by groups of pupils of similar ability, and then investigating further those schools, classes (i.e. teachers) and pupils which show progress much above or below the norm.

At the start of the project, all pupils take a mathematics Potential Test. This is a 40 minute test with 26 questions of increasing difficulty. It is taken only once and aims to assess the pupils' aptitude for mathematics with questions based on mathematical logic and spatial awareness. The test is designed for pupils aged 12-14 years and was trialled extensively in Germany and England before being used in this project.

The pupils then take tests in

- .Number
- .Algebra
- .Shape and Space
- .Handling Data (optional).

These 40 minute tests, each with 50 marks available, are designed to show progress in attainment and are based on the intersection of the English, Scottish and German mathematics curricula for pupils aged 13-16 years. Most questions are relatively short and precise with few

follow-through marks and relatively content-free. Similar tests, with questions either repeated or replaced with equivalent questions, are taken at the beginning of each of the following years of the project.

Testing began in 1993 with pupils aged 13+ in England, Scotland and Germany. Other countries joined one year later, either with pupils aged 13+ (equivalent to Y1 of the project enabling comparison to be made retrospectively) or 14+ (Y2 of the project).

During the first year, relevant information (which will be up-dated each year) has been obtained from the participating schools and teachers by using four kinds of questionnaire.

- (1)School Questionnaire in which we determine school details such as total roll, type, environment, department policies, etc.;
- (2)Teacher Questionnaire in which we ascertain the qualifications and experience of participating teachers;
- (3)Class Questionnaire in which we attempt to find out from the class teachers the style and management of the mathematics taught, including number of hours per year, class size, use of resources including calculators and computers, and teaching approaches;
- (4)Pupil Questionnaire in which we seek the ideas of pupils on their enjoyment of mathematics and the way in which it is taught.

To complete the picture schools are visited to

- (i)observe mathematics teaching, recording the important characteristics of the lesson;
- (ii)interview teachers and pupils individually (usually concentrating on pupils who have made either very good or very poor progress over the year).

We are guided on where those in-depths visits should be made by Performance Indicators, which are calculated for each pupil on progress made over Y1-Y2 and Y2-Y3. This progress is compared with the average progress made by groups of pupils with similar potential and similar

topic test scores at the start of the year. The formula is

1

Here T1 and T2 are the total scores on the three tests (Number, Algebra and Shape and Space) in Year 1 and Year 2, and dT is the average increase for the group of pupils with similar potential and first year attainment.

Singapore's Contribution (Kaur & Yap, 1996a; Kaur & Yap, 1996b)

Singapore joined the KASSEL project in January 1995. The entire cohorts of Secondary two (Special, Express and Normal (Academic)) pupils in 1995 from seven schools spread across the island are participating in the project. In 1995, 26 (9 Male, 17 Female) mathematics teachers and 64 secondary two classes from the seven schools were involved in the project. Approximately 2400 pupils took 4 short mathematics tests (Potential, Number, Algebra and Shape & Space) in January 1995 and 3 short mathematics tests (Number, Algebra, Shape & Space) in October 1995. The tests used in January and October were parallel forms i.e. questions in both the tests were exactly matched.

The data collected in January 1995 using the 4 tests have been analysed and presented in the form of a report "KASSEL Project Report - First Phase (Jan - Oct 95)" which is available at the National Institute of Education's library or from the coordinators. The key findings documented in the report are:

.the distributions of the Potential Test scores are fairly bell-shaped

for the entire sample and for the three streams,
.generally, the performance of the pupils for the three Topic tests are closely related to the actual curriculum coverage of the secondary one syllabus at the time of the testing,
.the mean scores are highest for Number Test and lowest for Shape & Space Test across the three streams,
.generally, items with a very low percentage of correct responses are those involving content which has not been taught to the pupils but there are however a few exceptions which are discussed in the report,
.there is a positive association between the pupil performance on the Potential Test and that on the Topic Tests.

In 1995, data were also gathered using school, class, teacher and pupil questionnaires. The analysis of the data collected in October 1995 using the tests provided information regarding the progress made by the pupils in their first year of participation in the project. Based on the progress made by the pupils in 1995, a sub-sample was drawn from the 2400 pupils for a more in depth study in 1996. During the first half of 1996, 137 pupils were interviewed. Among these pupils were those who made positive, zero or negative progress. Mathematics lessons taught by 21 of the 26 mathematics teachers who taught the pupils during the first year of participation in the project were also observed. The teachers were also interviewed.

Preliminary analysis of the data collected using the teacher and class questionnaires in 1995 and lesson observations during the first half of 1996 suggest some teacher and class characteristics prevalent in the seven participating schools. It is noteworthy that in the seven schools where Year 8 mathematics teachers and classes were observed, it was found that there were more female than male teachers, half the teachers had 5 years or less of teaching mathematics experience and less than two-fifths of the teachers taught only mathematics at school. More than three-fifths of the teachers were university graduates.

In general, the teachers were found to be task oriented and their lessons were highly structured with specific objectives. A majority of the lessons were expository in nature punctuated with appropriate class practice emphasising procedures, answers and accuracy. Teachers have sound knowledge of mathematics and are able to handle their teaching confidently. Teachers are in control of their lessons. They may best be described as firm yet approachable by their pupils.

Average class size was 37 and pupils were either seated in rows facing forward or in pairs facing forward. In class, pupils were orderly, quiet and receptive to the teaching. They seldom raise doubts but were responsive when called upon. Pupils had 5 or 6 periods (a period is of 35 minutes duration) of mathematics per week. At least once a week, pupils were given homework which is marked. Whole class teaching appears to be the main style of teaching. The textbook, writing board and overhead projector were observed to be essential tools. Pupils are formally tested at least twice a year and class tests are held at least once a term (ten weeks) in mathematics. The use of calculators was not found to be rampant in the classes.

In 1996, more data has been collected with the help of the class and teacher questionnaires as the pupils are now in secondary three and most of them are being taught by a different mathematics teacher. Also, as the pupils were streamed at the beginning of 1996 into Science / Art / Commerce streams they are no longer in the same classes. In October 1996 the 2400 secondary pupils took four short mathematics tests (Number, Algebra, Shape & Space and Applying Maths). At present the data are being analysed and in 1997 more reports are expected to be

prepared by the Singapore coordinators of KASSEL Project.

Recommendations for Mathematics Teaching and Learning in the United Kingdom (Burghes, 1996a)

The table below shows the sample progress results of five of the countries participating in the KASSEL project. David Burghes and his team's observations of teaching in these countries (and others such as Hungary which also showed very high attainment in Y1) have led them to make draft recommendations for mathematics teaching and learning in England in order to raise expectations.

Kassel Project : Year 1 - Year 2 Sample Progress Results

	Number		Algebra		Shape & Space		Totals		Progress
	13+	14+	13+	14+	13+	14+	13+	14+	
England	17.6	20.2	11.3	14.4	15.4	19.9	44.3	54.5	10.2
Scotland	18.2	21.6	9.6	13.0	14.1	18.4	41.9	53.0	11.1
Germany	23.5	26.9	12.5	17.6	11.3	17.3	47.3	61.8	14.5
Poland	24.0	29.2	16.6	24.9	13.6	22.4	54.2	76.5	22.3
Singapore	33.4	34.6	23.9	30.7	18.1	26.9	75.4	92.2	16.8

The draft recommendations are:

Mathematics Curriculum

- .Topics to be given a more systematic in-depth treatment, with far less jumping around from topic to topic.
- .Clearly stated schemes of work for each year and differentiated ability ranges.
- .More emphasis on practical numeracy, particularly for pupils who will not be continuing their mathematical studies beyond 16+.
- .More use of relevant applications, both for coursework and for motivation with new topics and concepts.

Mathematics Teaching

- .Emphasis on a clear, precise description of the basic idea or concept being taught, with worked examples and applications where appropriate.
- .Correct, precise, orderly, spoken and written mathematics to be used at all times.
- .Limited and effective use of calculators.
- .Greater emphasis on whole class interactive teaching, with less individualised work during lessons, but a planned combination.
- .Homework to be used as a key component of learning.
- .Individual pupil mistakes to be used as teaching points for the whole class.

Mathematics Assessment

- .Regular testing (including mental tests) linked to schemes of work.
- .Modified tiering arrangements for GCSE, with
 - i) all candidates taking two papers for awards up to and including grade C; and
 - ii) an optional extension paper for award of higher grades.
- .Coursework carefully controlled.
- .Encouragement to enter candidates for GCSE Statistics.

David Burghes and his team in England are not saying that they have 'proved' that the above recommendations will work - only that their

data indicates underachievement and their observations have led them to suggest that these factors might enhance performance.

The MEP Demonstration Project in United Kingdom (Burghes, 1996b)

The draft recommendations made by David Burghes and his team for mathematics teaching and learning in England in order to raise expectations are being implemented through the Mathematics Enhancement

Programme (MEP) demonstration project. This project started in September 1995. Over 90 schools in England and Wales are participating in the project.

In this project the emphasis is on whole class teaching and raising expectations. The resources framework consists of
.pupils' texts
.practice books
.teacher support.

Details of the content of these are as follows:

Pupils' Texts

- .Revision sections
- .Theory clearly highlighted
- .Plenty of worked examples
- .Plenty of questions
- .Answers provided at back of book
- .Exam language used
- .Precise, consistent notation
- .Suitable contexts and practical applications
- .Interesting and motivating for students
- .Attractive design
- .Use of colour

Practice Books

- .Short tasks and starters for homework
- .Homework exercises for consolidation
- .Past exam questions

Teacher Support

- .Ideas/hints for introduction of topics
- .Historical facts and snippets of information
- .Answers to questions in Practice Books
- .Extension material
- .OHPs
- .Ideas for investigations, coursework
- .Hints for use of IT
- .Mental Tests, Written Tests (+ answers)
- .Recording/monitoring material
- .National Curriculum Referencing

Concluding Remarks

To date some of the countries participating in the KASSEL Project have contributed to the MEP Project in the United Kingdom initiated by David Burghes and his team. As the project did not start simultaneously in all the participating countries, there are at present many participating countries which are still collecting the data or analysing it.

Countries participating in the KASSEL Project are encouraged to use data (both national and international) from the project to make

recommendations about good practice in helping pupils achieve their mathematical potential and if need be to embark on further action-oriented research type of projects to enhance the teaching and learning of mathematics in schools.

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