

NEWSLETTER

International Society for the Study of Behavioural Development



1998 Number 1
Serial No. 33

TIMSS—Mathematics and Science Achievement in International Comparison: Goals, Design, and Research Questions

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Human Development

Distribution within North America:
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The educational systems of individual countries are embedded in their respective cultural traditions and have developed over the last decades in different ways. They differ with respect to their school populations and curricula, their school organisation, financing, teaching methods, etc. However, in every country the educational system is entrusted with the task of imparting knowledge, abilities, and values outside the family. This task has to be carried out by schools and through teaching.

Solid training in mathematics and science is regarded by an increasing number of countries as an investment in future technological and economic competitiveness. They observe the level of performance of their school systems with the long-term goal of optimizing educational processes. International comparisons provide opportunities to evaluate one's own educational system.

The Study

The Third International Mathematics and Science Study (TIMSS) continues the series of international comparative school achievement studies which have been carried out by the International Association for the Evaluation of Educational Achievement (IEA) since 1959. The First and Second International Mathematics Studies (FIMS, SIMS) were implemented in respectively 1964 and between 1980 and 1982. International comparisons of science achievement were conducted in the First and Second International Science Studies (FISS, SISS). These studies were carried out respectively 1970/71 and 1983/84. TIMSS, however, investigates for the first time mathematics and science achievement simultaneously in the key grades of elementary school and of the secondary levels I and II. Aside from achievement data, TIMSS also investigated the mathematics and science curricula of all participating countries. With this concept TIMSS is the IEA's most ambitious research project. Table 1 shows all countries that participated in at least one of the cohorts (see below) which were investigated.

Components of TIMSS

TIMSS is comprised of five components, which provide substance and context to the achievement comparison. The *first component* is an international comparative curriculum study, which includes curriculum and textbook analysis, as well

Table 1: List of the Countries Participating in TIMSS

Argentina	Hungary	Philippines
Australia	Iceland	Portugal
Belgium (Fl)	Indonesia	Romania
Belgium (Fr)	Iran, Islamic Republic	Russian Federation
Bulgaria	Ireland	Scotland
Canada	Israel	Singapore
Columbia	Italy	Slovak Republic
Cyprus	Japan	Slovenia
Czech Republic	Korea	South Africa
Denmark	Kuwait	Spain
England	Latvia	Sweden
France	Mexico	Switzerland
Germany	Netherlands	Thailand
Greece	New Zealand	USA
Hong Kong	Norway	

as detailed records of the material actually taught (e.g., Robitaille, McKnight, Schmidt, Britton, Raizen, & Nicol, 1993). The *second component* is an achievement study (see Beaton, Martin, Mullis, Gonzales, Smith, & Kelly, 1996; Beaton, Mullis, Martin, Gonzales, Kelly, & Smith, 1996). The *third component* includes interviews of principals about school organization and culture, as well as surveys of teachers on their lessons and general professional activities. The *fourth component* consists of a series of case studies in which mathematics and science instruction in Germany, Japan, and the United States are investigated in the context of the school, school administration, the home, and youth culture (Stevenson & Nerison-Low, 1997). As the *fifth and final component* the TIMSS Videotape Classroom Study was carried out in Germany, Japan, and the United States. Mathematics lessons in 100 German, 81 American, and 50 Japanese classes of grade 8 were videotaped. Participating classes represented a random subsample of the main TIMSS cohort (Stiegler, Gonzales, Kawanaka, Knoll, & Serrano, 1996).

Examination of Three Age Groups

TIMSS investigates students from three age groups in different phases of their schooling and educational careers. *Population 1* represents the primary school, *Population 2* the secondary level I, and *Population 3* the secondary level II.

Population 1: Students enrolled in grades that contain the largest proportion of 9-year-old students at the time of testing—3rd- and 4th-grade students in most countries (for results see Mullis, Martin, Beaton, Gonzalez, Kelly, & Smith, 1997; Martin, Mullis, Beaton, Gonzales, Smith, & Kelly, 1997).

Population 2: Students enrolled in grades that contained the largest proportion of 13-year-old students at the time of testing—7th- and 8th-grade students in most countries (for results see Beaton, Martin et al., 1996; Beaton, Mullis et al., 1996).

Population 3: Students in their final year of secondary education in either general or vocational full- and part-time schools (for results see Mullis, Martin, Beaton, Gonzalez, Kelly, & Smith, 1998).

Population 3 students specialized to some degree in either mathematics or physics have been identified as two subgroups of particular interest. Achievement comparisons of these students are part of the TIMSS design.

Instruments

The TIMSS achievement tests were prepared according to the principles of modern test construction. The content fit of the test items was empirically tested and inappropriate items were deleted. The curricular validity of the tasks could be confirmed using ratings of experts and teachers. Different response formats were used, that is, multiple-choice and open-ended format. Since the number of items was very large (i.e., about 150 math items and 135 science items in population 2) a multiple matrix sampling approach with unbalanced, incomplete block test booklets was chosen. Subsets of items selected from the total item pool were administered to random subsamples of students (Beaton, 1987; Adams & Gonzales, 1996). In this way, the individual testing time for each student could be limited to an acceptable level and accurate population estimates of achievement levels can be obtained. In order to build a common achievement metric for all students with different test forms, item-response techniques were applied to the data. However, to achieve more reliable indices of student proficiency, so-called plausible values based on multiple imputation techniques were calculated (Wu, Adams, & Macaskill, 1997).

The achievement tests were supplemented with student questionnaires on demographic background variables, motivation, and students' perceptions of the classroom environment.

Teacher questionnaires served to assess opportunities to learn. Here, teachers had to rate for selected math and science items whether or not the item content was part of the realized curriculum in grade 7 or grade 8. Teachers were furthermore asked about their training, professional activities, and instructional strategies. The instrument was completed with a school principals' questionnaire, in which principals recorded the most important background data on the schools under investigation.

Research Questions

Because of its complex design TIMSS can answer several questions regarding international comparisons, as well as questions concerning the status of mathematics and science instruction in national school systems.

Questions arising from an international perspective are (taken from Adams & Gonzales, 1996, pp. 38–43):

- (1) How do countries vary in the intended learning goals for mathematics and science (intended curriculum); and what characteristics of educational systems, schools, and students influence the development of those goals?
- (2) What opportunities are provided for students to learn mathematics and science (implemented curriculum); how do instructional practices in mathematics and science vary among nations; and what factors influence these variations?
- (3) What mathematics and science concepts, processes, and attitudes have students learned (attained curriculum); and what factors are linked to students' opportunity to learn?
- (4) How are the intended, the implemented, and the attended curriculum related with respect to the contexts of education, the arrangements for teaching and learning, and the outcomes of the educational process?

Note. The German part of TIMSS was funded by the German National Ministry of Education. The content of the text above is attributable to the authors and does not necessarily reflect the views of the National Ministry of Education.

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TIMSS-Findings in Sweden

Sweden has participated in two of the populations in TIMSS —population 2, which consists of 13-year-old students, and population 3, consisting of students in their final year of upper secondary education. In the latter population three samples were studied: one sample of students graduating from all tracks/programs in upper secondary school, a second sample of students taking advanced courses in mathematics, and a third sample of students taking advanced physics. Sweden has met the centrally established requirements for sampling procedure and participation rates in all samples which are part of the study.

Population 2: 13-year-olds

When it comes to the results for the 13-year-old students, in Sweden grades 6 and 7, the international results show that Sweden's result is average. Among the 26 countries in the comparison, Sweden is in the middle, in mathematics as well as science. However, there are variations in achievement for different content categories within mathematics. The Swedish students performed above the international average in the categories Data Representation, Analysis, & Probability, Measurement, and Fractions & Number Sense. Their achievement is below the international average in Algebra and Geometry and equal to the international average in Proportionality. The Swedish students performed higher than the international average in all categories in science except one, the category Environmental Issues and the Nature of Science, which mainly deals with scientific method.

A comparison from a Nordic perspective shows that Swedish students perform better in mathematics than students from the other Nordic countries, that is, Norway, Denmark, and Iceland. In science, the Swedish students on a par with Norwegian students, while Denmark and Iceland show lower results.

As to differences in achievement between Swedish males and females there are, on the whole, small differences in mathematics and large differences in science favoring the males. Items belonging to physics and chemistry are the ones where the differences are the largest.

Some items in TIMSS have also been used in earlier studies (SIMS and SISS) and it was therefore possible to make comparisons on item level for students in grade 7. In both mathematics and science the average result has improved compared with earlier studies. The improvement was somewhat larger in mathematics than in science.

Population 3: Students in their Final Year of Upper Secondary Education

There were three different tests: the mathematics and science literacy test, the advanced mathematics test, and the physics test, and there were therefore three different samples in Sweden. The mathematics and science literacy test was administered to the sample of students graduating from all tracks/programs in upper secondary school (gymnasiet). The advanced mathematics and physics tests were administered to two samples from students in their final year who have a larger number of classes in mathematics and science compared with other students in this population.

Swedish students performed extremely well on the mathematics and science literacy test. In this study 21 countries participated, eight of which satisfied the centrally established guidelines for participation rates and sampling. Together with Switzerland and New Zealand, Sweden has a leading position both in mathematics and science. Significant differences in achievement between males and females, favoring the males, can be found in both mathematics and science.

The results for the students in population 2 (13-year-olds) have been compared with the results for students taking the mathematics and science literacy test for the eight countries that have met the TIMSS requirements for sampling and participation rates. Since the scores in these two populations are not directly comparable, the comparison is based on the ranking of the countries in these two populations. The results show that the Czech Republic, Hungary, and the Russian Federation have a lower ranking in population 3 than in population 2 in both mathematics and science. For Sweden and New Zealand the situation is the opposite, that is, they have a higher ranking in population 3 than in population 2 in both mathematics and science. The remaining countries (Switzerland, Lithuania, and Cyprus) have roughly the same ranking in both populations.

The results from the tests in advanced mathematics show an average performance by the Swedish students compared with the group of countries that have carried out the study in a correct manner. Sixteen countries participated and eleven of these have satisfied all the guidelines for sampling and participation rate. Gender differences favored males. This is true for all participating countries, though not all differences were significant.

In physics the Swedish and Norwegian students have the highest results. In this study 16 countries have participated and eleven of these have satisfied the guidelines for sampling and participation rates. Results for males on the physics test were significantly higher than for females, something which is true for all participating countries. An interesting result is that on more than half of the physics items the Swedish females had a better average result than the average for males in all countries.

Comparisons with previous studies show a marginally improved result for Swedish students on the items that are identical in both studies. The achievement in physics, on the other hand, is much better in TIMSS than in SISS for the items that are included in both tests.

In an attempt to explain student achievement in mathematics and science for students taking the mathematics and science literacy test, as well as achievement for students taking the advanced mathematics and physics tests, it is clear that atti-

tudes toward their own achievement as well as family background are factors of great importance for understanding the achievement.

Concluding Remarks

Swedish students, and particularly students taking the science and mathematics literacy test, achieved a high or even very high result in mathematics and science. The TIMSS results attracted a lot of attention in the public discussions on education in Sweden as they in part were incompatible with the prevalent image of Swedish student achievement in these subjects as it is presented in the media. It is, however, important that further analyses are made and that even more background information is taken into consideration in these analyses. Information concerning curricula and syllabi as well as school systems must also be linked to the obtained test results in various ways.

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Challenges Facing Science and Mathematics Education in South Africa: Results from the Third International Mathematics and Science Study

Background

South Africa is a land of contrasts. Whilst part of the population reside in a first-world lifestyle, the majority of the population still reside in Third World impoverishment. South Africa's 41.5 million people form a multicultural society consisting of four ethnic groups: Indian (1 million people), colored (3.5 million people), white (5.4 million people), and black (31.6 million people) (Central Statistical Services [CSS], 1995). There are 11 dominant languages spoken which have all been declared official languages of the country.* Geographically South Africa is divided into 9 provinces incorporating former provinces and black homelands. Employment is scarce and unemployment figures stand at more than 40% of the economically active population in a number of provinces (CSS, 1995).

South Africa's political history is well-known and the impact on the education system and the disadvantaged youth who have passed through this system is especially devastating. The present education system is an amalgamation of 17 different education departments that were merged in 1995 as a result of the change in government. In total there are more than 32,000 primary and secondary schools of which the majority are comprehensive (offer general education) in nature. In the most recent survey, conducted by the HSRC (1996),** 57% of schools did not have electricity; less than 50% of schools had telephones, and 13% did not have any toilets. Seventy-two percent of schools did not have libraries and between 22% and 75% of the schools (depending on the province) did not have physical science laboratories.

General science and mathematics are compulsory until the end of grade 9 and beyond this grade the enrolments in mathematics and science vary dramatically between ethnic groups. For instance, whilst only 1 in 312 black pupils entering the school system leaves with physical science and mathematics as final year subjects, 1 in 5.2 white pupils (Blankley, 1994, p. 54) matriculate with these subjects.

South Africa's Participation in TIMSS

It was within this context that the decision was made by the Human Sciences Research Council (HSRC) to join the International Association for the Evaluation of Educational Achievement (IEA) and to coordinate South Africa's participation in TIMSS as this would provide the baseline data so urgently needed. South Africa's participation was significant in that it was the only country on the continent of Africa to take part in TIMSS.

Whilst TIMSS focused on 9-year-old pupils (grades 4 and 5), 13-year-old pupils (grades 7 and 8), and final-year (grade 12 in South Africa) secondary school pupils, South Africa participated in only the latter two groups. A nationally representative sample yielded 300 schools for the grade 7 and grade 8 age group (including 150 primary schools and 150 secondary schools). The same secondary school sample was used for the testing of grade 12 pupils. In total, the results for 9,792 13-year-old pupils (Howie, 1997, p. 33) and 2,757 final-year pupils were included for analysis in the study.

South African Pupils' Overall Performance in TIMSS

The South African grade 7 and grade 8 pupils performed very poorly overall and were ranked last out of 41 countries for both mathematics and science. Likewise, South Africa's grade 12 pupils obtained a significantly lower average score (352 points) than the other participating countries for which the international average score was 500 on a scale of 800 points.* Internationally, the male pupils performed significantly better than the female pupils. This was not the case for either target group in South Africa and no significant difference was found between male and female pupils.

South African Pupils' Performance in Mathematics

South Africa's 13-year-old pupils performed poorly, achieving a mean score of 348 (on a scale of 800 points) for the grade 7 pupils compared to the international mean of 484 points and a mean score of 354 for the grade 8 pupils, compared to the international mean of 513 (Beaton et al., 1996a). The difference between the performance of the grade 7 and grade 8 pupils was very slight (just 7 points) and was the lowest improvement in performance. The grade 12 pupils also performed poorly in mathematics literacy and achieved a significantly lower mean score of 356 points compared to the international mean score of 500 points.

South African Pupils' Performance in Science

The South African performance in science for both target groups, in comparison to the other participating countries, was very poor. South Africa's 13-year-old pupils' mean

* In practice, English (spoken by 9.1% of the population as their home language or mother tongue) is the language of business and government (replacing Afrikaans), however, it is not the most widely spoken language at home.

** HSRC report, *A schools needs based survey*, 1997.

* South African grade 12 pupils were ranked last out of 21 countries.

score was well beneath the international mean (Beaton et al., 1996b). South Africa's grade 12 pupils achieved a mean score of 349 for science literacy which was lower than that of all the other participating countries. The South African pupils' results generally did not reflect any significant differences across the content areas for either target group.

Findings from South African Pupils' Biographical Data

Pupils' profile

The average age of South African pupils in grade 7 was 13.9 years and in grade 8 was 15.4 (only Colombian pupils were older) (Howie, 1997, p. 48). South African grade 12 pupils had an average age of 20.1 years (only pupils from Iceland were older). Only 21% of the grade 7 and grade 8 group (Howie, 1997, p. 49) and only 19% of the grade 12 pupils wrote the achievement tests in their home language (Howie & Hughes, 1997, pp. 33–34).

Home environment

Many pupils come from socioeconomic backgrounds which are so impoverished that they can scarcely be imagined by first-world researchers. Survival is often given priority over education. The generation presently at school often have parents who are unable to assist with school work. The home environment most often provides a very poor incentive to study at home, even when this is physically possible. Another factor arising from this kind of environment is malnutrition, which can have adverse effects on powers of concentration.

TIMSS revealed a clear positive correlation cross-nationally between parents' education and pupils' mathematics and science literacy. Grade 12 pupils whose parents had had more education, had higher mathematics and science literacy scores. Along with Austria and the Netherlands, South Africa had the lowest proportion (11%) of pupils whose parents had completed university. In the various countries this percentage ranged from 11 to 44%, with Canada having the highest proportion. Most pupils in South Africa reported that the highest level attained by either parent was to complete primary school (Howie & Hughes, 1998, p. 39).

The average number of books reported in the homes, of both the grade 7 and grade 8, as well as grade 12 target groups, was far fewer than the international average. For instance, close to 60% of the grade 12 pupils had less than 26 books in their home. Compared to other countries, South Africa had the highest proportion of pupils reporting that they had less than 26 books in the homes (Howie & Hughes, 1998, p. 40).

South African pupils perceptions of and attitudes towards mathematics and science

The percentage of grade 7 and grade 8 pupils who felt that they did very well or well in science or mathematics ranged from 74 to 80%, in spite of the poor performance of the South African pupils in the achievement tests (Howie, 1997, p. 50). In the case of the grade 12 pupils, in general pupils expressed positive perceptions of their progress in mathematics and science. Pupils' academic performance appears to support their perceptions as the average performance of those who claimed that they usually did well generally exceeded the performance of those who disagreed. However, whereas most countries had a considerable differential in mean performance scores for those who thought they

usually did well as opposed to those who did not, in the case of South Africa this differential was very small for mathematics and the trend was reversed for science pupils.

The percentage of grade 7 and grade 8 pupils who felt they needed to do a lot of hard work and studying at home in order to do well in science or mathematics was lower than that in nearly all the other countries. On the other hand, the percentage of pupils who felt that good luck was needed in order to do well was higher than that in nearly all the other countries. This was in striking contrast to the results from high-performance countries such as Singapore, Hong Kong, Korea, and Japan, where very high percentages of pupils felt that hard work was important in order to do well (Howie, 1997, p. 50).

The percentage of grade 7 and grade 8 pupils reporting that they liked science and mathematics ranged from 65 to 74%, which was similar to the percentages in other countries (Howie, 1997, p. 51). In almost all countries the majority of grade 12 pupils reported that they liked mathematics to some degree. In every country, a positive relationship was observed between liking mathematics and achievement in mathematics. In general, there was no significant difference between males and females in their degree of liking mathematics. Of all the sciences, the majority of South African grade 12 pupils stated that they liked biology most and chemistry and physics seemed less appealing to pupils.

South African students' career aspirations

Amongst grade 8 pupils choosing a career in the natural sciences, 32% would choose biology, 24% would choose physics, and only 7% would choose chemistry (Howie, 1997, p. 50). The most popular area nominated for further study by South African grade 12 pupils was engineering (all the conventional engineering disciplines). The business field, which includes accounting, marketing, finance, administration, and management, was the second most popular choice. The fields of chemistry and physics were the least attractive to pupils. Only 1.8% and 0.9% of the pupils reported any interest in further studying chemistry and physics respectively. Ninety-five percent of the South African grade 12 pupils reported that they had intentions of pursuing tertiary studies. Of that cohort, 75% planned to visit the university.* Along with Slovenia this statistic constituted the highest percentage of pupils intending to visit the university (Howie & Hughes, 1998, p. 36).

Conclusion

From the results of the TIMSS study highlighted in this paper, it is clear that the South African education system is facing many challenges. These challenges include providing good schooling facilities, producing motivated, well-qualified teachers, and encouraging students to be motivated and hard-working. When attempting to improve mathematics and science education in South Africa there will be no single, magical cure-all solution. The most successful strategy will consist of simultaneous attacks on a number of different fronts, that is, an "and ... and" approach rather than and "or ... or" approach. TIMSS has provided the country with valuable information that will enable policymakers to ascertain quantitatively and relatively objectively, for the

* Due to difficulties in arriving at a consistent definition of "university" internationally, cross-national comparisons were somewhat inappropriate.

first time, the status quo in science and mathematics education in South Africa.

If South Africa is to succeed as a country in a rapidly changing competitive world in which science, engineering, and technology are becoming increasingly important, a premium must be placed on mathematics, science, and technology education. The development of human resources in these fields is of utmost importance. This study is useful as a frame of reference for monitoring purposes when programs, reforms, and other educational initiatives linked to mathematics and science education are implemented. The TIMSS study in South Africa provides the necessary information to contribute to finding solutions to the educational challenges that plague our country at present.

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(References are available from the author.)

TIMSS-Germany: Design, Instruments, and Research Questions

Germany participated for a variety of reasons only in the investigations of populations 2 and 3, with the data analyses restricted to students from secondary levels I and II. In order to answer several national research questions and to allow more psychologically-oriented data analyses, however, the German study contains some national extensions, particularly in population 2, consisting of 7th and 8th graders. Figure 1 shows the extended design of the German TIMSS investigation in this cohort.

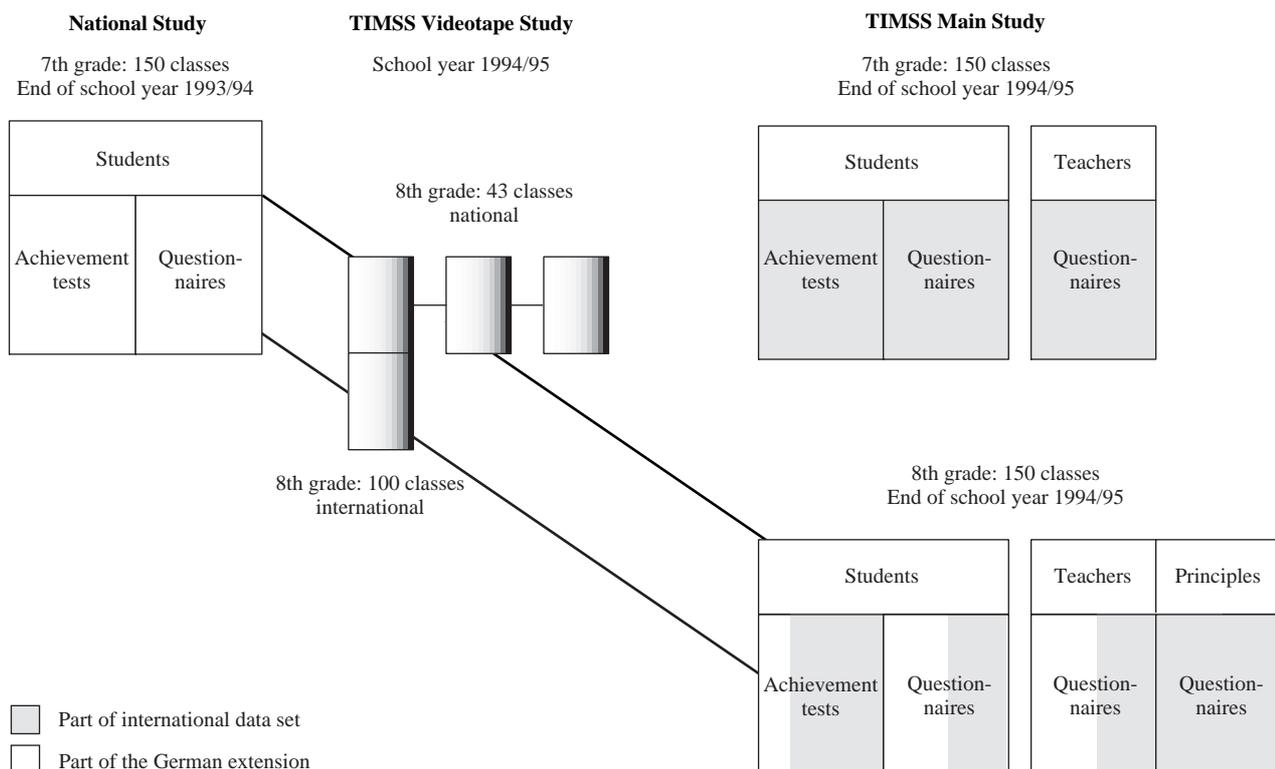
The most important feature of the German study is its longitudinal character, that is, we collected data from most of the 8th graders when they were in grade 7, one year before they officially participated in TIMSS. This sample is shown on the left side of Figure 1. Overall, 150 classes of 7th graders from different types of junior high schools (“Hauptschule,” “Realschule,” “Gesamtschule,” and “Gymnasium”) were tested by means of paper-pencil achievement tests. In addition, questionnaires on several motivational and other variables were administered. A substantial number of these students were tested again as part of the whole sample in grade 8 in the TIMSS main study. This sample is shown on the right side of Figure 1. Between both measurement points the TIMSS Videotape Study (Stiegler, Gonzales, Kawanaka, Knoll, & Serrano, 1996) was conducted in these classes.

The advantage of the longitudinal design is that analyses with respect to academic learning (here, learning could be defined as the difference in achievement between both measurement points) are possible, overcoming several problems of cross-sectional designs. The linking of video data with learning rates on classroom level in particular implies interesting analyses on the relationship between instructional variables and learning.

Another important extension in Germany was the systematic and theory-driven investigation of the development of motivational variables. Unfortunately, the international TIMSS part provided only a very small data basis for these characteristics.

Finally, student and teacher ratings on the quality of instruction were measured by means of several scales taken from prior national and international studies on classroom environment. This information, combined with the material of the Videotape Study, allow comparisons of three different

Figure 1: Design of the German TIMSS Study in Population 2



data sources according to the quality of instruction, that is, students' perceptions, teachers' assessments, and video ratings by experts.*

In population 3 (students in the final year of secondary education), the most important extensions refer to an oversampling of students from the new federal states, that is, states from the former German Democratic Republic (GDR) and an extra sample of West German 12th graders. These extensions allow for systematic East-West comparisons and analyses according to the gain and losses of 12 (like in most of the new states) versus 13 years (like in all old and some new states) of schooling.

Beyond the international research questions reported in the paper by Bos and Köller (this volume), further national topics refer to

- (1) achievement comparisons between the former GDR and the former Federal Republic of Germany (FRG). Furthermore, consequences of the transformation of the school system in the new federal states from a unitary to a differentiated system can be analyzed;
- (2) institutional effects of different types of secondary school on achievement and learning;
- (3) gender differences in achievement, learning, motivation, attitudes, etc.;
- (4) regional differences, that is, comparisons between selected federal states;
- (5) predicting achievement by means of cognitive, motivational, and instructional variables;
- (6) microanalysis of so-called introductory phases in mathematics instruction, in which new subject matter is introduced by the teacher.

Results on some of these topics can be found in Baumert, Lehmann et al. (1997), Köller, Baumert, Clausen, and Hosenfeld (1997), and Hosenfeld (1998).

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Why did Japanese Students do so well in TIMSS? Results from the TIMSS Videotape Study and Information about the Educational System in Japan

One of the striking results of TIMSS in population 2 (in most countries students of grades 7 and 8) was the superiority of Asian students in mathematics, that is, students from Singapore, Korea (South), and Japan performed on an achievement level, which was, for instance, unattainable for most of the German and American students. Compared to Germany or the United States, the mean achievement of 8th grade Japanese students indicated a qualitatively different level of mathematical reasoning at which real understanding of mathematical concepts and procedures becomes possible, while Germany and the USA scored (on average) on an abil-

ity level, at which mathematical routine procedures, which are 6th- to 8th-grade material, can be carried out with a sufficient degree of certainty.*

At first glance, it was, from a Western perspective, quite surprising, that Japanese students achieved so well, since lessons in Japan take place under relatively unfavorable circumstances which would normally lead one to expect low achievement:

- From 1st to 9th grades, far more than 90% of all students are taught together in unitary schools.
- There is absolutely no differentiation with respect to achievement, also no grade repetitions and no individualized learning.
- All classes are comparatively large. The Japanese TIMSS classes, for instance, consisted of 37 students on average, while American and German TIMSS classes had only 27 and 24 students, respectively.

However, the *TIMSS Videotape Classroom Study* (Stigler, Gonzales, Kawanaka, Knoll, & Serrano, 1996), as well as the *TIMSS Cases Studies* (Stevenson & Nerrison-Low, 1997) combined with prior reports on the educational system in Japan (e.g., Dorfman, 1987) provide fascinating material to generate hypotheses why Japanese students perform so much better than their counterparts from Germany and the United States.

The *TIMSS Videotape Classroom Study* was carried out in Japan, Germany, and the United States. A random sample of classes from the TIMSS main study were videotaped once. This sample consisted of 100 classes from Germany, 81 from the United States, and 50 from Japan. The videos, however, show dramatic differences between the three countries according to the instructional culture. Although Japanese students learn the same material as the German and U.S. students, it is presented using various strategies and is more demanding. In comparison to mathematics classes in the United States and Germany, Japanese mathematics lessons are more complex and at the same time constructed more coherently. Japanese mathematics teachers teach problem solving and mathematical understanding instead of ordinary skills. Students are encouraged to elaborate mathematical problems on their own, and a couple of solutions for one problem is often the consequence of this type of instruction. Mathematics lessons in Germany and in the United States are to greater extent instruction in knowledge acquisition, which are directed toward the mastery of computational procedures. In Germany mathematical concepts which lead to a single solution are developed in the teacher-students interaction, whereas in the United States teachers usually present concepts followed by practising these new concepts.

These observational data of the Videotape Study were supported by analyses of blind ratings of experts in mathematics didactics. The experts received transcriptions of the videos from all three countries. Since all country-specific terms were eliminated in the transcriptions, the experts did not know, from which country the lessons were. The results were striking. The quality of more than 80% of the American was rated low, while it was 40% in Germany, and less than 20% in Japan.

* A dissertation project on this comparison is currently being conducted at the Max Planck Institute for Human Development, analyzing the construct and predictive validity of all three data sources.

* The international mean in grade 8 (over 41 countries) was $\bar{M} = 500$, while it was $\bar{M} = 509$ for Germany, $\bar{M} = 500$ for the United States, and $\bar{M} = 605$ for Japan.

However, although the Japanese instruction is much more demanding, focuses on mathematical understanding, and represents a higher level of didactic quality, it is also important to take the out-of-school context of Japanese students into consideration to generate explanations for their high achievement level. Analyses of the TIMSS main study revealed that more than 60% of the Japanese students take additional mathematics lessons out of school, and contrary to most other countries, not only poor achieving but also students from high and middle ability levels do this. With this in mind, one plausible assumption is, that it is not only the type of instruction but the specific division of labor between school and home that let Japanese students perform as well as it came out in TIMSS. In 1993 more than 41.7% of the 6th graders, 52.5% of the 7th graders, and 59.1% of the 8th graders attended additional lessons in private supplementary schools (so-called *jukus*). These lessons typically take place in the afternoon or evening. Students receive the opportunity to practice, to do some homework, and to learn mathematical skills in a way which is quite similar to German or American instruction. Therefore, the aims of regular and of the supplementary schools are complementary. In mathematics lessons in public schools the focus is foremost on the transmission of conceptual knowledge, the (commercial) private education institutions, on the other side, want to transfer mainly procedural knowledge, that is, computational skills.

Summarizing this, it seems to be quite clear, that one important determinant of the high Japanese achievement level is the effective combination of cognitive demanding mathematical instruction in public schools and the very traditional, on simple computational competencies focusing type of instruction in private schools.

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Beyond the Year 2000: TIMSS-Findings from the U.S.

In 1989, the 50 Governors of the United States convened in Charlottesville, Virginia, to define a set of national goals that would guide educational progress in the U.S. during the 1990s. Joined by President Bush, they announced a set of five goals; several years later two more goals were added. The goals dealt with the preparation of children for school, citizenship, high school completion, adult literacy, teacher education, parental participation, and safe schools. A particular goal that has captured a great deal of current attention is the one that proposed: "By the year 2000, United States students will be first in the world in mathematics and science achievement."

The hope of attaining first place in the world anytime during this century was dealt a strong blow as the results of the *Third International Mathematics and Science Study* (TIMSS) have been published. This study, involving over 500,000 students from 41 countries in its various components, is the largest comparative study ever conducted of students' academic achievement.

U.S. students did not fare well. The only countries outperformed by American 8th graders in both mathematics and science were Cyprus, Iran, Lithuania, and Portugal. Although U.S. scores in science for middle school students were 18 points above the international average, they fell 73 points behind top-ranking Singapore 40 points behind the second place Czech Republic. (Raw scores were transposed to a distribution where the mean is 500 and the SD is 100.) In mathematics, differences were even greater—143 points behind Singapore and 107 points behind second place Korea. U.S. students were 13 points below the international average.

Low scores were not confined to the 8th grade. Although the average score for 4th graders of 545 was above the international average in mathematics, it was far below the average scores for Singapore (625), Korea (611), Japan (597), and Hong Kong (587). Scores in science were higher. The U.S. 4th graders had an average score of 565 points which was surpassed at a statistically significant level only by the 597 points received by students from Korea.

Why the status of science scores was higher at 4th than at 8th or 12th grades is hard to explain, but the ultimate negative outcome was evident by the final year of high school. Twelfth graders in only two of the 21 nations participating at this grade received scores below those of the U.S. in mathematics: Cyprus and South Africa. In science, scores of only five nations were below those of the U.S.: Italy, Hungary, Lithuania, Cyprus, and South Africa. When only scores on the advanced mathematics and advanced science were considered, the U.S. was outperformed in both subjects by the 16 other participating countries.

Needless to say, concerned citizens from President Clinton and Secretary of Education Riley to the nation's parents and classroom teachers found these results extremely distressing. The President soon announced major initiatives aimed at improving education, including a set of proposals dealing with the organization of education, training of teachers, extending access to computers and the Internet, national tests in reading and mathematics, and other related efforts. The National Institute of Child Health and Human Development initiated a conference on Mathematical Cognition whose purpose it was to help construct a research agenda for developing ways of improving students' understanding of mathematics. A group was convened in Washington, DC to discuss ways to improve U.S. students' reading. However, as is often the case, the degree to which these hopes can be fulfilled depends, in part, on the availability of funds. If the U.S. Congress authorizes the allocation and expenditure of funds for education and education research, there should be a sharp improvement in the investigation of teaching and learning processes.

The TIMSS main study involved tests for the students and responses by teachers and students to questionnaires. Although paper-and-pencil questionnaires are effective ways of obtaining large amounts of information very rapidly, interpretation of the information is often difficult without opportunities to actually observe or interact with the individuals being studied. For example, rather than presenting teachers with a list of questions about their teaching, a more direct approach would be to observe, either in person or through television, what is actually happening in the classrooms. This was done in the Video Study organized by James Stigler of the University of California, Los Angeles. The study involved three nations: Germany, Japan, and the United States. This

approach is unique in many ways, one of which is that it included nationally representative samples of mathematics lessons taught in each country. Over 200 lessons were videotaped, translated into English, transferred to a CD-ROM, and analyzed according to a new computer program designed by Stigler and his associates. Only parts of the results have been made available thus far, but those that have been published give strong indications of the power of this approach to understanding the teaching process.

A second approach to advancing our knowledge about beliefs, attitudes, and practices in the three countries was obtained in the Case Study Project, an ethnographic study involving observations, interviews, and conversations with representative samples of students, teachers, parents, and education authorities. The project focused attention on four topics deemed by policymakers to be of special interest: the role of secondary school in students' lives, the training and working conditions of teachers, dealing with differences in academic ability, and education standards. The study included students at grades 4, 8, and 12 residing in each of three locations visited within each country. Interviews and conversations were held for over 1,300 hours in the U.S., Germany, and Japan. All interviews and conversations were tape recorded, translated in the cases of German and Japanese into English, entered in a computer program with key words necessary for retrieval of information. Our research group at the University of Michigan was responsible for the conduct of this project.

A third innovation in TIMSS was an analysis of the curricula represented in the textbooks and teachers' guides of countries involved in TIMSS. These analyses served two purposes: The first was simply to develop a catalog providing details con-

cerning the topics covered in various countries; the second was to provide information about topics that should be covered in the mathematics and science tests that were to be used in TIMSS. This project, conducted by a large number of collaborating researchers headed by William Schmidt of Michigan State University, explored the content of textbooks and teachers' guides used in grades 4 through 12.

Funds for these three projects were provided primarily by the U.S. In the coming months the U.S. Department of Education will publish a volume describing results from the Video Project and five volumes describing the results of the Case Study Project. Several books describing the Curriculum Project have already been published. In addition, arrangements have been made for interested investigators to have access to the videotapes and field records for the Video and Case Study projects.

Methodologically, as well as substantively, the various components of TIMSS represent important advances over the earlier studies sponsored by the IEA (International Association for the Evaluation of Educational Achievement), the organization that has been responsible for much of the comparative research in education over the past 30 years. It will be interesting to see how influential this newest research proves to be. We know already that it has provided a stimulating topic for conversation. Whether it will be effective in moving the U.S. toward its goal of excellence in mathematics and science at the elementary and secondary levels is hard to predict.

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Obituary Harry McGurk: 1936–1998

At the age of 28, Harry McGurk began a degree in psychology at the University of Strathclyde. Even at that age, Harry had gained a lot of experience. He had not had an easy childhood. He was born in one of the rougher areas of Glasgow. His mother died when Harry was only 3 months old, and until his father's remarriage he was raised by various relatives. He left school at 15 to work as a clerk, eventually gained "A" levels at evening classes, qualified and worked as a probation officer, and, together with his wife Betty, spent a year in Eastern Nigeria under the auspices of the Church of Scotland, helping to manage a hospital and school. Having completed his first degree in 1968, he began a PhD under the supervision of Rudolph Schaffer. At that time, almost no one in Britain was working on babies, but Rudolph's laboratory was one of the few fully functioning infant laboratories and Harry thrived. Using the habituation technique, he successfully showed that even at 6 months of age infants can distinguish different orientations of the same shape. It was one of the very earliest demonstrations of the way that the process of habituation can be used as a tool to study key aspects of perception. These days we take the power of that tool for granted but in the late 1960s it is a mark of Harry's prescience that he saw how to use it.

While Harry was working on his doctorate, he became the happy and proud father of Rhona McGurk, little realizing at that point that he was raising a future psychologist. He also shared his love of Glasgow and the surrounding countryside with Michael Lewis, a visiting professor at Rudolph Schaffer's laboratory. On completing his thesis in 1971, Harry became a Research Fellow with Michael at the Educational Testing Service in Princeton. It was at ETS that he began to develop an enduring interest in cross-modal perception. On his return to Britain in 1972, Harry took up his first permanent academic post at the age of 36—he became lecturer at the University of Surrey. Indeed, Surrey was his home for almost 20 years and it was there in 1976 that he made one of his most exciting discoveries about cross-modal perception. When we hear a speech sound that does not match the visible shape of the lips producing the sound, our brain appears to arrive at a kind of compromise. What we "hear" does not correspond exactly to the auditory input—or to the sound that the lips are making—but to a sound somewhere "between" the two. Working out how the brain arrives at that compromise has proved a continuing challenge, but what was immediately apparent in Harry's discovery was that the lips convey important information about speech not just to the deaf, who are forced to rely on that visual channel, but to normal listeners as well. Harry's findings were published in the prestigious journal *Nature* under the captivating title "Hearing lips and seeing voices." The phenomenon that he had identified rapidly became known as the "McGurk effect." At the age of 40, Harry had the intriguing experience of being an illusion in his own time. Chatting with him one day about these findings, he explained half-seriously that he would like to explore their practical implications. His idea was that public announcements could be accompanied by a videoscreen displaying a pair

of moving lips to supplement and disambiguate the semi-audible message. To this day, when we hear a station announcement that we cannot decipher, we find ourselves gazing up—half-hoping to see some giant electronic lips coming to our rescue.

Alongside his research in Surrey, Harry continued to deploy his clinical and organizational skills. He was often asked to serve as an expert witness, especially in cases concerning the care or custody of children. He was promoted to a professorship in Surrey, and he served as Head of Department.

The beginning of the 1990s marked a transition point in Harry's career and professional concerns. He moved to London as Professor of Developmental Psychology at the University of London, and Director of the Thomas Coram Research Unit (TCRU), a division of the Institute of Education devoted to applied research on child care, family issues, and child protection. He developed an important research program on the quality and the effects of childcare. His internationalism appeared again when Harry became the coordinator of a network on the quality of childcare. In 1994, when he became Director of the Australian Institute of Family Studies (AIFS), his concern with childcare and child protection issues became integrated into a wider framework. On the one hand, family problems regarding the upbringing and care of children became prominent in his mind as a research topic—in this connection, Harry was very active in the organization of a trans-national project currently being carried out in America, Europe and Australia, a project he called Parenting-21. On the other hand, the analysis and implementation of sound policies for children and their families were important components of the work of the AIFS as a Government advisory agency. His vision of a caring society and of "socially distributed parenting"—the need for a societal commitment to high quality services for families and children—was based not only on scientific research, but also on his socialist convictions, and his perception of the danger of analyzing childcare in narrow, financial terms.

As Director of the Thomas Coram Research Unit and the Australian Institute of Family Studies, Harry showed a very personal and engaged style. People who worked with him speak of Harry as a leader who fought for the Unit or for the Institute, as a scientist who was not afraid of courting controversy, and as someone whose energy and hard work were invariably accompanied by a strong sense of humor. Harry was also someone who encouraged and supported his colleagues at times of difficulty. Happily, in Australia, he himself was strengthened by his partner Anne Stonehouse, an Associate Professor in the field of early childhood.

As his career flourished, Harry became increasingly visible on the international stage. He was appointed Visiting Professor at several different universities: Minnesota, the Autonoma in Madrid, La Trobe, and Seville. He was also deeply involved in *ISSBD*. Indeed, his involvement goes back to the earliest days of the Society. He was a very active member right from the start. He organized the IIIrd Biennial Meetings at the University of Surrey in 1975, when the membership was still very small and resources were limited. He was Treasurer of the Society from 1975–1979, and Secretary from 1979–1981. In those capacities, he served on the ad hoc committee that wrote the Bye-Laws of the Society. From 1985–1990, Harry became the Editor of the Society's journal, the *International Journal of Behavioral Development*. Both the quality and the number of manuscripts published during his editorship improved noticeably. During this same period Harry was very active in the organization of the first *ISSBD* international workshops, and he was one of the *ISSBD* experts at the first Asian Workshop on Child and Adolescent Development that took place in Jakarta in 1978. He also participated in all the European Conferences on Developmental Psychology, organized for many years in affiliation with *ISSBD*. For several of these meetings, he served as an active member of the program committee, supporting the local organizers with his experience, his wisdom, and his know-how.

After so many responsibilities in *ISSBD* (conference organizer, Secretary, Treasurer, Editor of the Journal, and member of ad hoc committees), taking up the office of President was Harry's last service to the Society. He began his presidency in 1996 and his term of office was due to run until the end of the millennium. He was the ideal candidate for the position, with his long experience of the whole range of *ISSBD* activities, his internationalism, his scientific reputation, his energy and enthusiasm, his leadership skills, and his acquaintance with colleagues all over the world. Although his service as *ISSBD* President has been truncated prematurely, it will remain as the culmination of an unmatched dedication to the governance and welfare of the Society.

One might think that with so many commitments, Harry had no time for other, less professional pursuits. In fact, he sustained and initiated various recreational activities. He enjoyed music of all kinds, and during his time at Surrey, he decided to take up the cello. Not only that, he committed himself to a public performance one year after starting. He kept the commitment—playing a duet with his daughter Rhona on the flute. He was also a keen cyclist. Indeed, Harry's bicycle was almost as well travelled as Harry himself. It could often be seen conquering the nearby hills of Surrey, and glimpsed in the more exotic landscapes of the Outer Hebrides, the Cevennes, southern Spain, and in later life, the Australian outback. Harry's cycling companions comment wryly on his almost Calvinistic relish of the sufferings and blessings of ascent. At the same time, Harry did not subscribe to any dour doctrine of predestination. He set himself goals and step by step he worked toward them. Indeed, planning of all kinds—whether it was a trip to Indonesia, a tricky point on the committee's agenda, or a vegetarian dinner—was one of Harry's passions. He was at once meticulous and adventurous. Recalling times spent with Harry, we think of his tenacity, of his resolve to push on and up. We think too of those moments of pleasurable anticipation—before an important lecture or reception—when Harry would appear, point-device, his head slightly to one side, smiling at what was to come.

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Faculty Scholars' Awards

Each year the William T. Grant Foundation makes awards to up to five investigators whose research contributes to understanding the development and well-being of children, adolescents, and youth. Awards are for five (5) years, totaling, \$250,000 including indirect costs.

The goal of the Faculty Scholars' Program is to promote children's development to healthy and productive adulthood by supporting investigators in a variety of fields on topics of child and youth development. Applicants should be junior or pre-tenure, not established investigators, in tenure-track positions. Award recipients will be called William T. Grant Faculty Scholars. Applicant institutions and individuals should obtain the brochure outlining the application procedure from:

Faculty Scholars Program
William T. Grant Foundation
570 Lexington Avenue, 18th floor
New York, NY 10022-6873 – USA

Deadline for applications for the 1999 awards is **July 1, 1998**.

Grants and Awards

Dissertation and Young Investigator Grants in Adolescence and Youth Research

The Johann Jacobs Foundation (JJF), a foundation devoted to the study of youth in a changing world and to the improvement of youth-related services, accepts competitive grant proposals for empirical research investigations conducted either in conjunction with dissertation projects or as independent projects by young investigators (particularly investigators from Eastern European and from developing countries in Asia, Africa, Middle and South America). Fields covered include the behavioral, educational, and social sciences, particularly in the following eight areas:

Positive beliefs about self agency and the future • Social relations and generational nexus • Life skills and life planning • Inner-city youth (poverty) • Impact of high-tech communication technology • Cultural and individual diversity • educational values • Match between institutions and individual development.

Dissertation grants are available to predoctoral students whose dissertation proposal has the approval of a dissertation mentor or a committee. Funds up to \$5,000 are available for materials, subject fees, research assistance, personal costs for field work, and other expenses required for conducting a study, analyzing data, presenting the data at an international conference, or for other forms of technical support.

Young investigator grants are aimed at postdoctoral investigators (normally within four to six years of award of the doctorate) who are initiating their own research in the field of adolescence and youth. Funds are available up to a maximum of \$10,000. Personal stipends (salaries) are not covered by either grant program. Institutions which administer or sponsor grants can receive an overhead of 10%.

To initiate a proposal, applicants should contact the Foundation at:

Johann Jacobs Foundation
Administrative Assistant
Seefeldquai 17
P.O. Box 101
CH-8034 Zurich – Switzerland
Phone: (+41) 1 388 6123
Fax: (+41) 1 388 6153

Proposals will be reviewed by an international Expert Committee (Rainer K. Silbereisen, Germany, Chair).

XVth Biennial Meetings of *ISSBD*
Berne, Switzerland, July 1–4, 1998
Special Events

Opening Ceremony

Wednesday, July 1, 1600 hours

Kursaal Berne

with reception and invited addresses by Inge Bretherton and Paul B. Baltes

Symposium in honour of the 60th birthday of August Flammer

Thursday, July 2, 1300–1450 hours

University Main Building, Aula

The “International Journal of Behavioral Development”

Friday, July 3, 1030–1130 hours

University Main Building

presented by the editors

Social Evening

Saturday, July 4, 2000 hours

Kursaal Berne

Banquet and musical entertainment with “I Salonisti,”
the Swiss ensemble that was engaged by James Cameron
to be the ship orchestra in the film “Titanic”