

Results of an Analysis of the TIMS Study from a Gender Perspective

Gabriele Kaiser, Tanja Steisel, Hamburg

Abstract: The results of gender analyses of the Third International Mathematics and Science Study with students of the lower secondary school level – exactly on Year 8 – are described. The analyses have been carried out and restricted to twelve selected nations. These TIMSS data were analysed following various categories, as there are mathematical content areas of the items, required mathematical qualification, type of answer, real world context and level of difficulty. The analyses do not show definite and consistent gender patterns for each category, and the apparent tendencies often are even contradictory. On the whole the analyses demonstrate that differences between countries are distinctly bigger than gender differences.

Kurzreferat: *Ergebnisse einer Analyse der TIMS-Studie aus einer geschlechtsspezifischen Perspektive.* Es werden Ergebnisse von geschlechtsspezifischen Analysen der Third International Mathematics and Science Study zu Lernenden des unteren Sekundarbereichs – genauer Jahrgangsklasse 8 – beschrieben, die für zwölf ausgewählte Nationen durchgeführt wurden. Die TIMSS-Daten wurden nach verschiedenen Kategorien wie mathematische Themengebiete, aus denen die Items stammen, Art der mathematischen Anforderung, Antwortart, außermathematischer Kontext und Schwierigkeitsgrad analysiert. Die Analysen lassen keine gesicherten einheitlichen geschlechtsspezifischen Muster für die einzelnen Kategorien deutlich werden, vielmehr sind erkennbare Tendenzen häufig sogar widersprüchlich. Insgesamt machen die Analysen deutlich, daß die Unterschiede zwischen den Nationen deutlich größer sind als die zwischen den Geschlechtern.

ZDM-Classification: C40

The analysis of mathematics achievement from a gender perspective has never been the explicit intention of the large international comparative studies in mathematics achievement – such as the First International Mathematics Study (FIMS), Second International Mathematics Study (SIMS), Third International Mathematics and Science Study (TIMSS) – which have been carried out during the last thirty years. However, the large amount of data collected in each of these studies allows an analysis of the data based on gender aspects, and therefore also allows the examination of the numerous theses which have arisen from the discussion of gender aspects of mathematics achievement. FIMS and SIMS data were already analysed respectively, but the data of the Third International Mathematics and Science Study, published in 1997-1998, have not yet been examined in detail under a gender perspective. The article of Hanna in this volume gives an overview of the development of FIMS, SIMS, TIMSS under a gender perspective (Hanna, 2000).

In the following, the results from a gender-focused analysis which we have carried out, will be presented. Our analysis was of population 2, which is the middle secondary level and one of the three populations examined by TIMSS, but limited to Year 8 from selected countries. Before discussing our analysis, an overview will be given on global gender differences within the TIMS Study, which

are apparent when the three examined populations were reviewed.

1. Overview of global gender differences within the TIMS Study

As it is generally known, the TIMS Study examines three populations: Years 3 and 4, Years 7 and 8, and Years 12 and 13. If the results of the three parts of the study are compared with each other from a gender perspective, the following revealing developments appear: In the primary school level almost no gender differences appear in mathematics achievement. Mullis et al. (1997) write in their report: “Regardless of their directions, most of the differences were not statistically significant, indicating that, for most countries, gender differences in mathematics achievement generally are small or negligible in the primary years of schooling” (p. 35). In some countries differences in achievement are found in favour of girls – for example in Thailand and Singapore. Boys show better results – for instance in Norway and Hongkong. However, the few statistically significant differences which came out are all to the advantage of boys. At the level of the six tested mathematics content areas gender related differences appear only in a few content areas, for instance in “Measurement, estimation and number sense”, boys in more than a third of all participating countries achieve better results, whereas in geometry no gender differences are found.

At first sight, in the middle secondary level nearly no gender related differences become evident; and the apparent differences are very small and not significant. However, boys achieve better results in many more countries than girls, whereas girls achieve better results in only a few countries, and none of the differences is significant. All differences which are significant, are to the advantage of boys. Thus the boys from Japan, Iran and Korea perform significantly better in Year 7 and 8. In Year 8 boys from Spain, Portugal, Denmark, Greece and Israel achieve better results, and in Year 7 boys from the French-speaking part of Belgium and from Switzerland and England. Beaton et al. (1996) summarise these results as follows: “Also, including those differences that were not statistically significant, the direction at both grades favored boys much more often than girls. A sign test across countries indicates that internationally there is a significant difference in achievement by gender favoring males” (p. 33). At the level of mathematics content areas only a few statistically significant differences appear. Here the greatest differences became obvious in the area of measurement, this is in favour of the boys; slight differences to the advantage of girls appeared in the area of algebra. Similar results have already been found in SIMS. In connection with supplementary questions of the TIMS Study concerning the students’ attitudes towards mathematics, most countries show only slight gender related differences. The differences appearing in some countries, such as Austria, France, Germany, Japan, Switzerland, indicate a more positive attitude of the boys.

In the upper secondary school level the situation changes markedly: In the field of mathematics literacy in all coun-

tries there exist gender differences to the benefit of the boys. In only three countries, namely South Africa, USA and Hungary, these differences are not significant. In some countries, such as Denmark and Canada, more male than female adolescents reported that they currently were taking mathematics courses. In the supplementary questioning concerning attitudes towards mathematics, on average, no significant differences between gender are apparent. In some countries, such as France and Switzerland, more male than female adolescents state that they like mathematics, but the opposite does not occur in any country. Similar tendencies concerning the students' self-perception about usually doing well in mathematics are recognisable. In most countries, gender differences are not great, but if occurring, in such a manner that male adolescents are showing a higher self-confidence concerning their mathematical abilities. This is the case with Switzerland, Austria, Denmark and the Netherlands. In the field of advanced mathematics remarkable gender differences in mathematics achievement to the benefit of the male adolescents appear and they are significant in most countries; in the Czech Republic and Austria great differences in achievement are found. Participation in such courses explains these differences only partially. In many countries many more male than female adolescents inscribed for such courses, and only in three countries – Germany, Czech Republic and Austria – more female than male adolescents participated in them. Nevertheless, especially in the Czech Republic and in Austria gender differences which go far beyond the international average appear. Concerning some single content areas the situation is not homogenous, as in some countries significant gender related differences appear, but in other countries no differences become obvious in any mathematical content area. However, distinct gender differences appear concerning aspects which are examined especially for these adolescents, namely their plans of career and willingness to take a profession that involves using mathematics: In total, more male adolescents named the fields of engineering or computer as possible fields of study, while more female adolescents chose the field of health; however, concerning mathematics, nearly no difference becomes obvious. As a whole, in nearly all countries, evidently more male than female adolescents are willing to take a profession that involves using mathematics (for details see Mullis et al., 1998).

The above stated results of TIMSS confirm the tendencies known from relevant didactic literature of the last decades (see for example Menacher, 1994), that performances of boys and girls develop divergently with growing age, and that gender differences mainly appear from puberty. Furthermore, it seems, that gender differences in the affective area which are known from former studies, i.e. smaller self-confidence of girls in their mathematical abilities, still do exist. Also there are still gender differences concerning career wishes, as well as women more often refuse professions that involve using mathematics. However, here it must be taken into account that, though differences still exist, the differences have become smaller. Hanna stated this emphatically in her contribution about

the development of FIMS, SIMS and TIMSS from a gender perspective in this volume (Hanna, 2000).

2. Aims and reasons for gender analyses of the TIMS Study, used methodical approach

The international results of TIMSS seen from a gender perspective are quite reassuring for the following reasons: On the one hand – as demonstrated in Chapter one – the results show that gender differences concerning attitudes towards mathematics still exist. On the other hand the results are almost not interpretable, and therefore the influencing factors only scarcely can be identified and countermeasures can hardly be taken.

For that reason we carried out our own analyses of selected data of TIMSS with the following purposes: On the one hand, as far as possible the influencing factors for the internationally stated differences in achievement will be identified and then, hypotheses for the interpretation of the results shall be developed. On the other hand, strengths and weaknesses of each gender will be identified in relation to selected aspects, such as required mathematical qualification or mathematics content areas, in order to re-examine relevant results of earlier empirical studies.

These analyses are carried out on the basis of the following methodical approach: We concentrated on Year 8 and selected 12 countries divided into three groups: Countries with statistically significant differences in achievement for the benefit of boys (Japan, Korea, Denmark, Israel), countries with distinct (but statistically not significant) differences for the benefit of girls (Australia, Thailand) and countries with only small differences (3–8 points difference in mean in favour of boys) (England, USA, Switzerland, Netherlands, France, Germany).

The analyses have been carried out on the one hand based on all the achievements of boys and girls, but on the other hand based on single items, which have partly been grouped together into special categories. The interpretation of the results of these analyses are based on the average percent of correct answers of the items by boys and girls.

The analyses have been carried out according to different categories, such as mathematics content area from which the item has been chosen, required mathematical qualification and possible type of answer. Because of our own interests, we partially analysed Germany more intensely than other countries: For this reason, we additionally examined the category relation to real world contexts and international difficulty index. These categories will be described in more detail below in Chapter 3 where the results are displayed.

The gender differences we found out were not controlled for (statistical) significance, for the following reason: The data are structured hierarchically according to the design of the study. Therefore usual statistical significance tests are not applicable (see Köller, 1998, p. 63). Empirically based thumb rules which are usually applied in such cases, indicate that almost none of the differences in achievement between boys and girls are significant; in almost all countries the differences between boys and girls for most categories are quite small. However, in our opinion, these small differences concerning certain aspects do al-

low statements about tendencies, whereas for other aspects – as we will demonstrate in Chapter 3 – such statements are not possible.

The used TIMSS results – which partly are available via the Internet – were taken from the CD-ROM of the Data Processing Center in Hamburg, published in 1998. This CD-ROM contains the solution frequencies for all items – including the not released items. Short descriptions of the characteristics of the unreleased items can be found in the Internet (<http://timms.bc.edu>).

3. Results of the analyses

Below we present the results of our analyses according to the different categories. At first we show the results of all countries, before a more deeply elaboration of the German sample follows.

3.1 The category “Mathematics Content Area”

Within the TIMS Study the following mathematical areas have been examined for the lower secondary level: Fraction and number sense (52 items), geometry (23 items), algebra (29 items), data representation, analysis and probability (20 items), measurement (21 items), proportionality (12 items). The results are presented in Table 1. A positive difference in mean percent correct represents a higher mean percent for girls, and a negative difference a higher mean for boys.

Table 1: Mean percent differences of correct responses by country and by mathematics content area

	Algebra	Data/ Probab.	Geometry	Measure- ment	Proportio- nality	Number
Australia	3.94	1.63	0.58	-0.80	-0.84	1.33
Germany	2.88	0.09	2.10	-1.78	-3.19	-2.26
Denmark	-3.28	-4.31	-3.74	-6.42	3.83	-4.50
England	3.80	-2.43	0.12	-2.94	-1.95	-0.75
France	0.10	-2.76	-2.38	-3.44	-2.30	-1.44
Israel	-3.98	-6.03	-5.98	-6.95	-7.77	-6.58
Japan	0.38	-1.57	0.11	-1.96	-2.60	-1.29
Korea	-0.69	-4.58	-3.70	-6.70	-1.44	-3.63
Netherlands	0.82	-3.07	-2.24	-1.83	-4.51	-3.20
Switzerland	0.56	-1.74	-1.41	-3.85	-0.88	-0.83
Thailand	4.28	1.49	2.70	0	2.63	2.45
USA	1.17	0.48	-1.50	-3.42	-1.17	-1.16

Remarkable gender differences concerning particular mathematics content areas are recognisable from the above table. Thus, there is a tendency that girls achieve better results in only one mathematics content area, namely in algebra, whereas in all other areas boys achieve better results. The biggest differences in achievement to the benefit of the boys occur in the area of measurement for all countries except Thailand. A quite similar situation is found in the areas proportionality, fractions and number sense. In the areas data representation, analysis and probability, differences in achievement in favour to the boys are not very noticeable.

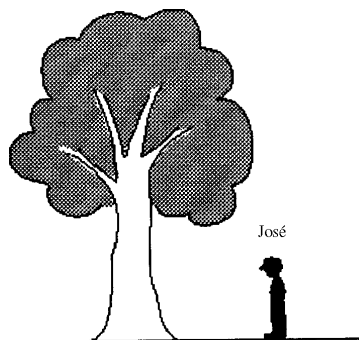
In Germany the situation is slightly different: Girls attain better results in algebra and geometry, as boys do in proportionality, fractions and number sense as well as in measurement, whereas no differences occur in data representation, analysis and probability.

3.2 Category “Required Mathematical Qualification”

For the analysis of the mathematical abilities which are required to answer an item, the category “performance expectations” has been used in the TIMS Study. According to this, the items are classified as knowing, performing routine procedures, solving problems and using complex procedures. From a mathematics didactical point of view, this type of classification seems not to be well enough differentiated to us. In addition to that, the classification of an item strongly depends on the pupils and their knowledge (problems with this classification are pointed out by Neubrand, Neubrand and Sibberns, 1998). Therefore, with reference to didactical aspects, we developed our own classification, by assigning the items according to the type of required mathematical qualification into eight sub-categories (for an analysis of TIMSS-items with reference to similar aspects see Blum, Wiegand, 1998).

We distinguish the following sub-categories:

(1) *Elementary Conceptual Understanding* [ECU]: In our classification, the solution of this type of items requires that a basic idea of a certain mathematical content is applied once (26 items). In Fig. 1 we will show one item of TIMSS which is based on the parts-of-a-whole understanding of fractions as an example.

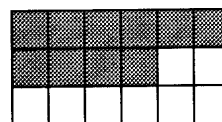


José is 1.5 m tall. About how tall is the tree?

- A. 4 m
- B. 6 m
- C. 8 m
- D. 10 m

Fig. 1: TIMSS-item L8 to elementary conceptual understanding

(2) *Multiple Conceptual Understanding* [MCU]: Application of different basic ideas of mathematical contents (5 items) or multiple application of the same basic idea. Fig. 2 provides an example item also based on the parts-of-a-whole understanding of fractions, but applied twice.



Which circle has approximately the same fraction shaded as that of the rectangle above?

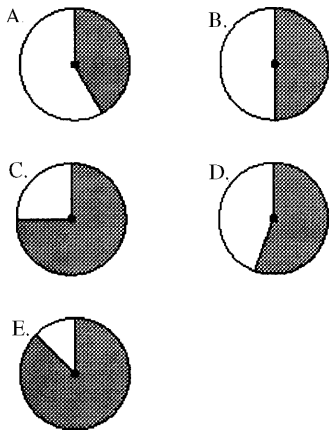


Fig. 2: TIMSS-item K1 to multiple conceptual understanding

(3) *One-step Application of a Known Algorithm [OKA]*: Single application of a known algorithm (48 items). See for example Fig. 3.

What is the value of $\frac{2}{3} - \frac{1}{4} - \frac{1}{12}$?

- A. $\frac{1}{6}$
- B. $\frac{1}{3}$
- C. $\frac{3}{8}$
- D. $\frac{5}{12}$
- E. $\frac{1}{2}$

Fig. 3: TIMSS-item L17 to one-step application of a known algorithm

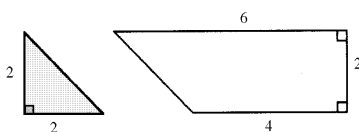
(4) *Multiple-step Application of a Known Algorithm [MKA]*: The application of several different algorithms or the multiple application of one algorithm (17 items). Fig. 4 provides an item which requires the successive application of the formulae of the perimeter and the area of a rectangle.

The length of a rectangle is 6 cm, and its perimeter is 16 cm. What is the area of the rectangle in square centimeters?

Answer: _____

Fig. 4: TIMSS-item K5 to multi-step application of a known algorithm

(5) *Elementary Conceptual Understanding and One-step Application of a Known Algorithm [ECU+OKA]*: Subsequent application of both sub-categories (9 items). In Fig. 5 an example item based on the concept of the area of a rectangular triangle and the division of a trapezoid in rectangular triangles is given.



How many triangles of the shape and size of the shaded triangle can the trapezoid above be divided into?

- A. Three
- B. Four
- C. Five
- D. Six

Fig. 5: TIMSS-item R10 to elementary conceptual understanding and known one-step algorithm

(6) *Problem Solving [PS]*: Developing individual solutions of a problem by using already known mathematical methods (11 items). In most cases, the items assigned to this category, are pure word problems. These word problems seldom comply with demands defined in the German language area for problem solving tasks, such as open formulation of a problem which solution requires creativity.

See Fig. 6 for an example item, which requires to extract the needed information from an advertisement, as well as to calculate and compose prices.

The following two advertisements appeared in a newspaper in a country where the units of currency are *zeds*.

BUILDING A	BUILDING B
Office space available	Office space available
85 – 95 square meters	35 – 260 square meters
475 <i>zeds</i> per month	90 <i>zeds</i> per square meter
100 – 120 square meters	per year
800 <i>zeds</i> per month	

If a company is interested in renting an office of 110 square meters in that country for a year, at which office building, A or B, should they rent the office in order to get the lower price? Show your work.

Fig. 6: TIMSS-item V2 to problem solving

(7) *Translation of a Mathematical or Real-world Context into a Mathematical-symbolic Form [TMR]*: (8 items). See for example Fig. 7.

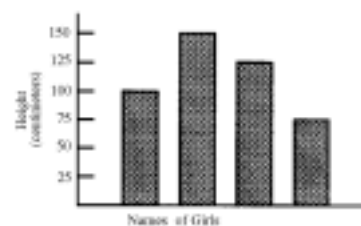
Brad wanted to find three consecutive whole numbers that add up to 81. He wrote the equation $(n - 1) + n + (n + 1) = 81$. What does the n stand for?

- A. The least of the three whole numbers
- B. The middle whole number
- C. The greatest of the three whole numbers
- D. The difference between the least and greatest of the three whole numbers

Fig. 7: TIMSS-item I1 to translation into mathematical-symbolic form

(8) *Extraction of Information [EI]*: In our understanding the extraction of information from tables and graphs (10 items). See for example Fig. 8.

The graph shows the heights of four girls.



The names are missing from the graph. Debbie is the tallest. Amy is the shortest. Dawn is taller than Sarah. How tall is Sarah?

- A. 75 cm
- B. 100 cm
- C. 125 cm
- D. 150 cm

Fig. 8: TIMSS-item Q4 to extraction of information

The results of the analyses are presented in Table 2. The positive or negative differences in mean percent correct represent the same as in Table 1. For these analyses the average value of the items of all mathematical content areas has been taken.

Table 2: Mean percent differences of correct responses by country and by required mathematical qualification

	ECU	MCU	OKA	MKA	ECU & OKA	PS	TMR	EI
Australia	0.14	-0.01	2.12	0.14	1.17	3.72	3.09	1.71
Germany	-0.91	0.54	-0.66	-1.57	1.83	1.70	0.13	0.35
Denmark	-5.23	-6.89	-3.46	-4.64	-6.57	-1.46	-3.47	-3.97
England	-0.11	-2.26	-1.22	-1.08	-2.08	2.62	3.89	-0.80
France	-1.71	-2.38	-1.76	-2.48	-3.39	-0.69	-0.91	-1.88
Israel	-8.33	-7.78	-4.93	-6.40	-5.11	-5.11	-2.01	-5.89
Japan	-1.83	-1.84	-0.44	0.17	-3.96	-0.59	0.29	-0.14
Korea	-4.26	-5.73	-2.89	-3.88	-2.13	-4.56	-1.12	-2.41
Netherlands	-4.43	-2.29	-2.47	-0.14	-2.29	-0.11	0.90	-0.22
Switzerland	-1.73	-1.95	-0.21	-1.26	-0.04	-1.42	-0.74	-2.89
Thailand	2.31	4.74	2.83	2.69	0.63	0.65	3.81	0.88
USA	-1.70	-2.28	-0.50	-1.05	-2.84	0.64	1.50	0.25

Table 2 demonstrates the tendency of boys from the analysed countries to achieve distinctly better results. Boys show clearly better achievements with items for which an elementary or multiple conceptual understanding is needed. For items requiring a one- and/or multi-step application of known algorithms, or items which are based on a combination of conceptual understanding and the application of algorithms and items requiring the extraction of information, boys attain better results. For items requiring problem solving or the translation from a mathematical or a real-world context into a mathematical-symbolic form, as one (possible) phase within a problem solving process, only slight differences between girls and boys occur, meaning that in some countries the boys produce better results and in other countries the girls.

For the German sample we analysed the items for each mathematical content area according to the category of required mathematical qualification. Because of the small number of items in some sub-categories we used a more qualitative approach by considering only bigger percentage differences (over 5%) of solution frequencies of boys or girls. From the separate analysis of each content area, there emerged partly contradictory tendencies: For instance with items on elementary conceptual understanding girls attained better results in algebra and geometry, but boys scored higher in fractions and number sense. The analysis of the category "One-step Application of a known Algorithm" produced an irregular situation as well: Girls attained better results in the areas fraction and number sense and boys in proportionality. Inconsistent patterns also occur with the category problem solving where the boys' achievements are better in fractions and number sense and that of the girls in algebra. The category "Multi-step Application of a Known Algorithm" shows a more homogeneous situation: Here, boys produce better results

in fractions and number sense and also in geometry.

If one analyses these differences in relation to the mathematical content areas, one receives a significantly more diverse picture for girls than for boys. Girls achieve better results in the following areas: in algebra with items on elementary conceptual understanding and problem solving; in fractions and number sense, with items on one-step applications of algorithms and in geometry with items on elementary conceptual understanding. By comparison boys demonstrate certain strengths in applying known algorithms focused on fractions and number sense, geometry and Proportionality: Their achievements were better in the areas of fractions and number sense concerning the elementary conceptual understanding, the multi-step applications of known algorithms and in problem solving, as well as in geometry with multi-step applications of unknown algorithms and in proportionality with one-step applications of known algorithms.

3.3 Category "Type of Answer"

In the TIMS Study there are three types of answer: Multiple Choice (130 items), Short Answer (23 items) and Extended Response (4 items). The analyses of the 12 countries we have taken into account demonstrate clear gender differences. The results are shown in Table 3.

Table 3: Mean percent differences of correct answers by country and type of answer

	Multiple Choice	Short Answer	Extended Response
Australia	1.05	1.79	2.77
Germany	-0.62	-1.07	2.70
Denmark	-4.67	-2.60	-3.81
England	-0.25	-0.83	-0.89
France	-1.92	-2.11	-0.29
Israel	-6.53	-4.62	-4.19
Japan	-0.70	-1.94	-2.67
Korea	-3.31	-2.02	-6.83
Netherlands	-2.57	-2.09	0.75
Switzerland	-0.93	-0.85	-3.90
Thailand	2.12	4.36	1.95
USA	-1.05	-0.56	0.24

From Table 3 it is evident that boys produce distinctly better achievements with multiple choice items, but with short answer items and with extended response items the differences are decreasing distinctly. If one looks at the differences between the three types of answers for each country separately, in a greater part of the countries, for the extended response items the differences decrease to the benefit of girls if compared with multiple choice items.

A detailed analysis on Germany which considers each of the content areas shows the following situation: girls attained better results in short answer and extended response items in algebra and measurement. In the area of fractions and number sense boys are also at the front with short answer and extended response items.

3.4 Category "Real World Context"

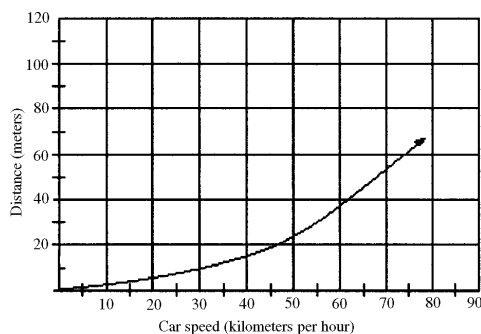
For the German sample we have analysed the real-world context. For this, we have divided the real-world items into realistic (46 items) and artificial (12 items) real-world (daily life) contexts.

The boys achieved significantly better results with items

with realistic real-world contexts (difference in mean percent: -2.18) and slightly better results with artificial real-world contexts (difference in mean percent: -0.57).

However, these are not generally occurring differences: In the case of two items which are identically in context and without any obvious difference between their required mathematical qualification, for one of the two items (O1) boys produced better results (76% correct answers of boys compared with 63% correct answers of girls), whereas for the other one (R8) the girls' achievements are better (64% correct answers of girls compared with 55% correct answers of boys). See Fig. 9.

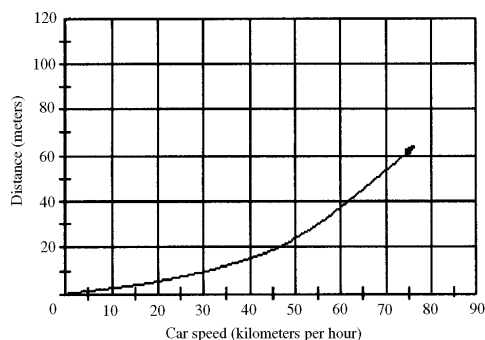
(O1) The graph shows the distance traveled before coming to a stop after the brakes are applied for a typical car traveling at different speeds.



A car traveling on a highway stopped 30 m after the brakes were applied. About how fast was the car traveling?

- A. 48 km per hour
- B. 55 km per hour
- C. 70 km per hour
- D. 160 km per hour

(R8) The graph shows the distance traveled before coming to a stop after the brakes are applied for a typical car traveling at different speeds.



A car is traveling 80 km per hour. About how far will the car travel after the brakes were applied?

- A. 60 m
- B. 70 m
- C. 85 m
- D. 100 m

Fig. 9: The two TIMSS-items O1 and R8 from the category "Real-world context"

3.5 Category "International Difficulty Index"

For each item the TIMS Study describes the level of difficulty by indicating an international difficulty index. For the German sample we analysed the five easiest and the five most difficult items. No uniform tendencies were apparent: In algebra girls produced the best results with the three most difficult and the five easiest items, whereas the boys got better results in fractions and number sense with the five most difficult items.

4. Interpretation of the results and conclusions

The analyses described in Chapter 3 can be interpreted as following: Seen from a global view, they affirm the results of the Second International Mathematics Study, that the appearing gender differences of achievements are quite small and, therefore are hardly of biological origin. As a result of her studies on SIMS, Hanna (1989) stated "The results suggest that at that age such differences vary from country to country and that they are at most very small. Since it is very unlikely that biological differences between the sexes vary from one country to another, the SIMS data tend to contradict those theories that attempt to explain boys' superiority in mathematics on the basis of biological differences" (p. 230).

Viewed in detail, our analyses show no or only a few homogeneous gender patterns. The following hypotheses seem to be assumable: On the one hand various influencing factors may possibly overlay each other – which is not unusual for large-scale studies – as for instance the reality content of the context or the type of the required mathematical qualification. Therefore the resulting tendencies cannot be interpreted unequivocally. On the other hand the TIMSS items were investigated for national and gender distortions before the main study was carried out. This means that items in which significant gender biased differences occurred, were not taken into account for the main study. Therefore, it is not surprising that for single items world-wide no big gender differences occurred and, that only if a quite large number of items is taken together, tendencies become evident.

Furthermore, some tendencies were found which in some cases were inconsistent with former research results:

- Concerning the mathematical content area, girls show some strengths in algebra, while the boys' strengths are clearly more with the content areas as measurement, proportionality and fractions and number sense. It is striking that in Germany boys are not better in the area of geometry in contrast to what was frequently stated in literature, especially for items which require spatial abilities (i.e. in a meta-analysis of a large number of studies of the type done by Hyde, Fennema, Lamon, 1990).
- Concerning the type of required mathematical qualification: Strengths of the boys are found in the algorithmical area. With problem solving and translation into mathematical-symbolic forms no sex showed distinctly better results. On the one hand this stands in contrast with the above cited meta-analysis of Hyde, Fennema, Lamon (1990) and a new meta-analysis of German studies (Klieme, 1997) which found, that boys

attained better achievements with complex tasks like problem solving. On the other hand it stands in contrast with strengths in the area of algorithms and computation which both meta-analyses subscribe to girls.

- Concerning the type of answer: The favouring of boys by multiple choice items cannot be affirmed as sharply as stated by Leder, Brew and Rowly (1999). In some cases the tendency becomes evident in that girls produce better results with items which require a more extended answer and for which guessing does not lead to the right solution; but the differences are not as distinct as one would expect from the literature concerned.
- Concerning the real-world context: In Germany boys show strengths with context related-items. This fits with the reported questioning results of Kaiser-Meßmer (1993) that boys prefer context-related tasks.

On the whole the described analyses show that general assumptions about gender differences with items on problem solving or algorithm-oriented items – at least by this type of research design – cannot be substantiated empirically. Quite similar results were received by Jungwirth (1998) with her analysis of the Austrian results of the TIMS Study from a gender perspective. If, on the one hand, one takes into consideration the results of the various countries in which – in some cases – highly different patterns of gender differences became obvious, and on the other hand the big differences between the countries, which play a remarkably more important role than the gender differences, our analyses seem to lead to the following conclusion: Gender is not the determining category for mathematics achievement, the dominating culture of learning in each country – determined by the esteem of mathematics within a society and the relevance of learning itself, the support of parents and others – is distinctly more important for the achievements in mathematics.

5. Bibliography

- Beaton, A. et al. (1996): Mathematics Achievement in the Middle School Years: IEA's Third International Mathematics and Science Study (TIMSS). – Chestnut Hill: TIMSS International Study Center
- Blum, W.; Wiegand, B. (1998): Wie kommen die deutschen TIMSS-Ergebnisse zustande? Ein Interpretationsansatz auf der Basis stoffdidaktischer Analysen. – In: Blum, W.; Neubrand, M. (Eds), TIMSS und der Mathematikunterricht. Hannover: Schroedel, p. 28-34
- Hanna, G. (1989): Mathematics Achievement of Girls and Boys in Grade Eight: Results from Twenty Countries. – In: Educational Studies in Mathematics 20, p. 225–232
- Hanna, G. (2000): Declining Gender Differences from FIMS to TIMSS. – In: ZDM Zentralblatt für Didaktik der Mathematik 32(1), p. 11–17
- Hyde, S. H.; Fennema, E.; Lamon, S. J. (1990): – Gender Differences in Mathematics Performance: a Meta-analysis. – In: Psychological Bulletin 107, p. 139–155
- Jungwirth, H. (1998): TIMSS und COMPED. Studien zur mathematisch-naturwissenschaftlichen und computerbezogenen Bildung. Konsequenzen in geschlechtsspezifischer Hinsicht. – Wien: Bundesministerium für Unterricht und kulturelle Angelegenheiten
- Kaiser-Messmer, G. (1993): Results of an Empirical Study into Gender Differences in Attitudes towards Mathematics. – In: Educational Studies in Mathematics 25, p. 209–233
- Klieme, E. (1997): Gender-related Differences in Mathematical Abilities. Effect Size, Spatial Mediation, and Item Content. – Paper presented at the 7th EARLI Conference, Athens,

29.08.1997

- Köller, O. (1998): Zielorientierungen und schulisches Lernen. – Münster: Waxmann
- Leder, G.; Brew, C.; Rowley, G. (1999): Gender Differences in Mathematics Achievement – Here Today and Gone Tomorrow? – In: Kaiser, G.; Huntley, I.; Luna, E. (Eds), International Comparisons in Mathematics Achievement. London: Falmer, p. 213–224
- Menacher, P. (1994): Erklärungsansätze für geschlechtsspezifische Interessen- und Leistungsunterschiede in Mathematik, Naturwissenschaften und Technik. – In: ZDM Zentralblatt für Didaktik der Mathematik 26(1), p. 1–11
- Mullis, I. et al. (1997): Mathematics Achievement in the Primary School Years: IEA's Third International Mathematics and Science Study (TIMSS)– Chestnut Hill: TIMSS International Study Center
- Mullis, I. et al. (1998): Mathematics and Science Achievement in the Final Year of Secondary School: IEA's Third International Mathematics and Science Study (TIMSS). – Chestnut Hill: TIMSS International Study Center
- Neubrand, J.; Neubrand, M.; Sibbers, H. (1998): Die TIMSS-Aufgaben aus mathematikdidaktischer Sicht: Stärken und Defizite deutscher Schülerinnen und Schüler. – In: Blum, W.; Neubrand, M. (Eds), TIMSS und der Mathematikunterricht. Hannover: Schroedel, p. 17–27

Authors

Kaiser, Gabriele, Prof. Dr., Universität Hamburg, Fachbereich Erziehungswissenschaften, Institut 9, Von-Melle-Park 8, D-20146 Hamburg.

E-mail: gkaiser@erzwiss.uni-hamburg.de

Steisel, Tanja, Universität Hamburg, Fachbereich Erziehungswissenschaften, Institut 9, Von-Melle-Park 8, D-20146 Hamburg.

E-mail: steisel@erzwiss.uni-hamburg.de