CHAPTER 14

ICELAND AND RURAL/URBAN GIRLS-PISA 2003 EXAMINED FROM AN EMANCIPATORY VIEWPOINT

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ABSTRACT

Scholarly research related to gender and mathematics is not as frequently published as it was in the 1980s and the 1990s. In Lubienski's (2000) survey of Mathematical Education Research from 1982 to 1998 there are 367 publications in Journal for Research in Mathematics Education (JRME) and 385 publications in Educational Studies in Mathematics (ESM) about gender. This gives us approximately 21 publications a year in JRME and 22 publications a year in ESM. We did a search of publications about gender in JRME and ESM from 1999 to 2005 (or today) and saw a very different picture. Over this period 14 publications were in JRME and 17 publications in ESM, which gives approximately 4 publications a year in JRME and 3 publications a year in ESM.

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> So what do these numbers tell us about the status of research about gender and mathematics? Does this mean that the gender gap has been closed? If so, for whom is that true? Does it mean that we don't have to worry about gender differences in mathematics any more? And if it is true, is it certain that it will sustain itself without any follow up? Finally, why are there still differences in women entering fields such as mathematics and physics?

A BRIEF SURVEY OF GENDER DIFFERENCES

According to Albert Bandura's (1977) persistence theory self-efficacy is positively related to persistence. In other words persistence on a (math) problem in spite of frustrations is more likely to lead to a solution/success (Brown, Lent & Larkin, 1989; Schunk, 1985). Low self-efficacy in females has been attributed to low parental expectancies and sexual stereotyping in the attitudes of teachers and male students in school. The literature in gender studies suggests that society as whole believes that females are less mathematically capable than men (Aiken, 1974; Burton, 1979; Fenemma & Sherman, 1977, 1978). The findings were also not different for gifted girls (Benbow & Stanley, 1980; Cramer, 1989; Eccles, 1985). Females are particularly vulnerable to the stereotype that "girls just can't do math" and when women go onto courses like calculus they fare less well than men who have shown equal promise up to that point (Fennema & Sherman, 1978). *Arguably the aforementioned literature is a bit outdated, which leads one to question whether the situation is different today?* At ICME 10 (International Congress of Mathematics Education) held in Copenhagen in 2004, Topics Study Group 26 was about gender and mathematics education and 15 papers were presented. Two studies from Scandinavia showed interesting results about gender differences still in existence. In particular, a study from Sweden with 9th and 11th grade students showed that students still viewed mathematics as a male domain (Brandell, Nystrom, & Sundqvist, 2004). Another study from Finland reported that teachers held different beliefs about girls and boys in their classroom, believing that girls tended towards routine procedures whereas boys use their power of reasoning (Soro, 2004). These findings suggest that not much has changed in terms of society's dominant conceptions of mathematics.

A study from the US indicated that girls' self-confidence was an important factor when it came their participation in mathematics. In this study 121 middle school girls took part in a 5 day residential summer camp about mathematics. The population distribution was 69% white, 10% American Indian, 7% Hispanic, 4% Asian, 2% black and 8% bi-racial. The summer camp had a positive impact on their achievement. These researchers suggested that the girls' increase in their self-confidence accounted for their achievement (Wiest, 2004). Again the implication we draw from this study is that girls' self-esteem was still perceived as an important factor when it came to their career choices and higher education.

Another study from South Africa reported gender differences in attitudes toward mathematics are in favor of males. Girls reasons for taking math course was external while the boys reasons were internal. Girls reported that math was difficult whereas boys did not think so. And finally girls did not think that math was particularly useful in their home environment whereas boys said it was useful because it was in their environment. These authors suggested that these fundamentally different views were due to differentiated socialization processes (Mahlomaholo & Sematle, 2004).

An Australian study reported gender differences in the use of technology (computers and hand-held technology) in mathematics classes. Males were more likely to believe that technology had a positive effect on mathematical learning. In addition, teachers perceived that males had more suitable characteristics to benefit from using technology to advance in mathematics. Compared to females, males were also more prepared to take risks and have a go at using the software. Is mathematics is doomed to be considered a male domain? (Forgasz, 2004).

A study from Iran which analyzed the University Entrance Exam reported that females were less interested in mathematics than their male counterparts. Also male students are more successful in Mathematics and Physics, and the acceptance rate based on the Exam was in favor of males (in 2003 approximately 64% were male) (Pourkazemi, 2004).

Becker and Rivera (2004) presented a synthesis of perspectives used to investigate gender and mathematics in different countries (from the gender working group for the last several meetings of PME-NA and PME international). There synthesis suggests that four perspectives are present in the research on gender and mathematics. They label them (1) Predict, (2) Understand, (3) Emancipate, and (4) Deconstruct. The first perspective Predict falls under the umbrella of a positivist view and many studies conducted in the '70s and '80s fall in this category. The second perspective, Understand, are studies that attempt to make sense of the reality of gender and math without changing the social environment. We would argue that many of the studies looking at gender and mathematics in the 90's fall under this category. The third perspective Emancipate is research where gender is not seen as an isolated variable but is intertwined with race, class, ethnicity, and culture. Finally in the fourth perspective, Deconstruct, gender is viewed as performances and is subject to social construction and the goal is to deconstruct common beliefs. Their findings suggest that even today not many studies about gender and mathematics fall under the third and fourth perspectives.

PISA (PROGRAMME FOR INTERNATIONAL STUDENT ASSESSMENT) 2000 AND 2003

Despite the common belief (in many western countries) that the gender differences in mathematical achievement has been bridged, PISA, in addition to various presentations at ICME 10 provided documented statistically significant gender differences in achievement in favor of boys both in the year 2000 and 2003. In the year 2000 statistically significant gender difference in achievement were found in 29 countires of the 41 participating countires. In year 2003 statistically significant gender differences in achievement were found in 27 countires of the 41 participating countires. The only country in PISA 2003 which had statistically significant gender differences in achievement in favor of girls was Iceland. In the following sections we will give a brief review of the PISA study followed by a closer look at the Icelandic data.

PISA—INTRODUCTION

In today's society the prosperity of a country is largely dependent on their human capital and how well individuals can advance their knowledge and skill in a rapidly changing world. In 1997 The Programme of Economic Cooperation and Development (OECD) launched the Programme for International Student Assessment (PISA) to develop an international study. The cross-national comparison on students performance could provide contries with information to judge their strengths and weaknesses and to monitor progress. PISA seeks to measure how well students at the age of 15 are prepared to meet the challences of today's knowledge societies.

The key features of PISA have been:

- its policy orientation, with design and reporting methods determined by the need of governments to draw policy lessons
- the innovative "literacy" concept that is concerned with the capacity of students to apply knowledge and skills in key subject areas and to analyze, reason and communicate effectively as they pose, solve and interpret problems in a variety of situations
- its relevance to lifelong learning, which does not limit PISA to assessing students' curricular and cross-curricular competencies but also asks them to report on their own motivation to learn, their beliefs about themselves and their learning strategies;
- its regularity, which will enable countries to monitor their progress in meeting key learning objectives

- its breadth of geographical coverage and collaborative nature, with the 49 countries that have participated in a PISA assessment so far and the 11 additional countries that will join the PISA 2006 assessment representing a total of one third of the world population and almost nine-tenths of the world's gross domestic product (GDP) (OECD, 2003, p. 20).

PISA measures students´ preformance in literature, mathematics, and science and is conduceted in stages. The first stage was conducted in 2000 with literature was the main focus. The second stage of the sudy was conducted in 2003, where mathematics was the main focus. The third stage is 2006, where the primary focus will be science. In 2009 the circle will start again, with the main focus on reading.

ITEM DESIGN, ANALYSIS AND SCALES

PISA measures student's mathematical knowledge and skills, which are assessed according to the following three dimensions.

1. The mathematical content to which different problems and questions relate
2. The processes that need to be activated in order to connect observed phenomena with mathematics and then to solve the respective problems
3. The situations and contexts that are used as sources of stimulus materials and in which problems are posed (OECD, 2003, p. 38)

The mathematical content area assessed in PISA is built on a consensus among OECD countries and appropriate for international comparison. The content areas are:

- *Space and shape* relates to spatial and geometric phenomena and relationships, often drawing on the curricular discipline of geometry. It requires looking for similarities and differences when analyzing the components of shapes and recognizing shapes in different representations and different dimensions, as well as understanding the properties of objects and their relative positions.
- *Change and relationships* involves mathematical manifestations of change as well as functional relationships and dependency among variables. This content area relates most closely to algebra. Mathematical relationships are often expressed as equations or inequalities, but relationships of a more general nature (*e.g.*, equivalence,

divisibility and inclusion, to mention but a few) are relevant as well. Relationships are given a variety of different representations, including symbolic, algebraic, graphic, tabular and geometric representations. Since different representations may serve different purposes and have different properties, translation between representations is often of key importance in dealing with situations and tasks.

- *Quantity* involves numeric phenomena as well as quantitative relationships and patterns. It relates to the understanding of relative size, the recognition of numerical patterns, and the use of numbers to represent quantities and quantifiable attributes of real-world objects (counts and measures). Furthermore, quantity deals with the processing and understanding of numbers that are represented in various ways. An important aspect of dealing with quantity is quantitative reasoning, which involves number sense, representing numbers, understanding the meaning of operations, mental arithmetic and estimating. The most common curricular branch of mathematics with which quantitative reasoning is associated is arithmetic
- *Uncertainty* involves probabilistic and statistical phenomena and relationships that become increasingly relevant in the information society. These phenomena are the subject of mathematical study in statistics and probability (OECD, 2003, p. 38–39)

The items had a variety of formats where various competencies were required. They include *thinking and reasoning, argumentation, communication, modeling, problem posing and solving, representation, and using symbolic, formal and technical language and operation.* The problems were then organized in three competency clusters. The first being *reproduction cluster,* the second being *connection clusters,* and finally *reflection clusters.* The tasks were set in different context varying in the degree of distance between the student and the situation, (1) personal situation, (2) educational or occupational situation, (3) public situation relating to the community, and (4) scientific situation.

The problems varied in formats. The items were categorized into (1) multiple choice, (2) complex multiple choice, (3) closed constructed response, (4) open constructed response, and (5) short response. According to the characteristics of each task and which competency they address the tasks were labeled from one to six according to difficulties, one being the easiest. Students were categorized according to these six proficiency levels depending on their scores and which problem they could solve (see Figure 14.1).

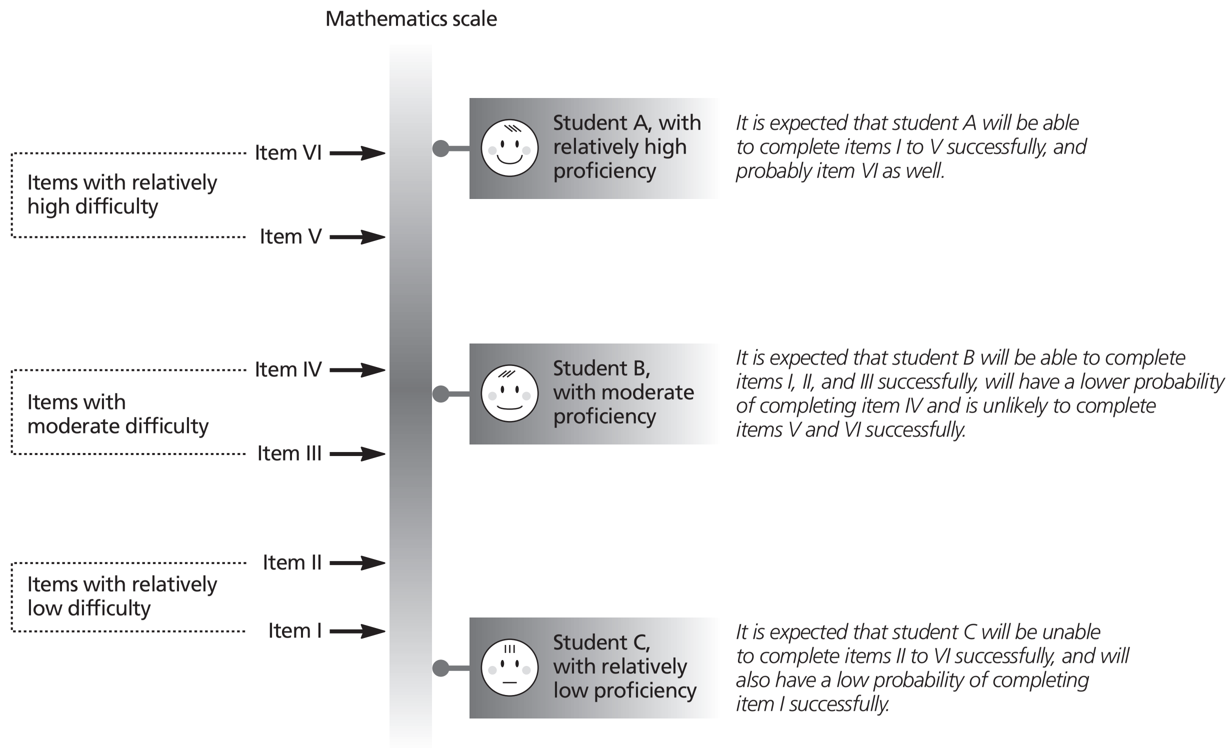

Figure 14.1 The relationship between items and students on a proficiency scale (OECD, 2003, p. 45).

OVERALL RESULTS

Overall students' achievement according to proficiency levels in each concept area is presented in Table 14.1. Around 90% of all students could solve level I problems. Approximately 50% of all students could solve level III, and around 5% of all students could solve level VI problems. Analysis of individual country performances is available in the PISA report (http://www.pisa.oecd.org) but it will not be summarized here.

TABLE 14.1 Students Performance and Level of Proficiency

Level of proficiency	Space and shape	Change and relationship	Quantity	Uncertainty
I	87%	87%	88%	90%
II	71%	73%	74%	75%
III	51%	54%	53%	54%
IV	30%	32%	31%	31%
V	15%	15%	13%	13%
VI	5%	5%	4%	4%

GENDER DIFFERENCES IN MATHEMATICS AND ICELAND

As mentioned before studies focusing on gender differences in mathematical achievement or other gender differences related to mathematics has declined considerably for the last 10 year. Also, a popular belief is that the gender difference favoring male students does not exist any more. Whether the lack of research on the issue at hand is a contributing factor to this common belief is unknown. Following this belief about the disappearing differences, voices claiming that males were now being shortchanged in school became louder and more public. PISA 2003 showed interesting results in relations to gender differences in mathematics that contradict the popular discourse that boys are on a losing streak in education.

According to PISA 2003, in just over half of the participating countries males outperformed females, or in 17 OECD countries and 4 partner countries.[1] In addition, in mathematics and computer science, gender differences favoring males remains persistently high (OECD, 2003). Looking closer at the graduating rate of females in different subject areas, the average number of females graduating in mathematics and computer science is only about 30% of total graduation. Interestingly, despite the reverse gender differences in mathematical achievement in Iceland, the proportion of females graduating with a postsecondary degree or higher in mathematics and computer sciences is just around 20%. For comparison postsecondary graduation of women in humanities, arts and sciences is around 70& within OECD countries but reaches 80% in Iceland (OECD, 2004).

In Iceland, as mentioned before, there were significant gender differences in mathematics achievement in favor of girls. Dividing Iceland into two regions, Reykjavik metropolitan area and rural area, significant gender differences in achievement was only found in rural Iceland. For further analysis Iceland was divided into 9 regions, 2 of them being Reykjavik metropolitan area and 7 rural areas. The largest difference was found on the south coast of Iceland with the point difference being 30 points. The lowest difference outside the Reykjavik area was 12 points found at the east fjords. Other five areas point differences was 17, 20, 25, and 26 points. As mentioned above the gender differences in the Reykjavik metropolitan area was not significant, or on an average 4 points (Olafsson, Halldorsson, & Bjornsson, 2006).

PISA 2003 categorized mathematical performance into 6 levels, level 0 being low proficiency and level 6 being high proficiency. In general the results show that more males than females reached level 6 or, 7% of males and 4% of females. In Iceland around 4% of all students performed at level 6. The gender differences in number of students performing at level 6 differ by regions. In Reykjavik and surrounding areas a greater portion of males reached level 6 compared to females. On the other hand in rural areas more females reached level 6 than males (Olafsson, Halldorsson, & Bjornsson, 2006). It is interesting that the difference at level 6 was less than the differences at other levels. At the other end of the spectrum, that is students at Level 0 and Level 1, more boys than girls were categorized at these levels in all regions, 18% and 11% respectively.

When the four areas of mathematics that were tested are analyzed according to gender it can be seen that the gender differences are not the same across areas. The largest difference was found in Quantities, followed by Space and Shape and Change and Relationship. The smallest difference was found in the category Uncertainty. It is also interesting that Iceland scored highest in the uncertainty category of all the countries (Olafsson, Halldorsson, & Bjornsson, 2006). Despite this unusual gender differences in favor of girls found in Iceland, Icelandic girls are not different from other girls in the study when it comes to math anxiety, and mathematical confidence, there the gender differences are in favor of boys (Olafsson, Halldorsson, & Bjornsson, 2006).

DISCUSSION AND REFLECTIONS

Some thoughts and ideas have been tossed around in the attempt to explain these unusual results. We will now share some of these ideas and add some of our own ideas.

One of the more popular explanations is so called "jokkmokk" effect. To explain it simply, jokkmokk effects refer to this "phenomena" of females outperforming males academically in rural areas. It suggest that the environment, such as the labor market, prevent males to see value in academic education, on the contrary the same environment encourage females to do well in school in the hope of achieving some status in their future or leave their hometown in search for a "better" life. Applying this idea to the Icelandic situation it probably has some effect but to believe it is the answer is naïve. It is true in some rural areas in Iceland males can be financially successful without a post secondary degree. On the other hand most traditional female jobs today require college degrees, such as nurse, teacher, or bank teller.[2]

Another explanation could be related to school environment and the gendered discourse that takes place among teenagers. A study in Iceland reported on interesting gender differences in what is accepted discourse among teenagers in Iceland (Magnusdottir, 2005). Their findings imply that it is accepted that girls work hard to get good grades and in fact it is expected of them to do so if they want to get good grades. For boys on the other hand it is not the case. The common belief is that boys do not have to study, they get good grades anyway. One can argue that most individuals, females or males, have to study to achieve good grades. With that in mind and the PISA results the teenage boys are then more likely to achieve lower scores than teenage girls. That is, if it is not "cool" for the teenage boys to study than one can expect that only few teenage boys will achieve high scores (assuming that most teenage boys are influenced by the dominant discourse in their peer group). But the question remains how does this argument explain the lack of gender difference in Reykjavik metropolitan area? Also the fact remains that a higher proportion of boys in the Reykjavik metropolitan area reached level 6. Are self efficacy and stereotyping vulnerability in mathematics contributing factors?

Related to the gendered discourse explanation is to examine if the classroom is a feminine environment and therefore less suited for boys. This question has been found within the circle of researchers and laymen that have been questioning the status of boys in primary and secondary education. Two Icelandic women Berglind R. Magnusdottir and Thordgerdur Einarsdottir (2006) make a compelling argument that rejects this notion in Iceland, one being the structure of the academic system from a historical point of view. Even though schools today have more female teachers and included more of what would be categorized as "feminine" trades, such as caring, cooperation and shared management, the "masculine" trades still have strong hold in the foundation of the educational system, such as teacher-center pedagogy, lectures, and individual work. One of the more "amusing" arguments that they provide is an Icelandic study that show that boys complain more that they do not feel so good in school and this complaint gets louder with age (Jonsdottir et. al, 2002). What is interesting about this is that in Iceland, as in many countries, the number of male teachers increases in secondary school. Maybe one can argue that with more male teachers, male students' feelings worsen. Finally, when the use of the special education budget is examined, proportionally more is spent on male students and in addition male students gain more from the special education that is offered in schools. With that being said and in all seriousness related to the number of male students in special education, we do think it is an issue that is worthy of more research.

The last idea that we will present, and the most interesting one to us, is the correlation between students' reading comprehension and mathematical achievement. An analysis of the achievement of Norwegian and Swedish students show high correlation[3] between the two, that is, high score in reading comprehension correlates with high score in mathematics (Roe & Taube, 2006). In addition the Norwegian and Swedish analysis shows that the strength of the correlation is greater on items that called for "more" complex mathematical understanding, such as reproduction and open constructed answers.

The gender differences in reading comprehension in favor of girls were the largest in Iceland of all the participating countries and were significant in all regions of Iceland. When the data was analyzed by controlling for reading comprehension the males scored little higher than females. That is, given the same level of reading ability one could predict that female would achieve lower scores than males (Olafsson, Halldorsson, & Bjornsson, 2006). These results are interesting and even though the gender differences in the urban area was slightly lower than the difference in the rural area it does not fully explain the lack of gender differences in mathematics in the Reykjavik area. The correlation between reading and mathematical achievement can potentially provide partial answers in the search for explanation and needs to be studied further.

Maybe the last question to ask is if these results are reliable or a flukish-one time results. Olafsson, Halldorsson, & Bjornsson (2006) look at the Icelandic National Mathematics Test scores from 1994 to 2004. According to their analysis the gender differences in mathematics in favor of girls has been measured all the years mentioned. On the other hand the differences between scores of urban and rural students are not consistent, that is over these 10 years the gender differences vary across regions each year. It is important to mention that The Icelandic National Mathematics Test scores for year 2003 mirrors the outcome of PISA 2003. We can then argue that the PISA result has some merits and deserve further research.

With all this said the question about the Icelandic "phenomena" remains mostly unanswered at this time. One thing that is clear to us though is that poor performance of boys in mathematics is *not* because they are receiving lesser quality mathematical instruction in school like the picture some media and politicians are trying to paint. As so often is the case, in the search for answers, before the answer is "found" more questions are generated with each step. We will therefore end this chapter by posing few questions that we feel compelled to ask or we interpret what the data suggests.

- If boys' reading comprehension score were higher or at the same level as girls would they do better than girls? In mathematics? In other subjects?
- Should the schools focus on boys reading comprehension more?
- Is the "problem" because of the mathematics curriculum or the teaching of mathematics?
- Are boys falling behind in mathematics because "doing" school mathematics calls for more reading and writing than it used to?

Our next step is indeed to search for some concrete answers!

NOTES

1. 30 OECD countries participated and 11 partner countries.
2. In today society jobs such as bank teller is often occupied by people with some business degrees.
3. Correlation coefficient of 0.57

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