

Pisa 2003 and the Gender Differences in Mathematics in Iceland: Possible Explanation

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Abstract

PISA 2003 presented interesting results about students' mathematical achievement in Iceland, where Iceland was the only country that showed significant gender differences in mathematics in favor of girls. These unique results when statistically analyzed, it became evident that the gender differences were only measurable in the rural areas of Iceland. This poses a very interesting question about differences in rural and urban educational communities. The authors conducted a qualitative study in Iceland in 2007, in which 19 students from rural and urban Iceland who participated in PISA 2003 were interviewed in order to investigate these differences and determine factors that contributed to gender differences. The purpose of these interviews was to get students to elicit their thoughts on their mathematical experiences, their beliefs about mathematical learning, their thoughts about the PISA results, and their ideas on the reasons behind the unusual PISA 03 results. The data was transcribed, coded and analyzed using techniques from grounded theory in order to build categories and to present feminine and masculine student perspectives on the Icelandic anomaly.

Revisiting the Gender Debate

Gender differences in mathematics achievement and its relationship to self-efficacy and numerous other variables such as parental, teacher and societal expectancies (Burton, 1979, 1986; Fenemma & Sherman, 1977, 1978; Fenemma, Peterson et al., 1990), sexual stereotyping as well as differential achievement-relevant attitudes (Taylor, Pollard, Leder, &

Atkins, 1996) are well documented in the research literature. These variables may be categorized as internal and external variables. For instance a major factor that impacts female achievement in mathematics are internal conceptions or beliefs imposed by external agents, such as the belief that *mathematics* is a male domain (Hyde et al., 1990; Fennema, 1990; Fennema and Peterson, 1985; Leder, 1986; Leder & Fennema, 1990; Sriraman & Steinthorsdottir, 2007). External influences include teacher-student interactions (Iben, 1991; Ma & Kishor, 1997; Keller, 2001; Tartre & Fennema, 1995). Another important dimension in this debate is the issue of race of class (Atweh and Cooper 1995; Ernest, 2007), research on which has shown that girls and children of immigrants and minority groups under achieve in mathematics (Coard, 1971; Walkerdine *et al.*, 1989).

In the UK and Australia several studies provide evidence for the “hidden” link between socio-economic class and their choices in university studies. Maslen (1995) wrote that students in their final years of compulsory schooling were twice as likely to pursue mathematics and science if they are from the higher socio-economic status bands, compared with the lower (Ernest, 2007). Albert Bandura’s (1977a,b) persistence theory suggests that a person’s self-efficacy has a positive relationship with 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. These findings are also not different for gifted girls (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; Lubienski & Bowen, 2000).

At ICME 10 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. 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). Their 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. Their findings suggest that even today not many studies about gender and mathematics fall under the third and fourth perspectives.

PISA 2000 and 2003

Despite the common belief (in many western countries) that the gender differences in mathematical achievement has been eliminated, PISA, documented statistically significant gender differences in achievement in favor of boys both in the year 2000 and 2003. The only one country in PISA 2003 which had statistically significant gender differences in achievement in favor of girls was Iceland.

The case of 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. Following this belief about the disappearing differences, voices claiming that males were now being shortchanged in school became louder and more public. According to PISA 2003, in just over half of the participating countries males outperformed females, or in 17 OECD countries and 4 partner countries. 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 was a significant gender differences in mathematical achievement in favor of girls. Dividing Iceland into two regions, Reykjavik metropolitan area and rural area, significant gender differences in achievement is only found in rural Iceland. (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). 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.

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?

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 (2005) 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. 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. 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. 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 a picture some media and politician try to paint.

The Study

Participants in our study were males and females that had taken part in the 2003 PISA. At the time of the interviews these individuals were turning 20 years old. It is important to note that Iceland is a very homogeneous country in term of race and religion. All the participants were Caucasian low to high middle class. To collect the data for this study we selected 3 rural towns and the Reykjavik area to conduct the interviews. These interviews were conducted in Spring 2007. We conducted 4 group interviews with 17 individuals, 9 females and 8 males, and two individual interviews, one female and one male. Two groups were from the northern part of Iceland, one group was from the Reykjavik metropolitan area, one group was from the Reykjanes peninsula, and two individuals from the south-west part of Iceland. Only three of the participants interviewed where not in school at the time of the interview. Others were either in a traditional academic track, planning to apply to the

university, or in vocational schools mastering trades such as carpentry, hairstylist, or fashion design.

All interviews had 3 parts and were structured the same way. The first part was to have the students reflect on what math class looked like in 8th -10th grade. The second part was to have them respond to the PISA 2003 results. In the third part they were introduced to two hypotheses that have been proposed as an explanation of the Icelandic results. Each interview lasted from 1 hour to 1.5 hours. Each interview was transcribed.

Each interview started with our asking the students about what they remembered about the structure of the mathematics classes in 8th -10th grade. The purpose was to get some idea of what pedagogical practices were common among them in grade 8th -10th. In questions two, three and four, students were introduced to different results of PISA and they were asked to reflect on the results. The second question was a general question about the results of the PISA 2003 and the unique gender differences in Iceland. The third question introduced them to the results that show that the gender difference was only found in the rural Iceland but not in the Reykjavik metropolitan area. Question four introduced them to the analyses that show the connection between students score in reading comprehension and mathematics. For the fifth question they were introduced to the “jokkmokk” effect hypothesis and asked to respond to the reasonableness of the argument. For the sixth question they were introduced our hypothesis about financial independence. Finally they were offered to make some final remarks or add thought that had not come up.

Data Analysis

Since gender differences in achievement is an extremely complex construct involving a wide range of interacting behaviors, we believe it should be studied holistically. The principle of analytic induction (Patton, 2002) was applied to the interview transcripts to discover dominant themes that described the behavior under study. Following the principles

of analytic induction, the data was carefully analyzed in order to extract common strands. These strands were then compared to theoretical constructs in the existing literature with the explicit purpose of verifying whether existing gender models was applicable to this qualitative data as well as to extract themes that characterized the student's views. If an emerging theme could not be classified or named because we were unable to grasp its properties or significance, then theoretical comparisons were made.

Results

Not to any surprise all the students we interviewed described their mathematics classes in 8th through 10th grade as a traditional. That is the teacher explained an example on the board and they were then to solve assigned problems. If they did not finish the assigned problems in class they were suppose to finish them at home. The textbook that they all used was a traditional mathematics textbook. Icelandic educational system is centralized and due to the size of the country the variation of textbooks is small and in 2003 the textbooks that were used in 8th to 10th grade can be categorized as a traditional textbook. It is therefore likely that most students' experiences similar mathematics lessons in 10th grade.

Gender differences and gender difference in rural Iceland

Four general themes emerged from the interviews about why girls did better than boys. They were parental influence and upbringing, peer pressure and the gendered discourse among teenagers, professional ambition, and general human development.

Parental influences and Upbringing

Most of them agreed about the importance of parent's involvement and caring. They articulated the importance of parents showing interest in their school work and keeping track on if they were doing their school work. Few males thought it was important for parents to put some pressure on them to do their school work by for example cutting their allowances if

they did not do well. The females did not agree with that, but emphasized that parents should show interests in their children's school work.

The term children's upbringing and gender differences in upbringing were frequently mentioned. They all agreed that girls were more likely taught to behave accordingly and do what they were supposed to do. "Boys are supposed to be handful, they are just supposed to be like that, boys will be boys" was one girl's explanation. It is clear that our interviewers thought that the upbringing was gendered from birth. Their perception was that because of the differences in upbringing girls were more capable to adapt to the demands of the mathematics classroom at this age and do what was expected of them. Boys on the other hand were more likely to be "thrown out" because of their behavior and as consequences they were more likely miss what was covered in the math classes.

When asked further how that might explain the gender differences in Iceland interesting interpretations emerged. Their perception of parents' involvement was that parents paid more attention to their girls. Parents were more likely to keep track on their daughters if they did their homework and if they were doing well in school. On the other hand their sons seem to have more freedom to do what they pleased, such as hang out with friends and go to soccer practices. An interesting explanation came from some of our interviewers why parents might be more concerned about their daughters' achievement was related to the society and the world they live in today. Following is a comment from one of the girls.

"Girls pay more attention to their studying because it is important for them to do well in school to get somewhere, particularly for our generation. Parents are maybe more likely to push their girls to study because they know it is very important for the girls." Women's possibility to get educated and be an influential citizen in the society is relatively new and therefore parents were more concerned that their daughters understood what that meant for them. If a woman wants to take advantage of the possibilities that the society has to

offer women's education is very important. On the other hand, from a historical perspective white males have a certain status already in the society and therefore the "danger" for them to lose the opportunities that come their way.

Peer pressure and the gendered discourse among teenagers

Our data supports Magnusdottir's findings (2005) related to the influences of the school environment and the gendered discourse that takes place among teenagers in Iceland. All our participants brought up the notion that boys are under more pressure to be "cool" than girls. When asked what it meant to be "cool" one major factor was not to study. This idea was presented in multiple contexts and phrases. "Girls are expected to study hard to get good grades so they can" and "if boys study hard there is something wrong with them" were common explanations both from our male and female participants. One of our male participants emphasized the teenage culture and its influence on their behavior at this age. His explanation was that "the expectation and norms of the society at this age is that boys are tough and girls well behaved, I think it has an impact. In my school it was not cool to do math or study."

The phrase "boys are supposed to be smart and not study" was brought up by all groups. The male participants were all agreeing with this notion and had multiple examples to offer. The affect it had was that boys tended not to admit that they did study, or as one boy articulated "if you had to study for the exam you were not very smart, it was cooler to get the 10 without studying." This reflects to some extent the common belief and biases that white males are biologically superior in intellect than women. It is depressing to think that this notion is still very much alive among some Icelandic teenagers. But there is a light at the end of the tunnel. These individuals we interviewed were aware that most boys who did well in school did also study hard and everybody agreed when they were reflecting back that "if a boy did get good grades he never admitted that he had to study". We might therefore argue that their view of male superiority in intellect had changed as they matured. This will be

contradicted later when the discussions about smart boys and smart girls surfaced. The girls particularly had the view that smart boys were smarter than smart girls, where the term “smart” referred to being good in mathematics.

Sports and school work

Sport is an important factor in adolescence life in Iceland. Most of our participant practiced some sport when they were in 10th grade of various degrees. During our conversations about male’s experience of peer pressure it became evident that the pressure from the peer group where twofold, school work and sport. Our male participant all agreed that sport was important than school at this age. Phrases like “for boys it is more important to go to a soccer practice than to study”, or “for boys it is more important to be good in sport than to get good grades” were not uncommon.

Our female participant did not experience the same pressure of the importance of being good in sport rather than school. They agreed in general that “it was important to be in sport but also to study and we all did both”. Again they believe that female have to study to be good in school is expected and girls did not feel any negative pressure if they decided to spend more or less time on school work and sport.

When asked how this explains why there was only gender difference in the rural area they thought of the differences school size in Reykjavik and rural areas. In Reykjavik there could be up to six 10th grade classes in one school, whereas in rural area there might only be one 10th grade class in the town. In a larger school system there is more variety of peer groups to choose from. There a male student that studies hard is more likely to find few others that share his view and together they support each other and develop a friendship. One girls’ explanation was this:

“In a school in Reykjavik if there are two boys that like read all day long then there might be the third one that like would join them and then they are a group and they

can like support each other. But there might be like this one boy in a small town that does well in school, but he does not have any chance to like redeem him self because there is no one to support him because there is no one else like him.”

Related to this our participants talked about cliques and to belong to a clique. Their perception was that in Reykjavik a guy had more cliques to choose from. In Reykjavik one would be more likely to find different groups such as the sport clique, the do-well-in-school clique, and the party clique to be part of but in a small town there might be only one group.

Ambition, maturity, and future goals

In general our male participant all agreed that their female counterparts where more ambitious and goal oriented at this age. They agreed that the “boys are more busy being cool” then thinking about how they might achieve the future goals they might have during the teenage years. In our interviews it was clear in all parts that both our male and female participant thought that girls were more independent then them boys at this age.

Reading comprehension and gender differences

Peer pressure and the gendered discourse

When introduced to the possible relationship between reading comprehension scores and math scores in the PISA 2003 assessments the theme of peer pressure and the gendered discourse became prevalent. The all agreed that boys were more likely ridiculed for their passion of reading then girls. Most of them agreed that “a boy that likes to read is more likely to be looked at as being weird rather than girl and therefore they might not spend as much time of reading as girls”. One girl’s view added and interesting look on why boys might not have scored as high as girls on reading comprehension. She believed that the content of the text the student had to read might be a factor.

“I don’t remember any reading comprehension text about like soccer. It is always about people and emotions and girls are usually better to like analyze people and

emotions than boys so it easier for girls to understand ...Girls can see the like tiniest differences between emotions but for boys it is black or white.”

Smart boys and reading vs. smart girls and reading

Interestingly the girls were more vocal when it came to the results that indicate that boys with high reading comprehension score are more likely than girls to also have high score in mathematics. Their explanation came back to the gendered discourse about male superiority in intellect. Phrases like “smart girls are more likely to be smart in reading comprehension than boys”, “boys with high score in reading comprehension are good in everything”, “a girl with a high score in reading comprehension is not necessarily also good in math”, “smart boys are more likely to be smart in math or math related fields than girls”, “smart boys are smart in everything”, and “smart girl is often smart in one or two things” came only from our female participants. They had multiple examples of girls they knew that loved reading and were very good at it that did not do well in mathematics. They believed that was not the case with the boys and examples like “I don’t know any boy that likes reading that is not also good in math and other things” were shared. Our male participants were more likely to believe that this study was a one case phenomenon that would not necessarily repeat it self.

Role models

Both our female and male participants talked about the importance of role models and how it might influence their view of different professions. The girls talked about the lack of women in math related fields such as physics and mathematics and how it might have an impact on girls’ choices and support the common belief that males are more suited to learn mathematics. One girl’s comment was “of course it is important for young girls to see that women can do the same thing as men and as well as men”. Another girl discussed the importance of seeing women with different careers.

“Now women are more in public places and in administration positions than before.

Also when I looked at the brochures from the University there were a lot of photos of women, there are not only old men that teach at the University, there are lots of young and beautiful women.”

The males agreed with the importance of role model. They also expressed pleasure in seeing more women at the university and other public places, “I think it is great, that is the way it is supposed to be.

The Jokkmokk effect and individual’s financial independence

The “jokkmokk” effect

Most of our participants agreed with the general idea of the “jokkmokk” effect hypothesis. They thought that most kids want to leave their small town in search of adventure and/or opportunities. They did agree that girls were more likely to move because girls are more organized and goal oriented. That is, girls were more likely to work towards the goal of leaving if that were their goal. Boys on the other hand talk about wanting to leave but don’t work towards that goal. One girl thought explained this idea clearly when she said “it is not that the boys don’t want to leave they just are too careless at this age that they don’t think about it as something they have to plan ahead to go”. Another supportive argument for the “jokkmokk” effect hypothesis came from a girl in Reykjavik.

“Boys are more homebound, girls want to stand on their own feet and they want to show that they can do it, the girls want to show it to their community that they can do it. I have two (girl) friends that go to school in Reykjavik from their home town. They take the bus to Reykjavik every morning to be able to go to that particular school and it is very important for them to show their community that they can do it. I don’t know any guy that does something like this”.

Financial independences

Our participants were more in agreement with the idea that the importance of gaining financial independence were more likely explanatory factor for rural girls' achievement rather than the "jokkmokk" effect. They did agree that the chances in rural areas for uneducated male to become financially independent then women. All the males agreed that "there are much more jobs for males in rural areas, it is probably not the dream of many girls to work in the fish factory or in the grocery store."

In our discussions about what made more sense the "jokkmokk" effect hypothesis or the search for financial independence it became clear that the two hypotheses are highly linked in their mind. In our discussions they linked the "jokkmokk" effect hypothesis to the need of financial independence. Two male participants talked about how they could understand why more females might leave their hometown and how it was connected to the possibilities of gaining financial independence.

"I think some guys go out on see and earn a lot and then there is no need to go anywhere"

"Role models for guys in the rural area that quit school are more positive than for girls. The role models that the girls have are women working in the fish factory or in the store earning minimum salary."

Our female participant agreed that female wanted to leave their communities but not because they did not want to return. Even if women wanted to stay in their communities and have a possibility to gain financial independence they need education. If women have career goals in their hometown that is beyond working in the fish factory or in the grocery store they need some post secondary education.

Discussions

In a country where girls out performance males one should think that more women would continue their studies related to mathematics. Unfortunately that is not the case. For

example all of the women in our interviews were finishing their college preparatory schools or gymnasium and entering university in fall of 2007 but none of them were going to study mathematics, physics, computer science or engineering. The women were interested in business, teaching profession, medical fields, biology or biochemistry. What is also interesting were the women's perceptions of males' mathematical superiority. Their beliefs were that males catch up with the females when there are in the gymnasium and at the end of 4 years in gymnasium the females in the study believed that males outperformed females. When the females were asked further if they thought that males were in general better than females in mathematics they agreed with the statement.

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