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**Girls play with Barbies, boys play with Legos: *Explanation for gender differences in mathematics***



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# Presentation Outline

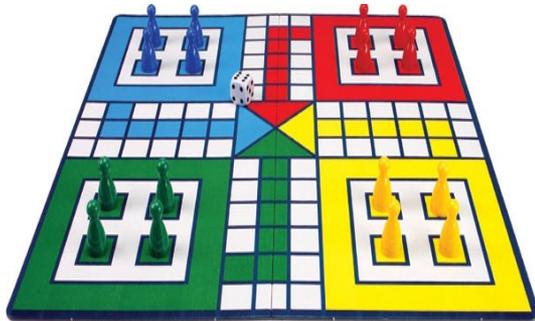
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- **My relation to Mathematics**
  - **Historical background information on gender and mathematics**
  - **Research findings on representation of females in mathematics, science, and engineering and the causes of low female participation in mathematics**
  - **My case study with undergraduate female students**
  - **Recommendations**
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# My Relation to Mathematics

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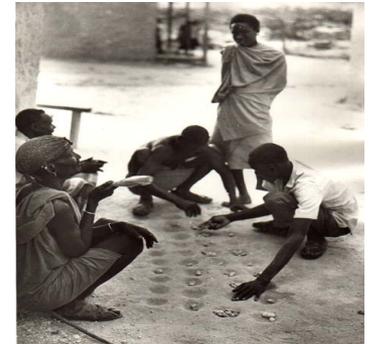
- Past experiences
  - Role models
  - Games



Ludo game



Ayo game



- Research Interest: My life experiences have greatly influenced my research interest in mathematics
    - Low female participation in mathematics despite government interventions
    - Public confessions by individuals about mathematics
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# Introductory Video (Girl and Boy)

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- Gender Role Expectations

<http://www.youtube.com/watch?v=pF1j22x-yU8>

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# Some Context

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- Historically, education of females was problematic across the Globe (e.g., under-investment in girls' and women's education)
  - Females were (still are) considered **most** suitable for care-giving professions
  - Many obstacles for professional advancement of women still exist (e.g., assumption that they are not capable; need to maintain balance between family and careers)
  - “Women and minorities ...” = “women as minority”
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# Some Context.../2

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- During the 1960s, concerns over female's underrepresentation in mathematics and sciences were first raised.
  - Research findings gave a fairly consistent image of gender differences in mathematics achievement that favoured male students (*Maccoby, 1966*). Fewer females than males enroll in more advanced mathematics courses, such as calculus (*Keeves in 1973*).
  - In early 1990s, several national publications, such as *How School Shortchange Girls* (AAUW, 1992), drew national awareness to the gender gap in mathematics and science, and ultimately resulted in decreased gap and achievement (*Hill, Corbett, & St. Rose, 2010; Hyde et al., 2008*).
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# Some Context.../3

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- By early 2000, on standardized mathematics tests, high school female students' performance had improved and was deemed to be similar to that of their male counterparts (*Crombie et al., 2005; Hyde et al., 2008*).
  - The number of females taking advanced mathematics courses, such as calculus, has increased and is about the same as the number of males (*Chacon & Soto-Johnson, 2003; Hill, Corbett, & St. Rose, 2010*).
  - However, the participation of females in mathematics and science fields decreases as they progress to higher educational (*Park, Cook, & Greenwald, 2002*) and professional levels (*Herzig, 2004*).
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# Female representation in the work force?

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- In the US, women represent 92% of nurses, 68% of psychologists, 48% of biological and life scientists, 26% of mathematical and computer scientists, and 10% of engineers (*National Science Foundation, 2011*).
  - In Canada, women represent 87% of nurses & health-related therapists, 75% of clerks & other administrators, 64% of teachers, 57% of sales & service personnel, and only 22% of natural scientists, engineers & mathematicians (*Statistics Canada, 2008*).
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# Female representation in math, science, and engineering in the EU

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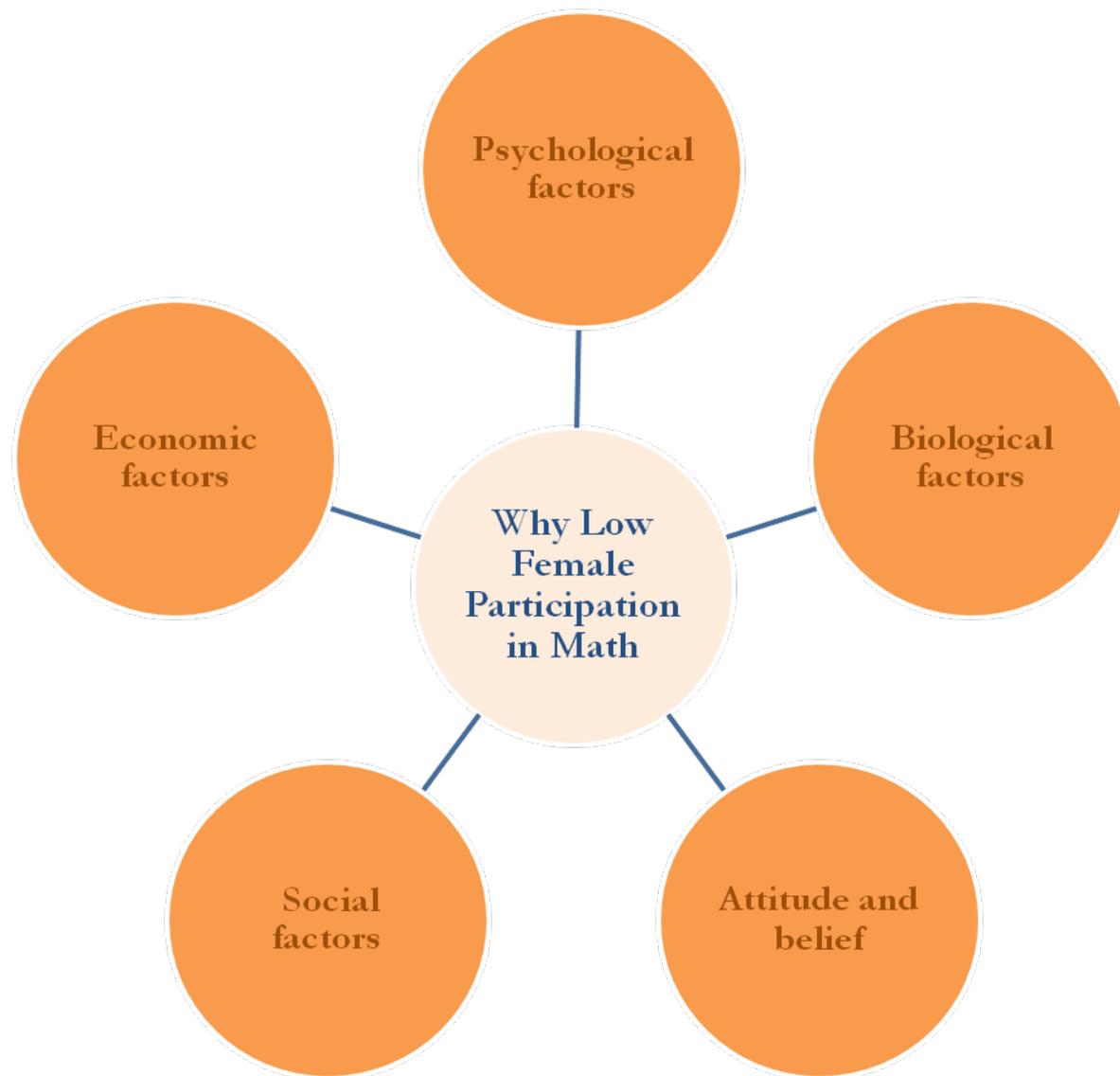
- Norway - 37%
- Turkey - 31%
- Hungary, Italy, The Netherlands - 30%
- Finland - 29%
- France - 27%
- Austria - 25%
- Germany - 22%
- United Kingdom (UK) - 21%
- Switzerland - 18%
- Latvia - 50%
- Lithuania - 53%
- Poland - 54%

On average **32%** of scientists and engineers were women in the EU-27 (Source: European Commission - She Figures, 2009)

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# Reasons for Low Female Participation in Math

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# Psychological factors

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- **Math anxiety:** The female students' anxiety toward mathematics grew significantly faster than their male counterparts (Cat & Wright, 2003)
- May lead females to avoid courses and majors that they are clearly capable of handling; thus, failing to pursue careers in mathematics and the sciences (AAUW, 1998; Altermatt & Kim)



# Psychological factors.../2

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## Self- concept/Self-perceived ability

- Studies consistently found that female students have a lower self-concept of mathematics ability than male students (Jameson, 2010; Ma & Kishor 1997; Wilkins, 2004).
  - Wilkins (2004) sampled 290,000 students from 41 countries to investigate mathematics and science self-concept from an international perspective.
  - Watt (2006) found that boys rated their self-perception of mathematical talent and expected success higher than females despite equal level of prior achievements.
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# Biological factors

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- Researchers (Halpern 1992; Northrup, 2001) argue that the males' brains have neurological qualities that make it possible for them to perform better in mathematics than females.
- However, females' continual improvements in achievement scores refute this argument (Crombie et al., 2005; EQAO 1999; Margolis et al., 2002).



Video-

<http://www.youtube.com/watch?v=z-19yWY90>



# Attitude and Beliefs

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## Confidence

- From middle grades, females are less confident of their mathematics ability than males (*Catsambis, 2005*); thus they become uninterested, unmotivated, and are more likely to abandon academic tasks (including advanced mathematical tasks) than males (*AAUW, 1998; Sanders & Nelson, 2004*).



# Attitude and Beliefs.../2

- **Usefulness of mathematics:** Boys report higher perceived usefulness of mathematics throughout high school than girls (*Winkins & Ma, 2003*) and Watt (2006) found that for girls valuing mathematics as highly useful for future career is likely to lead to the choice of mathematics-related career intentions.
- **Attribution style:** Females are more likely to attribute their success in mathematics to luck (or effort) and failure to low ability (*Hanna, 2003*).



# Social factors and Cultural Milieu

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Socializers' attitude, behaviour, and expectations, can affect female's achievement, self-perception, and career choice.

## Parents



- Provide different mathematics experiences for boys and girls (e.g., activities); boys play with legos, trains, and building blocks while girls play with dolls, princess dress-up clothes, tea parties.
  - Boys are provided with the opportunity to be involved in sports and computing while girls are to read and interact with their peers.
  - Encourage and provide more support for males than female
  - Parents' education and socioeconomic status (SES).  
Education attainment for parents predicted Canadian females participation in advanced math courses (Ercikan et al., 2005).
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# Social factors and Cultural Milieu.../2

## Teachers

- Differential treatment in classrooms through interaction feedbacks, and display of higher expectations
- Teaching practices: competitive vs. cooperative classroom
- Stereotypical remarks (Math as a male domain)
- **Employment trends** - most of the women are employed in female-dominated careers (Statistics Canada, 2008; NSF, 2011). Thus, few role models and less females in the highest paying occupations.
- **Media** – **Big Bang Theory** & **Numb3rs**
- **Video-**



<http://www.cbc.ca/archives/categories/economy-business/cons>

# Economic factors

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## Career values and interest

- Salary expectation, job availability as well as students' interests, have been isolated as determinants of students' enrolment in any post-secondary program. For example, Pelletier (2006) found that females' intentions to pursue career in mathematics were linked with genuine interest in mathematics, while males' intentions were linked to both genuine interest and pay.



# My Past Research

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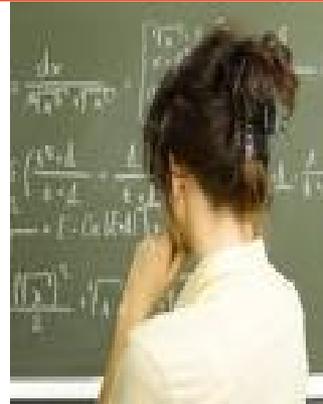
- A qualitative case study research
- It examined the factors that impact females' decisions to pursue studies in mathematics-related disciplines. The obstacles they encountered and how they overcome them was also investigated
- Participants were second to final year undergraduate mathematics and physics students
- Data were collected through face-to-face interviews and focus group interviews



# Major Findings

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- The females in this study made their decisions to pursue mathematics-related disciplines mainly due to their interest in mathematics and science.
- The findings present socializers, specifically parents and teachers, as influential on the females' decisions - by encouragement and support, and/or by being role models.
- Strong self-confidence and self-concept, sense of determination, hard work/efforts, and derived enjoyment from their subjects helped the female succeed and persist in their chosen careers.



# Participants Comments

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“If you can’t make students interested in it, it doesn’t matter if they are good at it or not, they just don’t [want to do math]... I know people that had bad math teachers in elementary school and they never liked it since. Teachers may not be good in maths and if they are forced to teach it and if they don’t like it, the kids don’t really have a chance” (*Anna*)

“Most girls have to choose between being good in language or arts and being good in mathematics, because they are good in both... ...a lot of little girls want to do what their mom did, ...  
“I know what my mom did and that was a good job, why would I do something non-traditional” (*Femida*)

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# Participants Comments../2

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“I think girls in high school are totally unaware of the possibilities. I think they don’t even really know what physicists do other than “experiments.” *(Betty)*

“People do not see [Mathematics degree] as really useful or practical. They told me “you are gonna know all these crazy theorems, what are you going to do with them?”... I don’t think a lot of [girls] see or know what kind of jobs you get after maths and physics degrees, whereas if you go into chemistry or biology there seems to be, chemist goes into pharmacy and biologist goes into medical school; it seems to be a lot more clear [what are] available careers once you graduate” *(Anna)*

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# Participants Comments../3

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“I think in our society, the emphasis for females is first to be good looking or be a trophy wife of a sort. Even though girls are supposed to be equal, I think we are still back in the days where women were dependent on their companion.... I don't think there is direct link between going into a field like, say engineering, and having a happy life. I just don't think it fits into [girls] idea [plan]... we did not grow up with a Barbie mathematician” (*Cathy*)

“Maths and physics require a lot of time throughout your educational life to be successful and for most women the main priority is the family” (*Ella*)

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# What could be done?

- Stimulate and increase female's interest in mathematics-related disciplines through exposure to positive experiences, as well as encouragement and support from a younger age
- Use appropriate teaching methods/ instructional activities that are appealing, engaging, and interesting
- Use teaching methods that emphasise collaborative problem solving and group work



# What could be done?

- Awareness of careers and professions relating to mathematics fields from a younger age (career days, visits to offices).
- Organise more outreach programs and math-related extracurricular activities to engage students and parents. (Talk about great women in math)
- Teachers, parents, and counsellor should be role models for female students; fight against gender stereotypes.



# Q & A

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