Diversity/Difference Paper: Gender Differences in Mathematics

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Abstract

The purpose of the part I of this paper is to understand the differences and similarities of genders in mathematics. Males outperformed on average females on standardized college admission tests such as SAT-M and ACT-M, and standardized international tests such as Trends in International Mathematics and Science Study (TIMSS) and Programme of International Student Assessment (PISA). To compare gender differences in math between the U.S. and Hong Kong in standardized international math tests, four categorizations in math learning are analyzed (Strand and item format, content topics, and competency cluster). To compare gender differences in mathematics-related affect, eight affective factors are analyzed (Interest, confidence, motivation, anxiety, enjoy, pride, hopelessness, and shame). Also, a comparative gender and mother-child interactions during mathematics homework was analyzed for both genders. The purpose of part II of this paper is to understand how to teach math for girls. We conclude that in fact real-life examples (story problems) can improve the girls learning. Because math is processed in the same part of the brain that is responsible for language and verbal functioning, girls learn math best in context (real-life examples). Also, the technology used to generated the video is an important tool to help students to understand math because they can stop the video to take notes or repeat it to understand better the subject.

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Part I

Chapter 1 – Introduction

The lower performance of females in standardized math performance has long been a source of concern. A wealth of research has documented the existence of gender differences in math performance over the past three decades. Males outperformed on average females on standardized college admission tests such as SAT-M and ACT-M, and standardized international tests Trends in International Mathematics and Science Study (TIMSS) and Programme of International Student Assessment (PISA) (Liu, 2009).

Gender Differences in Standardized National Math Tests: SAT and ACT

Keller (2012) reported that boys outperformed consistently girls in SAT and ACT math scores from 1997 to 2010. The possible maximal score in the SAT and ACT are 800 and 36 respectively. The males and females' performances are showed in table.1.

Table 1. Performance of men and women in SAT and ACT math sections.

	SAT		ACT	
Year	Men	Women	Men	Women
1997	530 (114) 520,338	494 (108) 606,683	21.3 (5.2) 419,049	20.1 (4.7) 540,252
1998	531 (114) 541,962	496 (108) 630,817	21.5 (5.3) 430,724	20.2 (4.8) 564,315
1999	531 (115) 562,911	495 (110) 657,219	21.4 (5.2) 437,293	20.2 (4.7) 577,828
2000	533 (115) 583,331	498 (109) 676,947	21.4 (5.2) 455,817	20.2 (4.8) 604,646
2001	533 (115) 592,366	498 (109) 683,954	21.4 (5.2) 459,547	20.2 (4.7) 604,808
2002	534 (116) 616,201	500 (110) 711,630	21.2 (5.3) 485,797	20.1 (4.8) 623,128
2003	537 (116) 652,606	503 (111) 753,718	21.2 (5.3) 509,969	20.1 (4.8) 656,587
2004	537 (116) 660,270	501 (110) 758,737	21.3 (5.3) 508,835	20.2 (4.8) 653,158
2005	538 (116) 686,298	504 (111) 789,325	21.3 (5.3) 515,398	20.2 (4.8) 660,870
2006	536 (117) 680,725	502 (111) 785,019	21.5 (5.2*) 517,563	20.3 (4.8*) 646,688
2007	533 (116) 690,500	499 (110) 798,030	21.6 (5.2*) 544,522	20.4 (4.8*) 674,636
2008	533 (118) 704,226	500 (111) 812,764	21.6 (5.2*) 625,887	20.4 (4.8*) 764,282
2009	534 (118) 711,368	499 (112) 818,760	21.6 (5.2*) 688,165	20.4 (4.8*) 808,097
2010	534 (118) 720,793	500 (112) 827,197	21.6 (5.2*) 713,544	20.5 (4.8*) 852,493

Gender Differences in Standardized International Math Tests: PISA and TIMSSP

In Else-Quest, Hyde, and Linn (2010), two international math assessments were meta-analyzed to compare gender differences. They compared the 18 nations participating in both PISA and TIMSS, and the effect sizes found for gender differences in math achievement on them were not significantly correlated. PISA showed a pattern of a male advantage over females, and TIMSS showed a stronger pattern of gender similarities. These varying patterns of results in math achievement may be understood best in the context of the explicit aims of PISA and TIMSS. In fact, PISA focuses on the concept of literacy, aiming to assess the abilities of students to use their mathematics knowledge and skills in the "real world.", and TIMSS claims to assess the attained curriculum (i.e., what students have learned from the curriculum).

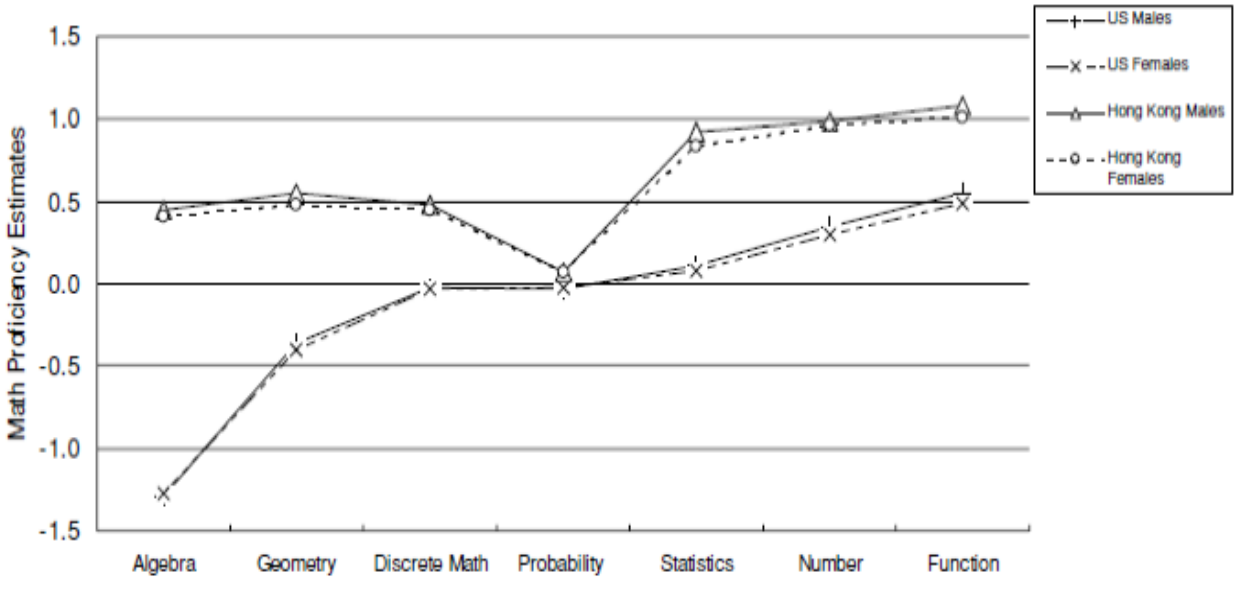
Chapter 2 - Comparative Gender Differences in Math between the U.S. and Hong Kong

The students from Hong Kong were selected for comparison because Hong Kong has continuously been one of the top-performing countries in many international mathematics tests. To compare gender differences in math between the U.S. and Hong Kong in standardized international math tests, four categorizations in math learning are analyzed (Strand, item format, content topics, and competency cluster). Liu and Wilson (2009) reported that male and female performance on the Programme for International Student Assessment (PISA) 2003 mathematics along four in-depth dimensions (strand, content topics, competency cluster, and item format).

Strand

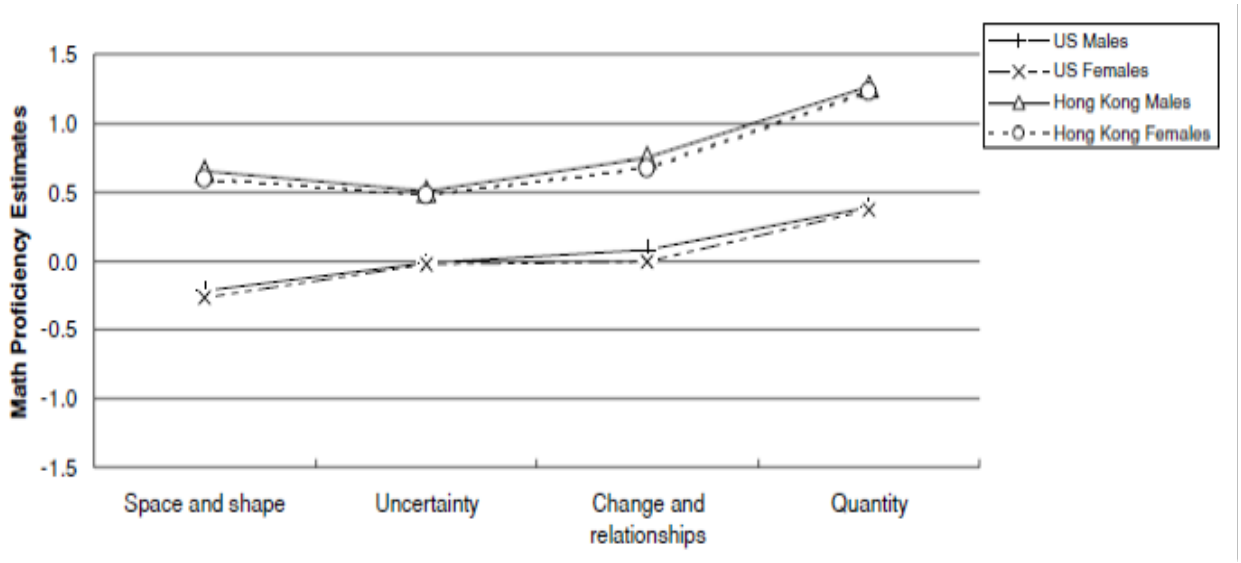
Liu and Wilson (2009) compared gender differences in math between the U.S. and Hong Kong among seven strands: Algebra, geometry, discrete math, probability, statistics, number, and function. Hong Kong students scored better than American in almost all strands. Only on probability Hong Kong students scored similar to American students. However, there were no gender differences in both countries in all strands. Table 2 shows math proficiency estimates by strand among Hong Kong and Americans students from both genders (Liu & Wilson, 2009).

Table 2. Math proficiency estimates by strand.



Liu and Wilson (2009) compared gender differences in math between the U.S. and Hong Kong among four topic contents:Shape and space, uncertainty, change and relationship, and quantity. Hong Kong students scored better than Americans in all topic contents. However, there were small gender differences in both countries in (Shape and space) and (change and relationship) in favor of males (Liu & Wilson, 2009). Table 2 shows math proficiency estimates by content topics among Hong Kong and Americans students from both genders.

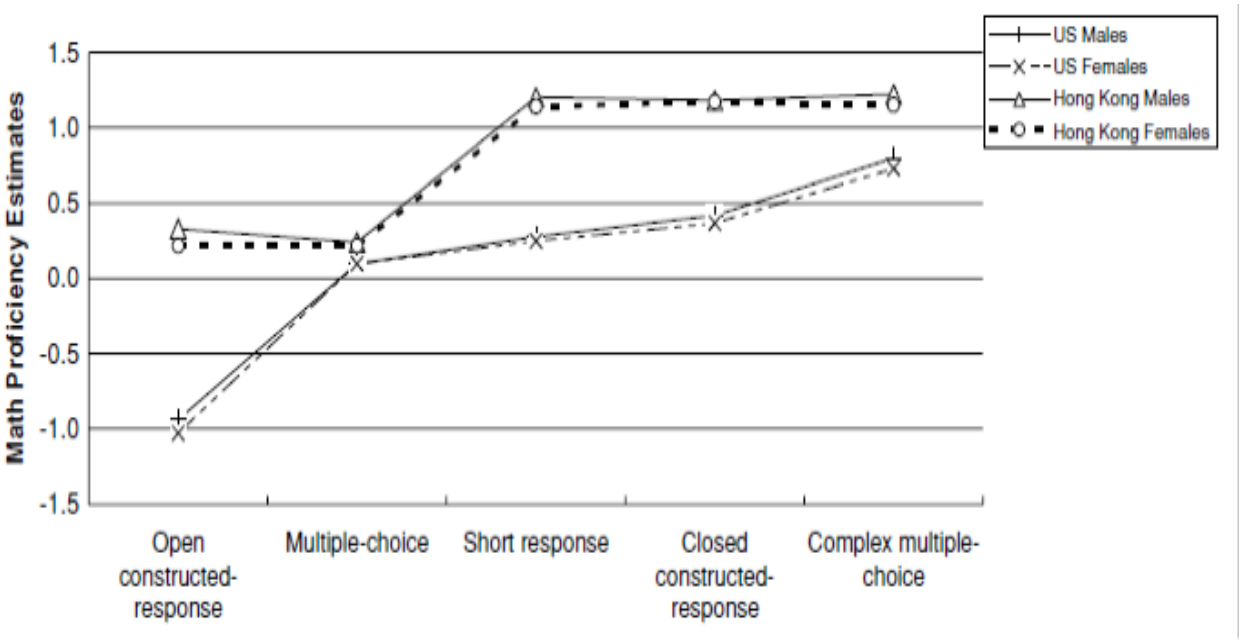
Table 3. Math proficiency estimates by content topics.



Item Format

Liu and Wilson (2009) compared gender differences in math between the U.S. and Hong Kong among fiver item formats: Open constructed response, multiple-choice, short response, closed constructed-response, and complex multiple-choice. Hong Kong students scored better than Americans in almost all item formats. Only on multiple-choice Hong Kong students scored similar to American students. However, there were no gender differences in both countries. Table 4 shows math proficiency estimates by item format among Hong Kong and Americans students

from both genders (Liu & Wilson, 2009). However, there were no gender differences in both countries in all item format. Table 4 shows math proficiency estimates by item format among Hong Kong and Americans students from both genders.*Table 4.* Math proficiency estimates by item formats.



Competency Cluster

Liu and Wilson (2009) compared gender differences in math between U.S. and Hong Kong among three competency clusters: Connection, reflection, and reproduction. American students scored better than Hong Kong in reproduction. Hong Kong and American students had the same performance in connection. However, there were no gender differences in both countries in all competency clusters. Table 5 shows math proficiency estimates by competency cluster among Hong Kong and Americans students from both genders (Liu & Wilson, 2009).

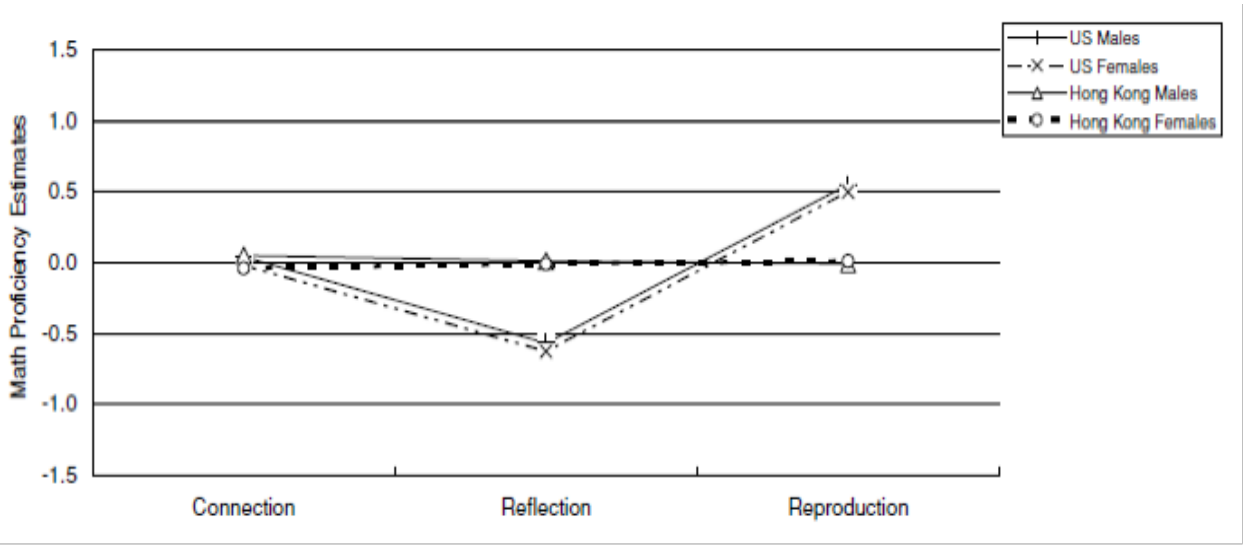


Table 5. Math proficiency estimates by competency clusters.

Chapter 3 – Gender Differences in Mathematics-Related Affect

The lower performance of females in standardized math performance can be partially explained by Mathematics-Related Affect because Learning strategies and affective factors could have a profound impact on students' mathematics performance. Liu and Wilson (2009) reported the gender differences in math due six affective factors: Interest, confidence, motivation, anxiety, enjoy, pride, hopelessness, and shame.

Interest, Confidence, and Motivation

According to Liu and Wilson (2009), there exists evidences in gender difference in mathematical interests, confidence, and motivation. She concludes that boys and girls show similar interest in math during elementary school. However, during secondary school, boys tend to be more interested in learning math than girls, and this difference tends to enlarge by adolescence. Also, she concluded that boys have higher confidence than girls in math learning, and girls tend to underestimate their competence in math, including among gifted girls who have demonstrated proficiency in math performance. On the other hand, she reported that motivation has been guided by two types of goals: intrinsic goals and extrinsic goals. She found that girls were better motivated than boys in learning math, especially in terms of intrinsic motivation.

Anxiety, Enjoy, Pride, Hopelessness, and Shame

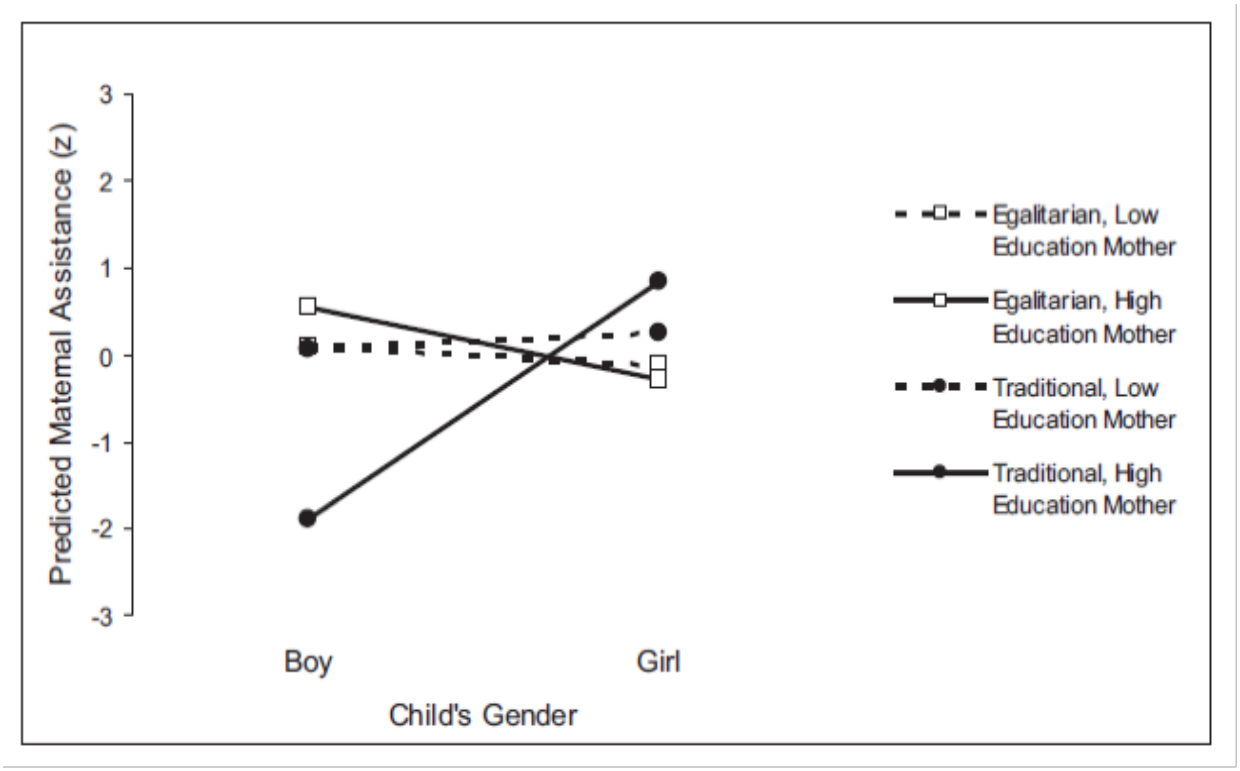
Frenzel, Pekrun, and Goetz (2007) reported that there exists evidences in gender difference in mathematics due to anxiety, enjoy, pride, hopelessness, and shame. They reported the emotions and beliefs of 1,036 male and 1,017 female 5th grade students who were assessed by self-report measures, and their prior mathematics achievement was assessed by academic grades.

Among girls and boys, who had received similar grades in mathematics, girls had significantly less enjoyment and pride than boys, but more anxiety, hopelessness and shame.

Gender and Mother-Child Interactions during Mathematics Homework

Do contemporary families promote gender-differentiated or egalitarian attitudes and behavior surrounding mathematics? Lindberg, Hyde, and Hirsch (2008) examined mother-child interactions during mathematics homework. Table 6 shows the values of maternal assistance from four groups of mothers: Egalitarian and low education mother, egalitarian and high education mother, traditional and low education mother, and traditional and high education mother.

Table 6. Predicted maternal assistance by child's gender.



The results show that mothers with high education have different assistance between genders. Egalitarian high educated mothers gave more assistance for boys, and traditional high educated mothers gave more assistance for girls.

Part II

Chapter 4 - How to Teach Math for Girls

Why do our students today "HATE" math so much? Kelly Trotter King, the President and CEO of Generation Think (An educational services and academic tutoring company in Los Angeles, California), explained that students hate math for three reasons: 1) They are intimidated by math. 2) No one has taken the time to help build their self-confidence in this subject. 3) Math is processed very differently by male and female brains which can account for a lack of conceptual understanding (King, 2011, March 29). The goal of this chapter is to understand the reasons students 'hate math' related with a lack of conceptual understanding. King (2011, April 11) explained that lack of understanding can be attributed to where math is processed in the brain. This biological component can have a huge impact on understanding math because boys and girls process math in very different parts of the brain. In girls, math is processed in the cerebral cortex of the brain where language, verbal functioning, perceptual awareness, memory are also processed. In boys, math is processed in the hippocampus of the brain, where short & long term memory and spatial navigation is also processed. To know where math is processed in the brain can give a clue how to teach math for girls. Here are some of the successful teaching techniques that I use when I am instructing girls in math. The best way to teach math for girls are:

Real-life examples: Because math is processed in the same part of the brain that is responsible for language and verbal functioning, girls learn math best in context. Context means using real-life examples and background information to illustrate math. King (2011, April 11) reported that if you are teaching your daughter about percent discount problems, put it in the context of

shopping at her favorite store where she finds a super cute sale item for 15% off. With her limited amount of available cash, can she afford to purchase this new item?

Story problems: Use story problems (word problems) to teach math to young girls. According King (2011, April 11) reported that many workbooks aimed at students in Grades 1-4 use story problems to teach math. The advantage to use story problems is they often incorporate multiple step computations and tend to refine and develop critical thinking skills.

Verbal feedback to correct errors: When she makes mistakes in math, give her feedback and explain why she made the mistakes. King (2011, April 11) explained that math is a very black and white subject, and girls feel more comfortable in the gray area of learning because that leaves room for subjectivity, effort, and progress. Consequently, girls tend to lose confidence in "objective" subjects (namely math & science). The solution is to build up girls' math confidence. When she gets problems correct, scores well on a test, or figures out a difficult math problem, use strong words of affirmation to build up her confidence. On the other hand, if she made a mistake, the more explanation she receives, the less she will internalize the mistake, and the less intimated she will feel towards math.

Chapter 5 – Methodology

Purpose

The purpose of pat II of the study is to investigate if real-life examples or story problems can motivate girls to learn math. This chapter is divided into five different sections: Purpose, Method of Inquiry, The Enigmatic Lady Problem, Population and Sampling Techniques, and Measurement and Instrumentation.

Method of Inquiry

The method of inquiry is based on a non-experimental design, which collected all the data through a interview. First the student see a video about the enigmatic lady problem.

The Enigmatic Lady Problem

A mathematician (M) asked an enigmatic lady (L).

(M) - What is the age of your three children?

(L) - The product of their ages is 36.

(M) - I don't know.

(L) - The sum of the ages is this house number in front of us.

(M) - I still don't know.

(L) - My oldest son plays the piano.

(M) - Now I know.

What is the age of the lady's children?

Solution:

The first clue is to list all 3 possible ages that form the product of 36. Then list their sum for later.

1, 1, 36 - 38

1, 2, 18 - 21

1, 3, 12 - 16

1, 4, 9 - 14

1, 6, 6 - 13

2, 2, 9 - 13

2, 3, 6 - 11

3, 3, 4 - 10

The second clue says the sum of the ages is equal to the house number in front of the mathematician, but he still didn't know the ages, so that means the right ages and another possibility had the same sum. The remaining possibilities are:

1, 6, 6 - 13

2, 2, 9 - 13

The last clue was the oldest plays the piano, then that meant one child had to be older then the rest, so the answer is the second possibility: 2, 2, 9.

After the student watched the video, they answered three questions on the interview:

Question 1: Do you like to learn math using technology?

Question 2: are you motivated to see the video? Why?

Question 3: Do you have any comments about this math video?

Population and Sampling

The population of this study is the female secondary students, and a convenient sampling was selected for this study. The sample of this study was my daughter Kellen (12) and my son Kevin (15).

Measurement and Instrumentation

The instrumentation that was used in this study to evaluate if real life example (story problem) can motivate girls to study math was an interview (See the video "The Enigmatic Lady" to see and hear the interview answers).

Chapter 6 – Conclusions

On part I, we concluded that males outperformed on average females on standardized college admission tests such as SAT-M and ACT-M, and standardized international tests Trends in International Mathematics and Science Study (TIMSS) and Programme of International Student Assessment (PISA). Two international math assessments were meta-analyzed to compare gender differences. PISA showed a pattern of a male advantage over females, and TIMSS showed a stronger pattern of gender similarities due to the differences between the tests. PISA focuses on the concept of literacy, aiming to assess the abilities of students to use their mathematics knowledge and skills in the "real world.", and TIMSS claims to assess the attained curriculum (i.e., what students have learned from the curriculum). Liu and Wilson (2009) compared gender differences in math between U.S. and Hong Kong in standardized international math tests, four categorizations in math learning is analyzed (Strand and item format, content topics, and competency cluster). A Liu and Wilson (2009) compared gender differences in math between U.S. and Hong Kong among seven strands: Algebra, geometry, discrete math, probability, statistics, number, and function, Hong Kong students scored better than American in almost all strands, except in probability where Hong Kong students scored similar to American students. However, there were no gender differences in both countries in all strands. A comparative gender differences in math between the U.S. and Hong Kong among four topic contents: Shape and space, uncertainty, change and relationship, and quantity. Hong Kong students scored better than American in all topic contents. However, there were small gender differences in both countries in (Shape and space) and (change and relationship) in favor of males. A comparative gender differences in math between the U.S. and Hong Kong among fiver

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On part II, we conclude that in fact real-life examples (story problems) can improve the girls learning. Because math is processed in the same part of the brain that is responsible for language and verbal functioning, girls learn math best in context (real-life examples). Also, the technology used to generated the video is an important tool to help students to understand math because they can stop the video to take notes or repeat it to understand better the subject.

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