AERA Proposal: Finding the answers behind Students' Level of Confidence Level in Mathematics across countries: A Secondary Analysis using TIMSS 2011

Purpose and Background: The purpose of this paper is to examine what are the most effective predictors, both externally and internally, of students' self-confidence in mathematics across 3 different countries in Asia. This paper also compares the effect of each predictor – how each may vary across eastern countries and also the United States, where most of the existing literature has been done.

Self-perception in mathematics is the perception of a student about his or her level of mathematics skill, or how confident they are in solving and tackling math problem. In other words, students who believe that they are good at mathematics tend to excel in it. Numerous of studies have been conducted on the multidimensionality and hierarchical structure of student's self-concept since 1970s and also have shown a tight relationship between self-perception in mathematics and math performance and achievement (Antonio, 2004; Brookhart et al., 2004; Cates et al., 1999; Yang et al., 2014; Yoshino, 2012). For example, in 2008, using TIMSS 2003 dataset, Chiu (2008) focused on the multidimensional aspect of self-concept in math and science and its effect on students' academic achievement. He used structural equation modelling (SEM) to conduct multilevel analyses. Consequently, Chiu suggested that there are strong correlations between mathematics and science achievement. Thus as educators, it's essential to know what factors would affect a student self-perception and more specifically, among those factors which are controlled by the student's characteristic and which are controlled by external factors, like the environment or interaction with others. The ideal of studying student's confidence is crucial - as Yoshino (2012) mentioned in her study, while one's academic ability is mostly invisible, studying student's self-concept could be in fact be a tangible contribution since it's feasible for an instructor to work on improving his student confidence level through his teaching method.

Even though multilevel analysis has been widely applied in research regarding to student's confidence, it's surprising that before Shavelson (1976), self-concept was treated as one dimension and not related to academic field. Marsh (1986), following the Shavelson's idea of complexity behind self-concept, was the first to differentiate between external and internal comparison and used internal/external (I/E) to explain the phenomenon. External comparison is when the students think they are good at mathematics if their scores are higher than other students' scores. Internal comparison is when the students use their own mathematics score to access their academic abilities. Marsh and Hau (2004) also confirmed the internal/external model that academic self-concept can be explained by internal (the student's characteristics) and external (the environment), by other words, self-concept is "multidimensional". However, the limitation of their research is its generalization which comes from the fact that only three countries out of 26 countries were non-western countries. Therefore, in this study, I want to fill in the gap by focusing on eastern countries. Additionally, I want to further examine which are the strongest predictors of students' in mathematics self-concept, how those factors can vary between countries. By comparing and contrasting those different predictors within each country between external (school's characteristics) and internal (student's characteristics), this study not only examines the multidimensional aspect of self-concept but also confirms the universal of Marsh theory.

The first predictor that greatly influences a student perception in mathematics in the western literature is gender. Many researches have produced statistical evidences of higher self-perception in math in male students than their female counterparts (Brown & Josephs, 1999; Randhawa et al., 1993). The literature suggested that even though gender may not be the source of self-perception, the end result of female being suffered from disadvantage in math self-efficacy (and therefore math performance) should be carefully considered by educators and policy makers. In addition, many other factors are based on gender as input for their outcomes such as social-expectation from their parent (Bleekr & Jacob, 2004). In contrast, Ma and Kishor (1997) concluded that gender differences did not influence the relationship between mathematics achievement and mathematics self-concept, the perception of family support and the perception of mathematics as a male domain. They pointed out that there were age differences, and the time spent at junior high school was particularly important for the relationship between self-concept and achievement. In addition, Kurtz-Coste et al. (2008) showed the favored group (boys) is significantly impacted by parent stereotype than the less favored group (girls). Other than parents, the next important figure who influences student's confidence is teacher. Teachers tend to give more attentions and open encouragement to male students (Einarsson & Granstrom, 2002).

In the literature, the most frequently mentioned aspect that affects self-efficacy and student's confidence in external dimension is location of the school. Two-way ANOVA was conducted on a research that shows a higher level of self-efficacy on urban children than rural children in Basak & Ghosh, 2014. Jesse L. M. Wilkins' (2004) study also differentiated self-concept by the individual and by geographic region. He found that countries which showed markedly higher self-concepts had lower achievement and vice versa. Wilkins pointed out that Asian and East European students tended to have a lower self-concept than students in Middle Eastern, Western European, North and South American and Australasian countries. Wilkins's findings showed that mathematics and science self-concepts were embedded in culture, and academic achievement was not necessarily associated with the level of self-concept. This study in addition, also takes the average classroom achievement and social-economic background following Marsh (1986).

Framework of the Study:

Thus, to further expanding and fill in the gap in previous research, this study will first examine whether student's confidence varies between and within schools by the null model with no predictor. Second, this paper will search for what are the strongest predictors internal and external among those that Marsh and other researchers have been suggested by adding students-level and school-level independent variables into the null model above. Third, this study will compare and contrast those effects across different eastern countries. Last but not least, looking at the remaining variance in each country that cannot be explained by all the predictors suggested in the literature in western culture, I am interested to find out if those predictors are universal across the globe.

Research questions:

(1) To what extent do students' characteristics such as gender and socio-economics status, their achievements, their level of engagement in mathematics, their perception about their teacher's expectation to do well in mathematics are associated with confidence level in Mathematics.

(2) To what extent do classroom/school characteristics such as location, class size, teacher's gender and teacher's years of experience associated with students' confidence level in Mathematics.

(3) How do the above characteristics vary between countries? Are there consistent universal effects across eastern countries and United States?

Methods:

Data: TIMSS 2011 is the fifth in IEA's series of international assessments of student achievement dedicated to improving teaching and learning in mathematics and science, which over 60 countries participated in. Similar to other edition of TIMSS, it consists of an assessment of mathematics and science, as well as student, teacher, and school questionnaires. The dataset given by TIMSS 2011 was useful in examination of the research questions because the dataset was collected internationally from a large sampling population and publically available. Second, with all 60 countries participated, TIMSS designed a two-stage stratified probability sampling to select schools and students, and the process of random sampling were carefully conducted in each country (Wilkins, 2004). Thus, TIMSS data is a nested dataset that can be used for HLM research method in this paper (Heck, Thomas and Tabata, 2013). Last but not least, TIMSS 2011 asked the students, teachers and the school principal questions that strongly related to this study, thus the dataset contained the appropriate set of variables. The final dataset used for this analysis was taken from TIMSS 2011, which contained the total of 19,712 8th grade students in almost 1200 classrooms across 4 countries in Asia, Southeast Asia and the United States.

Analysis: This study looks at the effects of both students' characteristics and also the classroom' characteristics after controlling for student-level factors, thus, an appropriate procedure for doing this analysis is the hierarchical linear model or HLM (Mertler & Vannatta, 2012; Heck, Thomas & Tabata, 2013).

Results:

First, the unconditional HLM indicated that confidence vary between and within school. Even though, the ICC between countries varies between from 4% (Singapore) to 17% (Malaysia), all the Wald Z test was significant at $p < .001$. This means that total variance in student's level of confidence in mathematics can be explained by variance between the classrooms across all four countries. Second as shown in tables 2-5 below, the effect of each predictor varies between country, in term of significant, magnitude and also the direction of the effect. Across all countries, there is a strong effect in Level-1 between students' level of engagement in Math and their confidence-level in mathematics, and it's significantly stronger than all other predictors across all countries. Furthermore, the affect is also positive, high and significant across students of different genders, socio-economic status and across different types of school. Even for countries where engagement level for mathematics is quite low compare to others (Malaysia), the result still suggests that higher student engagement with mathematics in the classroom would allow students to feel more confident about their ability to learn math. The most important message to take out from this finding is that the factor predicting students' confidence is not defined only based on their achievement and other classmates' achievement, but how much they think they engage in the classroom (as TIMSS measured by number of hours spending doing mathematics per week, the number of times student participated or asking questions about mathematics in class). In addition, as the students become more engaged and at the same time more confident with mathematics, the better they will do in mathematics as compared to the same students with the same characteristics.

Another interesting finding, as shown in Figure 2 is that four countries in this study can be divided into four categories: the high confidence- high achievement (HCHA), the high confidence- low achievement (HCLA), the low confidence – high achievement (LCHA) and low confident – low achievement (LCLA). Within high-achieving countries, Singapore and Korea, we can already find the gap between their students' confident-level. While students in Singapore (HCHA) in this study seem to realize that they are indeed good at mathematics, students in Korea, the LCHA, is not totally confident and somewhat underestimate with their math ability. The United States, achieved lower than the other two countries but its students are more confident about their mathematics ability than both countries' students. Malaysian students didn't do so well compare to other three and its students are also less confident. As the results shown in tables 2-5, the effect of achievement to student's confidence also differ a lot between the four.

Significance & Conclusion:

This study first confirmed Shavelson's idea of complexity behind student's confidence, which need to be explained by internal/external predictors. It also suggests that the strongest predictor to students' confidence in Mathematics is their engagement in Mathematics. This is important to note because while improving the students' achievement, or improving the students' confidence level is often considered intangible, improving the students' engagement level is something achievable through better curriculum and better teaching approach.

In addition, another significant contribution of this study to the existing literature is that it suggests that the predictors that predicting student's confidence level is not universal. There are four types of countries with different effect of predictors have been found, which suggests that latent class analysis, including all countries in TIMSS 2011 should follow after this study to understand the phenomenon more in depth.

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Figure 1: Conceptual Framework Model

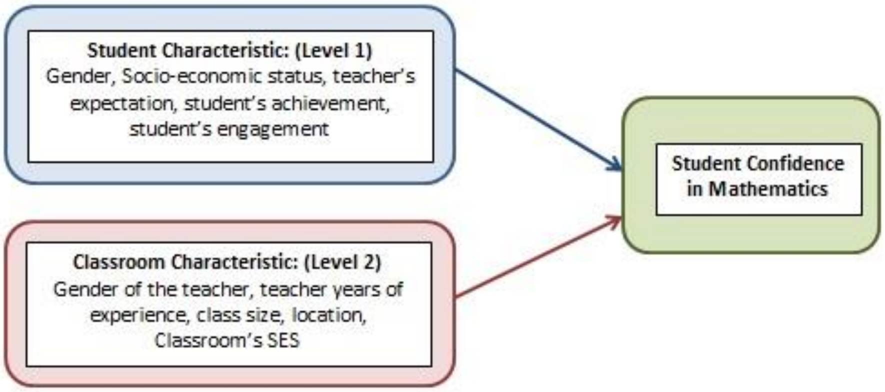
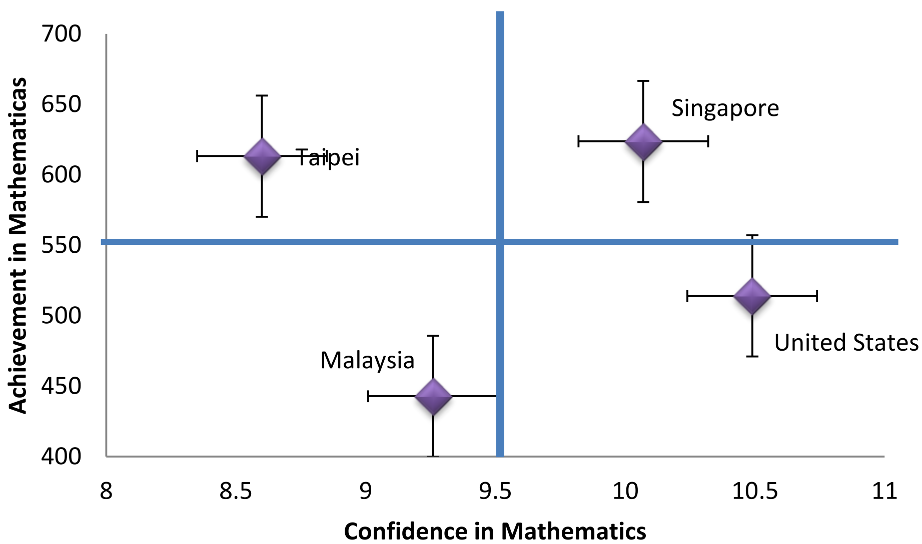


Figure 2: Achievement in Math vs. Confidence Level (Country Level)



Equations

(1) Student-Level (Level-1)

$$Y_{ij} = B_{0j} + \beta_{1j} female_{ti} + \beta_{2j} books\ at\ home_{ti} + \beta_{3j} teacher's\ expectation_{ti} + \beta_{4j} student's\ achiement_{ti} + \beta_{5j} student's\ engagement_{ti} + \varepsilon_{ji}$$

(2) Classroom Level (Level 2):

$$\beta_{0j} = \gamma_{00} + \gamma_{01} teacher\_female_j + \gamma_{02} teacher's\ years\ of\ experience\ _j + \gamma_{03} class\ size_j + \gamma_{04} location_j + \gamma_{05} average\ classroom\_achievement_j + u_{0j} + \varepsilon_{ij}$$

Table 1. Description of Variables (N= 19,712)

Variable Name	Variable Labels	Definition and metrics	Mean	Std. Dev	Min	Max
Dependent Variable						
Confidence Level in Mathematics	BSBGSCM	Taking the "student's confidence with mathematics" variable from TIMSS 2011.	9.56	1.12	2.14	16.82
Level-1 Independent Variables						
Student's Gender (Female)	ITSEX	Male =0, Female =1	0.51	0.5	0	1
Students' home literature	BSBG04	Substitute measure of Social-Economic class (SES). Students were asked about the amount of books they have at home, with the following categories: 0= having none or fewer than a bookshelf (0-10 books) 1= having one bookshelf (11-25 books) 2= having one bookcase (26-100 books) 3= having two bookcases (101-200 books) 4= having three or more bookcases (200+books)	2.03	0.81	0	4
Teacher Expectation	BSBM15A	The student was asked to agree or disagree with the following statement " Teacher expects me to do well in Mathematics": 0=Disagree a lot 1=Disagree a little 2=Agree a little 3=Agree a lot	2.16	0.57	0	3
Student's achievement in Mathematics	BSMMAT01	Taking the first plausible value for mathematics achievement from TIMSS 2011. This variable will be grand mean centered.	501.82	93.63	79.31	902.64

Student's engagement in mathematics	BSBGEML	Scale of engagement with science lesson based on 7 items, taken from TIMSS 2011. This variable will be grand mean centered.	9.94	1.19	3.27	14.34
Level-2 Independent Variables						
Teacher's Gender (Female)	BTBG02	Male=0, Female=1	0.57	0.5	0	1
Teacher's years of experience	BTDG01	The teachers were asked to report how many years they have been working as teacher: 0= Less than 5 years 1= At least 5 but less than 10 2=At least 10 but less than 20 3=20 years or more	1.77	0.06	0	3
Class size[(1)]	BTBG12	The teachers were asked to report their class size. This variable will be grand-centered.	36.89	7.38	6	67
Location	BCBG05B	The location of the school (dummies): 1= Urban 2= Suburban (reference group) 3= Medium size city 4= Small town 5= Remote Rural	0.07 0.56 0.12 0.21 0.04	0.26 0.5 0.32 0.4 0.19	0 0 0 0 0	1 1 1 1 1
Classroom's average achievement[(1)]	Generated variable.	The average of math achievement in each class room.	498.83	54.74	285.99	581.61

Note: [(1)] In TIMSS 2011, each school only included one classroom with all the students in that classroom. Hence, classroom-level here can be referred to school-level (TIMSS User Guide, 2011)

Table 2: HLM Table Result for Malaysia (N= 5,235)

	Model A	Model B	Model C	
Intercept	9.21***	9.39***	9.42***	
	(.03)	(.03)	-.04)	
Level-1 Independent Variables			Unstandardized Coeff.	Standardized Coeff.
Female		-.11***	-.11***	**-.05**
		(.03)	(.03)	
Student's SES (grandcent_books)		.02***	.02***	**.02**
		(.01)	(.01)	
Teacher's Expectation		.16***	.16***	**.09**

		(.03)	(.03)	
TIMSS Achievement in Mathematics (per100pts)(grandcent_score)		.02*** (.00)	.02*** (.00)	**.02**
Student's Engagement in Mathematics (grandcent_engage)		.43*** (.13)	.43*** (.13)	**.51**
Level-2 Independent Variables				
Gender of Teacher			-.04 (.05)	
Teacher's Years of Experience			-.05 (.03)	
Class size (grandcent_class)			-.01* (.00)	**-.07**
Urban			.14 (.12)	
Medium Size City			.01 (.11)	
Small Town			.08 (.08)	
Remote Areas			.17 (.15)	
Classroom-achievement (per 100points) – grand_class_score			-.41*** (.12)	**-.22**
Intraclass Correlation	.17	.14	.12	
% of Level-1 Variance explained by the Model		20.75%	20.71%	
% of Level-2 Variance explained by the Model			40.18%	

Table 3: HLM Table Result for United States (N= 6,761)

	Model A	Model B	Model C	
Intercept	10.49*** (.04)	10.26*** (.13)	10.14*** (.18)	
Level-1 Independent Variables			Unstandardized Coeff	Standandardized Coeff
Female		-.53*** (.05)	-.53*** (.05)	**-.12**
Student's SES (grandcent_books)		.19*** (.02)	.16*** (.02)	**.12**
TIMSS Achievement in Mathematics (per100pts)(grandcent_score)		.15 (.00)	.15 (.00)	
Teacher's Expectation		.06* (.04)	.06* (.04)	**.06**
Student's Engagement in Mathematics (grandcent_engage)		.53*** (.02)	.53*** (.02)	**.41**
Level-2 Independent Variables				
Gender of Teacher			.17** (.07)	**.03**
Teacher's Years of Experience			.04* (.03)	**.01**
grandcent_class size			.00 (.00)	
Urban			0.1 (.01)	
Medium Size City			-.05* (.09)	**-.01**
Small Town			.05 (.09)	
Remote Areas			-.24* (.15)	**-.09**
School_achievement			.16** (.06)	**.10**
Intraclass Correlation	0.07	.05	.04	
% of Level-1 Variance explained		30.45%	30.71%	
% of Level-2 Variance			77.18%	

Table 4: HLM Table Result for Korea (N=3,754)

	Model A	Model B	Model C	
Intercept	9.07*** (.03)	8.65*** (.03)	8.62*** (.04)	
Level-1 Independent Variables			Unstandardized Coeff.	Standardized Coeff.
Female		-.33*** (.03)	-.33*** (.03)	**-.07**
Student's SES (grandcent_books)		.26*** (.01)	.26*** (.01)	**.15**
Teacher's Expectation		.06 (.03)	.06 (.03)	
TIMSS Achievement in Mathematics (per100pts)(grandcent_score)		.02 (.00)	.02 (.00)	
Student's Engagement in Mathematics (grandcent_engage)		.50 (.13)	.50 (.13)	
Level-2 Independent Variables				
Gender of Teacher			.07 (.07)	
Teacher's Years of Experience			.08 (.05)	
Class size (grandcent_class)			.51 (.02)	
Urban			-.08 (.08)	
Medium Size City			-.13 (.10)	
Small Town			-.35 (.36)	
Remote Areas				
Classroom-achievement (per 100points) – grand_class_score			.26*** .07	**.12**
Intraclass Correlation	.08	.07	.04	
% of Level-1 Variance explained by the Model		27.45%	27.45%	

% of Level-2 Variance explained by the Model			70.51%

Table 5: HLM Table Result for Singapore (N=3,962)

	Model A	Model B	Model C	
Intercept	10.07*** (.05)	9.65*** (.17)	9.62*** (.24)	
Level-1 Independent Variables			Unstandardized Coeff.	Standardized Coeff.
Female		-.53*** (.07)	-.53*** (.07)	**-.07**
Student’s SES (grandcent_books)		.16*** (.01)	.16*** (.01)	**.15**
Teacher’s Expectation		.23** (.03)	.23** (.03)	
TIMSS Achievement in Mathematics (per100pts)(grandcent_score)		.07 (.00)	.07 (.00)	
Student’s Engagement in Mathematics (grandcent_engage)		.44*** (.13)	.44*** (.13)	
Level-2 Independent Variables				
Gender of Teacher			.07 (.07)	
Teacher’s Years of Experience				
Classroom-achievement (per 100points) – grand_class_score			.08 (.05)	
Intraclass Correlation	.07	.06	.04	
% of Level-1 Variance explained by the Model		56.73%	56.71%	
% of Level-2 Variance explained by the Model			60.18%	

AMERICAN EDUCATIONAL RESEARCH ASSOCIATION

Reviews

Summary of reviewers notes and ratings on criteria.

Finding the answers behind Students' Level of Confidence Level in Mathematics across countries: A Secondary Analysis using TIMSS 2011

Unit / Sub Unit: **Division C - Learning and Instruction / Division C - Section 2b: Learning and Motivation in Social and Cultural Contexts**

Review Worksheet

(2/3)

Review #1095127

Criteria	Rate
Objectives or purposes	3 / 5
Perspective(s) or theoretical framework	2 / 5
Methods, techniques, or modes of inquiry	3 / 5
Data sources, evidence, objects or materials	4 / 5
Results and/or substantiated conclusions or warrants for arguments/point of view	3 / 5
Scientific or scholarly significance of the study or work	3 / 5

Comments to the Author/Submitter

This is an interesting study that uses a multi-level modeling approach to understanding predictors of math self-concept across several countries using TIMSS data. Unfortunately, I had a difficult time following the proposal, due to grammatical and syntax issues in the writing. However, I do think the results surrounding differences in the relations of self-concept to achievement across different countries would be of interest to the AERA conference community. Also, results related to differential predictors of math self-concept across countries is interesting.

Review #1099160

Criteria	Rate
Objectives or purposes	4 / 5
Perspective(s) or theoretical framework	4 / 5
Methods, techniques, or modes of inquiry	4 / 5
Data sources, evidence, objects or materials	4 / 5
Results and/or substantiated conclusions or warrants for arguments/point of view	5 / 5

Scientific or scholarly significance of the study or work	5 / 5

Comments to the Author/Submitter

With impressive literature search and a very large data set your study contributes to the literature on mathematics achievements and elements that influence it differently in different Asian countries. I am surprised by the result that confidence level had little affect on achievement.

Review Worksheet (2/2)

Review #1096417

Criteria	Rate
Objectives or purposes	4 / 5
Perspective(s) or theoretical framework	4 / 5
Methods, techniques, or modes of inquiry	5 / 5
Data sources, evidence, objects or materials	5 / 5
Results and/or substantiated conclusions or warrants for arguments/point of view	5 / 5
Scientific or scholarly significance of the study or work	4 / 5

Comments to the Author/Submitter

This study takes an important look at the relevance of studies on self-concept in the Western world to Asian countries. The HLM approach is highly appropriate, and the results seem promising. The terms self-perception, confidence, and self-concept seem to be used interchangeably. A lot of the background literature uses the term “self-concept,” but you label your measures “confidence.” It would be nice to know if you are referring to the same idea when using any of these terms, or if there is meant to be a distinction between them.

Review #1096466

Criteria	Rate
Objectives or purposes	5 / 5
Perspective(s) or theoretical framework	5 / 5
Methods, techniques, or modes of inquiry	4 / 5
Data sources, evidence, objects or materials	5 / 5
Results and/or substantiated conclusions or warrants for arguments/point of view	5 / 5
Scientific or scholarly significance of the study or work	4 / 5

Comments to the Author/Submitter

Purpose is clearly stated, but is not situated within a theoretical/methodological/policy background to explain why the study tackles a pressing issue in education research. However, the Theoretical Framework section (which is combined with the Objectives section) very explicitly motivates the research question in the context of existing literature, so I gave the Objectives section a score of 5 given this later inclusion of the problem's relevance and importance as a subject of analysis. The relevant literature--both methodological and theoretical--is thoroughly reviewed and explicitly connected to the current study. The research questions and methodological approach are very clearly stated. The authors do not describe their analytical approach until reporting the results, and some key elements of the HLM approach are missing (e.g., how missing data was handled, approach to model building including fixed and random effects, how model selection was approached, whether data met assumptions of HLM, etc.). Nevertheless, the analyses are appropriate and well executed. The conclusions seem warranted from the results, and the significance of the study is clearly stated. Overall, I thought this was a very strong paper. As a small side note, I recommend that the author(s) have a native English speaker proofread their final paper (especially if they elect for it to go into the repository); I was absolutely able to understand and follow their writing, but there were several mistakes that required me to reread certain sentences several times.