Journal of Mathematics Education
Spring 2015, Vol. 8, No. 1, pp. 1-15

Self-efficacy and Attitudes Towards Mathematics of Undergraduates: A U.S. and Taiwan Comparison

Sandie Han
Janet Liou-Mark
Karmen T. Yu
Suhua Zeng
New York City College of Technology, CUNY, Brooklyn, New York

International studies have showed that Chinese students have consistently outperformed U.S. students in mathematics at the precollege levels. Although this difference remains at large, this study found that Taiwanese college students exhibited lower self-efficacy and motivational attitudes towards mathematics than students in the U.S. A mathematics attitudinal survey comparing three areas of learning metacognition was given to 139 U.S. and 536 Taiwanese undergraduates. Results showed statistically significant differences in responses regarding mathematics self-efficacy, task values, and goal orientation.

Key words: *Cross-Cultural Study; Comparison Study between US and Taiwan; Self-Efficacy; Task Value; Goal Orientation; Mathematics Attitude*

The CNN (2013) report, "Shanghai Teens Top International Education Ranking," highlighted the results from the 2012 Program for International Student Assessment (PISA) - a leading survey of education systems conducted every three years by the Organization for Economic Cooperation and Development (OECD). More than half a million 15- and 16-year olds across 65 countries participated in the assessment. The top seven ranking countries in the 2012 PISA mathematics achievement were from East Asian countries, with China in the number one ranking and Taiwan in the number four ranking (PISA, 2012). Similarly, the Trends in International Mathematics and Science Study (TIMSS) assessed the mathematics knowledge and skills of fourth and eighth graders, and found similar results. In the TIMSS (2011) study, 57 countries participated in the grade 4 assessment and 56 countries in the grade 8. Consistently, East Asian countries ranked at the top in mathematics achievement. Specifically, Singapore, Korea, Hong Kong, Taiwan, and Japan, were the high-performing countries at both the fourth and eighth grade levels.

The reasons for the high mathematical performance by the East Asian students are attributed to various beliefs and practices. CNN (2013) stated that many Shanghai students reported on the 2012 PISA questionnaire that effort

and hard work would bring them success. Previous cross-cultural studies have found similar attribution of success to effort (Chen & Zimmerman, 2007;Hess, McDevitte & Chih-Mei, 1987; Liu, 2012; Wei & Eisenhart, 2011). Studies also included examining pedagogical practices, curriculum, cultural, and family influences on the mathematics achievement of East Asian students (Chiu & Xihua, 2008, Geary, Salthouse, Chen & Fan, 1996; Li, 2009; Stigler, Lee, & Stevenson, 1987).

Recent cross-cultural studies have increasingly shifted focus from performance measurement to emotional or psychological measurement in mathematics learning (Lee, 2009; Liu & Lin, 2010; Monrony, Kleitman, Lee, Stankov, 2012; Nie, Lau & Liau, 2011). Several studies have used data from TIMSS and PISA to assess students' emotional responses toward mathematics across different cultures and to document the mathematics achievement patterns with mathematics attitudes. These attitudinal constructs, such as self-efficacy, task value, goal orientation, determine motivation and predict mathematics achievement (Ahmed, van der Werf, Kuyper & Minnaert, 2013; Mega, Ronconi, & De Beni, 2013; Zimmerman, 2000). Student responses to the TIMSS (2011) questionnaire "I usually do well in mathematics" and "I learn things quickly in mathematics" provide insight to the student's mathematics self-efficacy. "I think learning mathematics will help me in my daily life" gives a sense of their task value. "I learn many interesting things in mathematics" is an indication of the student's intrinsic motivation. "Mathematics makes me confused and nervous" is an indication of mathematics anxiety. Although East Asian students have showed high mathematics achievement on the PISA and TIMSS assessments, the results indicated that students in these countries have almost the lowest learning mathematics attitudes (Liou, 2013; Zhao, 2012).

Theoretical Background

Self-Efficacy

Self-efficacy is one's belief, or perception, about one's capability to perform at a certain level on a task. Research has shown that self-efficacy is positively related to academic performance (Hoffman, 2010; Pajares & Miller, 1995; Sartawi, Alsawaie, Dodeen, Tibi, & Alghazo, 2012). Students with high sense of self-efficacy exhibit strong motivation and approach difficulties as challenges to be mastered; whereas students with low sense of self-efficacy exhibit weak commitment and approach difficulties as threats and with anxiety (Bandura, 1994). Closely related to self-efficacy is self-concept which reflects a general sense of self-perception. Mathematics self-efficacy and self-concept affect the attitude and the behavior one holds towards mathematics, as well as the motivation and the confidence to perform well.

Using the student questionnaire data from the PISA 2003 project, Lee (2009) compared the mathematics self-concept, self-efficacy, and anxiety

across 41 countries and found that, in general, the low performing countries exhibited low mathematics self-efficacy and high mathematics anxiety; the high performing countries exhibited high mathematics self-efficacy and low mathematics anxiety. Lee (2009) also found a paradox for students in Japan and Korea. Both countries were among the top-performing nations and both exhibited one of the lowest scores on mathematics self-efficacy and the highest scores in mathematics anxiety. Monrony, Kleitman, Lee, and Stankov (2012) reported the same pattern among many East Asian countries, including Taiwan; despite their top ranking achievement scores in mathematics, students from the East Asian countries showed lower self-efficacy and self-concept, and higher mathematics anxiety.

Researchers are perplexed by this phenomenon and contrasting reasons have been suggested. Chiu and Klassen (2010) explained that, in a collectivist culture such as in the East Asian countries, family members and the community assume some of the responsibility of the student's success, and they tend to be more concerned and critical of the student's achievement. Measurement of learning success focuses on mastery of skills and school achievement. Thus, the student is more anxious about achievement and less concerned with self-concept and self-efficacy. However, in an individualistic culture such as the U.S., the student is held responsible for his or her accomplishments and challenges (Tsao, 2004). Thus, the student is more self-reliant and exhibits stronger self-concept and self-efficacy.

On the other hand, some studies in self-efficacy suggested a different perspective. Chen and Zimmerman (2007) and Chen (2003) have found that students who overestimate their self-efficacy tend to show less effort and poor performance. Meanwhile, students who underestimate their self-efficacy are more likely to show more effort and better performance. The high-achieving East Asian students may have underestimated their self-efficacy; whereas, the low-achieving students may have overestimated their self-efficacy which leads to the result of the East Asian students exhibiting low self-efficacy (Chiu & Klassen, 2010). Despite the explanations for why the high performing East Asian students show low mathematics self-efficacy, research continues to support that a strong sense of self-efficacy enhances human accomplishment and personal well-being (Bandura, 1994; Zimmerman, Bandura & Martinez-Pons, 1992), and expresses concern over the "East Asian learner paradox" (Stankov, 2010).

Task Value

Task value refers to one's perception or the awareness about the task in terms of usefulness, importance, or applicability (Liu & Lin, 2010). An individual's task value is instrumental to the pursuit of personally-valued future goals (Liem, Lau, & Nie, 2008).

Cultural and social values greatly impact one's sense of task value and consequently, one's learning towards mathematics. In the cross-cultural study

on the mathematics attitude of fifth graders between Taiwan and U.S. students, Tsao (2004) found that Taiwanese students place more task value on mathematics than the U.S. students. Tsao (2004) attributed this finding to historical social value which placed greater emphasis on scholarly accomplishments as they were means to social, political, and economic status. In the present day, mathematics learning is greatly valued because it is the pathway towards a stronger and more desirable science, technology, engineering, and mathematics (STEM) career track. The Americans, on the other hand, take on a more natural approach towards learning and place less emphasis on school achievement (Hess, McDevitte, & Chih-Mei, 1987). It is believed that mathematics learning should be individualized depending on the child's interests and innate abilities.

Jacobson and Harris (2008) have found that the perception of task value is also influenced by life experiences. They compared the responses of older non-traditional students with younger traditional students. They found non-traditional students were more motivated in their pursuit of college education, and they had a clearer purpose in mind; i.e., they took the advice of instructors more seriously, and they expected to gain something they can apply in the workforce. They also found traditional students were more likely to be affected by family goals and desires; i.e., they shared the same perceptions to task values as their parents, and they were less clear about the purpose of the task and the educational goals.

Although, task value is often regarded as an important motivator of students' learning, an over-emphasis in this area may produce anxiety. Therefore, in a society where mathematics is greatly valued, there is also high level of mathematics anxiety among the learners. It was suggested that an increase in mathematics self-efficacy is more beneficial than over-emphasizing mathematics task value (Nie, Lau & Liau, 2011).

Goal-Orientation

Goal orientation concerns the underlying attitudes or motivation that give rise to action (Ryan & Deci, 2000). The two types of goal orientation, intrinsic goal orientation and extrinsic goal orientation provide the reasons for learning. Intrinsic goal orientation refers to the inner reasons for learning, such as curiosity, self-development, or satisfaction. Extrinsic goal orientation concerns with outside factors, rewards, or punishments such as money, grades, or praises from others (Liu & Lin, 2010).

Students with intrinsic goal orientation value the "learning process," while students with extrinsic goal orientation value the performance outcome (Jacobson & Harris, 2008). Wolters (1998), in his research on goal orientation, found students who reported greater intrinsic goal orientation sought out "deeper learning" by taking on challenging assignments and putting forth more effort to learn. Students who reported greater extrinsic

motivation focused on performance and tended to learn on the surface for the sake of earning good grades.

It may be expected that in a collectivist culture, the students tend to share the same task values and goal orientations as their families, and they are more likely to be extrinsically motivated; some may even be negatively motivated for fear of punishment (Tsao, 2004). In an individualistic culture, the students have more options to choose what they want to learning based on their interests. It is expected that such students are more intrinsically motivated.

Methodology

The main research question answered in this study was "*Are there differences between Taiwan and U.S. college students in mathematics self-efficacy, task value, and goal orientation?"*

The Institutional and Study Participants

Three higher education institutions offering a baccalaureate degree in Applied Mathematics were selected for the study: 1) New York City College of Technology (NYCCT) in the U.S. and 2) Chinese Culture University (CCU) and 3) National Dong Hwa University (NDHU) in Taiwan. A brief description of each institution and its student body is provided below.

New York City College of Technology (NYCCT)

NYCCT, the designated college of technology within the City University of New York (CUNY) system, offers 27 associate, 24 baccalaureate degree programs, and no graduate degrees. NYYCT is an open access, minority serving, multicultural institution whose student body reflects the demographic diversity of the New York metropolitan area. Of the 16,000 students at NYCCT, close to 90% have identified minority ethnicities (Black, Hispanic, Asian, Native American and other); 42% indicated they were born outside of the U.S., representing 138 countries; 62% spoke a language other than English at home; approximately 70% received financial aid; 67% were first generation college attendees. Close to 20% work more than 20 hours per week. The median student age is 21. Majority of NYCCT students are in technical or health related programs. NYCCT's mission continues to focus on providing the education and the technology needed to fulfill individuals' career goals in today's workforce (New York City College of Technology, 2014).

Chinese Culture University (CCU) 中國文化大學

CCU offers 57 undergraduate programs, 39 Master's and 10 doctorate programs. The enrollment is approximately 10,000 students. With a focus on liberal arts education, CCU shows prominence in area of business

administration, foreign languages, legal studies, public policy, as well as engineering (Chinese Culture University, 2014).

National Dong Hwa University (NDHU) 國立東華大學

Focused on research and higher education, NDHU offers 35 academic departments, 48 graduate institutes, and 17 doctoral programs. More than a third of the university's 10,000 students are in the graduate program (National Dong Hwa University, 2014).

Students from both CCU and NDHU have no specific demographical data other than the Taiwan university entrance exam student data (2013) which had indicated that 98.3% of all students admitted to colleges in 2013 were identified as "regular applicants" and only 1.7% were identified as "special applicants" which included military veterans, aboriginal or indigenous people, minority tribes, and international students. In addition, 82.7% of those admitted in 2013 were between the age of 18 and 19; almost 99% were under 23 years of age. Both CCU and NDHU participate in the national university entrance selection process, in which college acceptance is based mostly on the student's score on the national university entrance exam and the college's cut-off score.

The participants for this study were full-time college students from the three institutions. College students were selected for this research because they are at an important stage in life where they have reached a level of success and autonomy in their education. This is also a critical time in which they find their passion that would lead to their life-long career. It is expected that the students have matured in their mathematics attitudes and are less influenced by parental and college admission pressures.

The survey was distributed during Fall 2011 and Spring 2012 semesters. A total of 139 NYCCT students took part in the survey. They were students enrolled in one of three entry-level mathematics courses: Fundamentals of Mathematics (topics cover intermediate algebra and geometry), Statistics with Probability, and Precalculus. They majored in one of the STEM disciplines. At CCU, the survey was distributed in entry-level calculus courses where 474 STEM and business majors participated. For NDHU, 62 mathematics majors took part in the survey.

Survey Instrument

A mathematics attitudes survey, comprised of carefully selected questions, was used as the instrument for this study. The survey has three sections, and it is based on a seven-point scale with 1 indicating strongly disagree and 7 indicating strongly agree. The first section, statements SE 1 – 5, addresses the students' sense of self-efficacy with regards to mathematics (Bong, 2002). A higher response indicates a higher sense of self-efficacy. The second section, statements TV 1 – 3, addresses the students' sense of task

values to mathematics (Bong, 2004). A higher response signifies a higher sense of mathematics relevancy for the students. The last section, statements GO 1 – 10, addresses the students' goal orientation (Van de Walle, 1997). This section is further separated into two categories: intrinsic goal orientation (GO 1 – 4) and extrinsic goal orientation (GO 5 – 10). Table 1 lists the statements for each focus.

Data Analysis

College students from each of the three institutions were asked to fill out the survey. Independent samples t-tests were used to compare the responses to the self-efficacy, task values, and goal orientation statements between two institutions at a time to determine if the mean responses were different.

Results

Even though gender, the levels of mathematics, and the majors of the students were not controlled in this study, a pattern emerged from the survey results. Overall, the mean responses on the self-efficacy, task values, and goal orientation statements have been higher for NYCCT students when compared to the two Taiwan Universities (Table 1). Notable results are shown that NYCCT students have indicated significantly higher scores in self-efficacy (statements SE 1 – 5), higher scores in task values (statements TV 1 – 3), and higher scores in intrinsic goal orientation (statements GO 1 – 4), when compared with each of the Taiwanese university students. However, when comparing extrinsic goal orientation, NYCCT students had mostly lower scores than CCU and NDHU (statements GO 8, 9, 10).

On the other hand, CCU and NDHU students show similar responses in most questions. The standard deviations of their responses are lower than the standard deviations of the responses by NYCCT students. This may be an indication that the mathematics attitudes of CCU and NDHU students are more homogeneous than NYCCT students due to a common culture.

There were statistically significantly differences in the means among the responses of NYCCT and the Taiwan university students (Table 2 and 3) for all the self-efficacy statements (SE 1 – 5), most of the task value statements (TV 1 – 2), all of the intrinsic goal orientation statements (GO 1 – 4), and a few extrinsic goal orientation statements (GO 5, 9, 10).

Table 1

Means and Standard Deviations of Self Efficacy Task Value, and Goal Orientation Student Responses

Statements	NYCCT Mean(SD) N=139	CCU Mean(SD) N=474	NDHU Mean(SD) N=62
SELF-EFFICACY			
SE 1. I'm certain I can understand the ideas taught in the Mathematics course.	5.32 (1.41)	4.20 (1.14)	4.03 (0.97)
SE 2. I expect to do very well in the Mathematics class.	5.62 (1.32)	4.28 (1.21)	3.94 (1.10)
SE 3. I am sure I can do an excellent job on the problems and tasks assigned in the Mathematics class.	5.34 (1.37)	4.35 (1.21)	4.08 (1.28)
SE 4. I think I will receive a good grade in the Mathematics course.	5.67 (1.25)	4.22 (1.23)	3.87 (1.08)
SE 5. I know that I will be able to learn the material presented in the Mathematics class	5.70 (1.19)	4.50 (1.20)	4.15 (1.20)
TASK VALUE			
TV 1. I think what I learn about Mathematics is important.	5.69 (1.53)	4.74 (1.36)	4.76 (1.22)
TV 2. I think Mathematics is a useful subject.	5.67 (1.54)	4.64 (1.34)	4.73 (1.07)
TV 3. I find Mathematics interesting.	4.77 (1.85)	4.39 (1.44)	4.65 (1.34)
GOAL ORIENTATION			
GO 1. I am willing to select a challenging assignment that I can learn a lot from.	5.37 (1.35)	4.42 (1.26)	4.37 (1.08)
GO 2. I often look for opportunities to develop new skills and knowledge.	5.78 (1.24)	4.55 (1.17)	4.42 (1.11)
GO 3. I enjoy challenging and difficult tasks where I'll learn new skills.	5.37 (1.44)	4.38 (1.19)	4.19 (1.16)
GO 4. I prefer to work in situations that require a high level of ability and talent.	5.30 (1.27)	4.37 (1.18)	4.34 (1.12)
GO 5. I am concerned with showing that I can perform better than my colleagues.	4.13 (1.74)	4.94 (1.31)	5.27 (1.16)
GO 6. I try to figure out what it takes to prove my ability to others.	4.80 (1.56)	4.78 (1.25)	4.94 (1.07)
GO 7. I enjoy it when others are aware of how well I am doing.	4.84 (1.59)	4.68 (1.30)	4.97 (1.10)
GO 8. I prefer to work on projects where I can prove my ability to others.	4.54 (1.58)	4.70 (1.24)	4.84 (1.28)
GO 9. I would avoid taking on a new task if there was a chance that I would appear rather incompetent to others.	3.55 (1.58)	4.31 (1.32)	4.18 (1.32)
GO 10. Avoiding a show of low ability is more important to me than learning a new skill.	3.01 (1.65)	3.84 (1.26)	3.71 (1.22)

Table 2
T-Test Results of Self Efficacy, Task Value, and Goal Orientation Student Responses between Institutions

Statements * p<0.05	NYCCT and CCU	NYCCT and NDHU	CCU and NDHU
SELF-EFFICACY			
SE 1. I'm certain I can understand the ideas taught in the Mathematics course.	t(194)=8.49*	t(165)=7.45*	t(84)=1.28
SE 2. I expect to do very well in the Mathematics class.	t(211)=10.66*	t(139)=9.40*	t(82)=2.32*
SE 3. I am sure I can do an excellent job on the problems and tasks assigned in the Mathematics class.	t(205)=7.70*	t(124)=6.28*	t(76)=1.54
SE 4. I think I will receive a good grade in the Mathematics course.	t(223)=12.10*	t(134)=10.34*	t(83)=2.34*
SE 5. I know that I will be able to learn the material presented in the Mathematics class	t(226)=10.42*	t(116)=8.50*	t(78)=2.20*
TASK VALUE			
TV 1. I think what I learn about Mathematics is important.	t(207)=6.63*	t(144)=4.61*	t(82)= -0.13
TV 2. I think Mathematics is a useful subject.	t(203)=7.11*	t(163)=5.00*	t(88)= -0.56
TV 3. I find Mathematics interesting.	t(189)=2.23*	t(158)=0.54	t(80)= -1.39
GOAL ORIENTATION			
GO 1. I am willing to select a challenging assignment that I can learn a lot from.	t(213)=7.45*	t(148)=5.67*	t(85)= 0.32
GO 2. I often look for opportunities to develop new skills and knowledge.	t(214)=10.45*	t(130)=7.75*	t(80)= 0.85
GO 3. I enjoy challenging and difficult tasks where I'll learn new skills.	t(196)=7.44*	t(144)=6.18*	t(79)= 1.18
GO 4. I prefer to work in situations that require a high level of ability and talent.	t(212)=7.73*	t(133)=5.41*	t(80)= 0.20
GO 5. I am concerned with showing that I can perform better than my colleagues.	t(186)= -5.07*	t(168)= -5.45*	t(82)= -2.10*
GO 6. I try to figure out what it takes to prove my ability to others.	t(192)=0.14	t(166)= -0.73	t(85)= -1.08
GO 7. I enjoy it when others are aware of how well I am doing.	t(194)=1.10	t(164)= -0.65	t(85)= -1.90*
GO 8. I prefer to work on projects where I can prove my ability to others.	t(173)= -1.02	t(145)= -1.38	t(77)= -0.83
GO 9. I would avoid taking on a new task if there was a chance that I would appear rather incompetent to others.	t(187)= -4.85*	t(149)= -2.82*	t(78)= 0.76
GO 10. Avoiding a show of low ability is more important to me than learning a new skill.	t(186)= -5.48*	t(156)= -3.36*	t(79)= 0.78

Table 3
Summary of T-test Results Showing Significant Differences

Statements * p<0.05	NYCCT and CCU	NYCCT and NDHU	CCU and NDHU
SE 1. I'm certain I can understand the ideas taught in the Mathematics course.	*	*	
SE 2. I expect to do very well in the Mathematics class.	*	*	*
SE 3. I am sure I can do an excellent job on the problems and tasks assigned in the Mathematics class.	*	*	
SE 4. I think I will receive a good grade in the Mathematics course.	*	*	*
SE 5. I know that I will be able to learn the material presented in the Mathematics class	*	*	*
TV 1. I think what I learn about Mathematics is important.	*	*	
TV 2. I think Mathematics is a useful subject.	*	*	
TV 3. I find Mathematics interesting.	*		
GO 1. I am willing to select a challenging assignment that I can learn a lot from.	*	*	
GO 2. I often look for opportunities to develop new skills and knowledge.	*	*	
GO 3. I enjoy challenging and difficult tasks where I'll learn new skills.	*	*	
GO 4. I prefer to work in situations that require a high level of ability and talent.	*	*	
GO 5. I am concerned with showing that I can perform better than my colleagues.	*	*	*
GO 6. I try to figure out what it takes to prove my ability to others.			
GO 7. I enjoy it when others are aware of how well I am doing.			*
GO 8. I prefer to work on projects where I can prove my ability to others.			
GO 9. I would avoid taking on a new task if there was a chance that I would appear rather incompetent to others.	*	*	
GO 10. Avoiding a show of low ability is more important to me than learning a new skill.	*	*	

Discussion

In this study, results showed significant differences in the mathematics attitudes between Taiwanese and U.S. college students. Consistently, both CCU and NDHU students have indicated lower self-efficacy and lower sense

of task value than the NYCCT students. In addition, CCU and NDHU students have indicated lower intrinsic goal orientation and somewhat higher extrinsic goal orientation than NYCCT students; specifically that CCU and NDHU students are more likely to be motivated by external factors such as family, societal pressures, or rewards. These results are consistent with the findings of Tsao (2004) where Taiwanese students' learning of mathematics was more influenced by negative motivation and American students by more positive motivation.

In comparing within the Taiwan universities, CCU and NDHU students have shown similar mathematics attitudes. Furthermore, the low standard deviations in the responses by CCU and NDHU students suggest that the mathematics attitudes of Taiwanese students are more homogeneous than the U.S. students.

The findings from this study support the cross-cultural research results on self-efficacy and self-concept. These differences reflect the cultural belief system which has impacted students' decisions on educational practices and learning attitudes. The Taiwanese culture values activities that help a child master prescribed skills, whereas the U.S. values experiences that will make a child more creative and confident (Tsao, 2004). Other research studies found that most American parents believe a child's mathematical performance primarily depends on the intelligence and their innate mathematics ability. However, Asian parents believe effort is more important for academic success (Wei & Eisenhart, 2011).

The differences in the findings can also be explained by the type of students surveyed. Taiwanese students are the young traditional students, who may not have the life experiences necessary to set clear career and educational goals (Jacobson & Harris, 2008). Moreover, in the collectivist society, cultural expectation and family pressure on the educational attainment are the main driving forces for most of these students. Thus, they tend not to have high sense of task values or show more extrinsic goal orientation. While NYCCT students come from more diverse backgrounds, they vary in culture, age, social class, education, and experiences. Many need to work or have family responsibilities while going to school which attributes to a higher sense of task value and more intrinsic goal orientation.

Is there a reason for concern? Stankov (2010) addressed the concern that although East Asian students show high mathematics performance, their mathematics self-efficacy is low. Bandura (1994), in his extensive study on self-efficacy, has made an important connection between self-efficacy, motivation, and life outlook; those with strong sense of self-efficacy exhibit intrinsic motivation, produce personal accomplishments, experience lower stress and vulnerability to depression. In contrast, those with low sense of self-efficacy quickly lose faith in their capabilities and fall easy victim to stress and depression. The same concern is reflected from this study.

Recommendations and Future Studies

There are many variables and challenges, in addition to cultural and social values, when conducting cross-cultural studies such as the one reported. For example, the higher educational system from both countries varies in its mathematics entry level. In Taiwan, the first-year mathematics course at the university level is calculus. While at NYCCT, most students are starting below calculus and often at the intermediate algebra level. While this study focused on the mathematics attitudes of the college students without regards to their mathematics level, future studies controlling for entry-level mathematics are recommended. Other factors shaping mathematics attitude such as age, gender, major, and career aspiration, should also be investigated. A longitudinal study will be helpful in finding other factors that affect mathematics attitudes and their long term effects.

The Ministry of Education in Taiwan had recently launched several educational reforms which included full implementation of the 12-year compulsory education program and a flexible college admission process. With these changes in place, a new generation of college students with different college admission requirements and expectations will emerge. It would be a worthwhile project to repeat the study and compare if these major restructuring in educational policy affects the students' mathematics attitudes.

Acknowledgements

This project was supported by the MAA Tensor Women and Mathematics Grant, New York City College of Technology's Honors Scholars and Emerging Scholars Program, and the CUNY Compact Funds.

References

Ahmed, W., van der Werf, G., Kuyper, H., & Minnaert, A. (2013). Emotions, self-regulated learning, and achievement in mathematics: A growth curve analysis. *Journal of Educational Psychology*, *105*(1), 150 -161.

Bandura, A. (1994). Self-efficacy. In V.S. Ramachaudran (Ed.), *Encyclopedia of human behavior, 4,* 71-81.

Bong, M. (2002). Predictive utility of subject-, task-, and problem-specific self-efficacy judgments for immediate and delayed academic performance. *Journal of Experimental Education, 70*(2), 133-162.

Bong, M. (2004). Academic motivation in self-efficacy, task value, achievement goal orientations, and attributional beliefs. *Journal of Educational Research, 97*(6), 287-297.

Chen, P. (2003). Exploring the accuracy and predictability of the self-efficacy beliefs of seventh-grade mathematics students. *Learning and Individual Differences, 14*, 79-92.

Chen, P., & Zimmerman, B. (2007). A cross-national comparison study on the accuracy of self-efficacy beliefs of middle-school mathematics students. *The Journal of Experimental Education*, 75(3), 221-244.

Chinese Cultural University. (2014). Retrieved from http://www.pccu.edu.tw

Chiu, M. M., & Klassen, R. M. (2010). Relations of mathematics self-concept and its calibration with mathematics achievement: Cultural differences among fifteen-year-olds in 34 countries. *Learning and Instruction*, 20, 2 - 17.

Chiu, M. M., & Xihua, Z. (2008). Family and motivation effects on mathematics achievement: Analyses of students in 41 countries. *Learning and Instruction*, *18*, 321 - 336.

CNN (2013). *Shanghai teens top international education ranking, OECD says*. Retrieved from http://www.cnn.com/2013/12/03/world/asia/pisa-education-study/.

Geary D., Salthouse, T., Chen, G.P., & Fan, L. (1996) Are East Asian versus American differences in arithmetical ability a recent phenonmenon? *Developmental Psychology, 32*(2), 254-262.

Hess, R., McDevitt, T., & Chih-Mei, C. (1987). Cultural variations in family beliefs about children's performance in mathematics: Comparisons among people's republic of China, chinese-american, and caucasian-American families. *Journal of Educational Psychology*, *79*(2), 179-188.

Hoffman, B. (2010). "I think I can, but I'm afraid to try": The role of self-efficacy beliefs and mathematics anxiety in mathematics problem-solving efficiency. *Learning and Individual Differences*, *20*, 276-283.

Jacobson, R. R., & Harris, S. M. (2008). Does the type of campus influence self-regulated learning as measured by the motivated strategies for learning questionnaire (MSLQ)? *Education*, *128*(3), 412-431.

Lee, J. (2009). Universals and specifics of math self-concept, math self-efficacy, and math anxiety across 41 PISA 2003 participating countries. *Learning and Individual Differences*, *19*, 355-365.

Li, Y. (2009). U.S. and Chinese teachers' practices and thinking in constructing curriculum for teaching. *Proceedings of the 31st annual meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education,* 911-919.

Liem, A. D., Lau, S., & Nie, Y. (2008). The role of self-efficacy, task value, and achievement goals in predicting learning strategies, task disengagement, peer relationship, and achievement outcome. *Contemporary Educational Psychology*, *33*, 486 -512.

Liou, P. Y. (2014). Examining the big-fish-little-pond effect on students' self-concept of learning science in Taiwan based on the TIMSS databases. *International Journal of Science Education*, *36*(12), 2009-2028.

Liu, E. Z. F., & Lin, C. H. (2010). The survey study of mathematics motivated strategies for learning questionnaire (MMSLQ) for grade 10

- 12 Taiwanese students. *TOJET: The Turkish Online Journal of Education Technology, 9*(2), 221-233.

Liu, J. (2012). Does cram schooling matter? Who goes to cram school? Evidence from Taiwan. *International Journal of Educational Development* 32, 46-52.

Ma, X. & Xu, J. (2004). The causal ordering of mathematics anxiety and mathematics achievement: A longitudinal panel analysis. *Journal of Adolescence*, 27, 165-179.

Mega, C, Ronconi, L. & De Beni, R. (2013). What makes a good student? How emotions, self-regulated learning, and motivation contribute to academics achievement. *Journal of Educational Psychology*, 106(1), 121-131.

Morony, S., Kleitman, S., Lee, Y. P., & Stankov, L. (2013). Predicting achievement: Confidence vs self-efficacy, anxiety, and self-concept in Confucian and European countries. *International Journal of Educational Research*, *58*, 79 -96.

National Dong Hwa University. (2014). Retrieved from http://www.ndhu.edu.tw/bin/home.php

New York City College of Technology. (2014). Retrieved from http://www.citytech.cuny.edu/aboutus/college_profile.shtml

Nie, Y., Lau, S., & Liau, A. (2011). Role of academic self-efficacy in moderating the relation between task importance and test anxiety. *Learning and Individual Differences*, 21, 736-741.

Pajares, F., & Miller, M. D. (1995). Mathematics self-efficacy and mathematics performances: The need for specificity of assessment. *Journal of Counseling Psychology, 42*, 190-198.

PISA (2012). Retrieved from http://www.oecd.org/pisa/keyfindings/pisa-2012-results.htm.

Ryan, R., & Deci, E. (2000) Intrinsic and extrinsic motivations: Classic definitions and new directions. *Contemporary Educational Psychology*, *25*, 54-67.

Sartawi, A., Alsawaie, O., Dodeen, H., Tibi, S., & Alghazo, I. (2012). Predicting mathematics achievement by motivation and self-efficacy across gender and achievement levels. *Interdisciplinary Journal of Teaching and Learning, 2*(2), 59-77.

Stankov, L. (2010). Unforgiving Confucian culture: A breeding ground for high academic achievement, test anxiety and self-doubt? *Learning and Individual Differences, 20,* 555-563.

Taiwan university entrance exam student data. (2013). Retrieved from http://www.uac.edu.tw/102data/102_14.pdf

Trends in International Mathematics and Science Study. (2011). Retrieved from http://nces.ed.gov/timss/results11.asp and http://nces.ed.gov/Timss/questionnaire.asp

Tsao, Y. L. (2004). A comparison of American and Taiwanese students: Their math perception. *Journal of Instructional Psychology, 31*(3), 206-213.

Van de Walle, D. (1997). Development and validation of a work domain goal orientation instrument. *Educational and Psychological Measurement, 57*(6), 995-1015.

Wei, M. H., & Eisenhart, C. (2011). Why do Taiwanese children excel at math? *Phi Delta Kappan, September,* 74-76.

Wolters, C.A. (1998). Self-regulated learning and college students' regulation of motivation. *Journal of Educational Psychology*, *90*(2), 224 - 235.

Zhao, Y. (2012, December 11). Numbers can lie: What TIMSS and PISA truly tell us, if anything? [Blog]. Retrieved from http://zhaolearning.com/2012/12/11/numbers-can-lie-what-timss-and-pisa-truly-tell-us-if-anything

Zimmerman, B. (2000). Self-efficacy: An essential motive to learn. *Contemporary Educational Psychology, 25*, 82-91.

Zimmerman, B., Bandura, A., & Martinez-Pons, M. (1992). Self-motivation for academic attainment: The role of self-efficacy beliefs and personal goal setting. *American Educational Research Journal, 29*(3), 663-676.

Authors:
Sandie Han
New York City College of Technology, CUNY
shan@citytech.cuny.edu

Janet Liou-Mark
New York City College of Technology, CUNY
Jliou-mark@citytech.cuny.edu