ISSN 2010-3093

RESEARCH BRIEF

No. 14-006

Implicit Social Cognition as a Predictor of Academic Performance

Manu Kapur and Cvencek Dario

TWO-HUNDRED AND NINETY-NINE Singapore primary school students (age 7 to 11 years old) completed two separate assessments on implicit and explicit gender identity (me=male/female), math-gender stereotype (math=male), and math self-concept (me=math). Results from these assessments were compared with students' achievement on a standardized mathematics test and school mathematics examination results. It was found that implicit, but not explicit, math self-concept positively correlated with students' mathematics achievement. Moreover, both implicit and explicit assessments found that a stronger math-gender stereotype led to stronger math self-concept for male students but weaker math self-concept for female students. Implicit math-gender stereotype was also found to be positively related to students' mathematics achievement. These findings suggest that implicit math-gender stereotype and math self-concept are crucial predictors of students' mathematics achievement, even in a country like Singapore, where students constantly excel in the subject.

INTRODUCTION

In many cultures, stereotypical beliefs exist at a societal level with respect to students' mathematics performance. Termed as "math-gender stereotype", the belief regards mathematics as a male domain from which females are excluded. Past studies found that females who adhered to this stereotypical belief tended to perform more poorly than males who had internalized the same belief (Ambady, Shih, Kim, & Pittinsky, 2001; Nosek, Banaji, & Greenwald, 2002). Math-gender stereotype not only created impairment in female students' mathematical performance (Kiefer

KEY IMPLICATION

- The current study has broadened our understanding of Singapore primary school students' social cognitive constructs. Students' implicit and explicit gender identity, math self-concept, and math-gender stereotype were explored in relation to their mathematical achievement.
- The results indicate that an intervention program could be generated to enable low achieving students to excel in math by raising their awareness of stereotypical belief and enabling them to realize their true math potential.

& Sekaquaptewa, 2007a; Kiefer & Sekaquatewa, 2007b), but might ultimately also have affected their choice of academic courses and career (Eccles, Wigfield, Harold, & Blumenfeld, 1993; Eccles, 2005, Liben, Bigler, & Krogh, 2001).

Three interrelated social cognitive constructs were found to be involved in math-related outcomes. The first construct, as proposed by Greenwald, Banaji, Rudman, Farnham, Nosek & Mellott (2002), is gender identity which refers to the association of oneself to one's gender roles and traits. The second is math self-concept, which is the association of oneself with mathematics. The third, math-gender stereotype, is the culturally formed gender bias of mathematics. If an individual strongly associates himself or herself to his/her gender identity, and a math-gender stereotype is prominent in his/her society, it is likely that the individual will regard himself/herself as able/not able to do mathematics. Heider's (1946) balance theory pointed out that individuals are often under pressure to keep their beliefs and identities in a balanced manner. The current study explored the relationship between the three social cognitive constructs and how they affect students' mathematical achievement.

Singapore is an appropriate location for this line of research because of the following reasons. First, Singapore students have been excelling in mathematics, as demonstrated by the Trends in International Mathematics and Science Study (TIMSS) and the Program of International Students Assessment (PISA) in both of which Singapore students consistently emerge as high achievers. In the recent TIMSS assessment, Singapore female students even outperformed their male peers at Grade 4. Nevertheless, a recent study found that Singapore students also succumb to the math-gender stereotype and Singapore male students seem to demonstrate a stronger association with mathematics compared to female students (Cvencek, Meltzoff, & Kapur, 2014). The second reason for this study is that no research has been conducted on the influence of students' math-gender stereotype and math self-concept on mathematics achievement in Singapore. Third, there is no explanation as to why Singapore female students continue to excel in mathematics despite the presence of a belief in males' mathematics dominance.

RESEARCH DESIGN

Students were assessed explicitly and implicitly for the three social cognitive constructs and attempted a standardized mathematical achievement test. For explicit measures, students were questioned directly while implicit measures took the form of a sorting test.

The standardized mathematical achievement test papers used in the current study were developed by a local mathematics curriculum expert who had more than 30 years of teaching experience and was working with Singapore's Ministry of Education (MOE). Test questions were grade-appropriate and had been piloted on a sample of 120 to 650 students previously.

Two Likert-scale questions accompanied by pictures from Harter & Pike's (1984) Pictorial Scale were asked to obtain students' explicit assessments of self-concept, math-gender stereotype and gender identity. The two questions asked were:

i. Which character (male or female) the students believed to possess an attribute (e.g., like math/like to read) to a greater degree; and
ii. Whether the character possessed the attribute "a lot" or "a little".

Students indicated their answers by pointing to 1 of the 2 circles (1.1cm and 2.3cm in diameter) below the pictures. Each student's set of two scores were subtracted from each other, giving an explicit score with a lower and upper bound of -2 and +2.

The Child Implicit Association Test (Ch-IAT) was administered to measure students' gender identity, math-gender stereotype and math self-concept. The Ch-IAT was adapted from the adult Implicit Association Test (IAT). During the test, students sorted words into their respective categories in the shortest time possible. For the gender identity IAT, students had to associate "Me" concept with "Girl" for female gender identity or "Boy" for male gender identity. For the math-gender stereotype IAT, students had to associate words concerning "Boy", "Girl", "Math", or "Reading". For the self-concept IAT, students had to associate "Me" concept with "Math" or "Reading".

At the start of the IAT, students tried several single-discrimination tasks by sorting words from one pair of categories (e.g., "Math" and "Reading") to familiarize them with the rules and apparatus used. After this, students moved to combined discrimination tasks requiring them to sort words from two pairs of categories. There were a total of 16 trials for single discrimination tasks and 24 for combined discrimination tasks.

KEY FINDINGS

Both male and female students scored well on the mathematical achievement test. No gender difference was found in students' performance. However, three findings were notable with respect to the measures of math self-concept, math-gender stereotype.

First, implicit, but not explicit, math self-concept was found to be positively correlated with mathematics achievement. This finding held true for both male and female students. The finding coincides with that of previous research, suggesting the strong predictive value of domain-specific self-concepts (Dweck, 2002; Eccles et al., 1993; Marsh & Yeung, 1998).

Second, implicit math-gender stereotype was found to be correlated with students' math self-concept. Male students with strong math-gender stereotype tended to have stronger math self-concept than those with less strong math-gender stereotype, while female students with stronger math-gender stereotype tended to have weaker math self-concept. This was true for both implicit and explicit assessments.

Third, implicit math-gender stereotype was positively related to math achievement. These findings extend previous research findings in two ways. The current study found that both implicit and explicit math-gender stereotype influenced students' math self-concept, an influence operating from a relatively young age at primary school. Previous studies found evidence of such an influence only at middle school level (Steffens et al., 2010). Furthermore, the student sample involved in the current study was made up of students who were high achievers in mathematics with no apparent gender differences in performance. Thus, the current finding suggests that other underlying disparities which affect math achievement could be removed. The current study also observed that social cognitive constructs increased with age. math-gender stereotype was found to be more prominent in older students.

IMPLICATIONS

For Policy

In 2005, a Steering Committee was set up by MOE to supervise the development of a Social Emotional Learning framework. Within the framework, the development of soft skills and well-rounded students was regarded as crucial as the achievement of high academic standards. Hence, the current study contributes to an improved understanding of academic performance in relation to the social-emotional development of students.

Particularly, the current study elucidated the patterns of beliefs—implicit and explicit—held by Singapore primary school students. The study also showed how different social cognitive constructs interact to shape students' sense of identity as learners and affect their academic performances. The cross cultural nature of the study also gave rise to opportunities for looking at different patterns of responses to the same set of social cognitive constructs.

Future follow-up studies could be planned with an intervention programme in mind. At the simplest level, intervention could consist of students being informed about the existence of stereotype, the belief that they might be holding, and how stereotypical beliefs might affect their performance.

For practice

The current study found that students who did well in the standardized mathematics achievement tests also implicitly held the belief that math=me. Thus, an intervention strategy could be developed and implemented in classrooms to nurture the desired implicit belief. The intervention should aim at moulding weaker students' belief about themselves, actual math abilities, and achievements. This intervention may be more effective than the traditional method of expending time and cost on tutoring and drilling students in math skills.

For teacher training

The current study has made evident how social cognitive constructs might impact students' academic performance. Hence, teachers could structure their lessons, keeping in mind the influence that math-gender stereotype can have on students' math achievement. Moreover, a classroom-based intervention could be generated in future follow up studies, and implemented by teachers..

REFERENCES

Ambady, N., Shih, M., Kim, A., & Pittinsky, T. L. (2001). Stereotype susceptibility in children: Effects of identity activation on quantitative performance. *Psychological Science*, *12*(5), 385–390. doi:10.1111/1467-9280.00371

Cvencek, D., Meltzoff, A. N., & Kapur, M. (2014). Cognitive consistency and math-gender stereotype in Singaporean children. *Journal of Experimental Child Psychology*, *117*, 73–91. doi: 10.1016/j.jecp.2013.07.018

Dweck, C. S. (2002). The development of ability conceptions. In A. Wigifeld & J. S. Eccles (Eds.), *Development of achievement motivation* (pp. 57–88). San Diego, CA: Academic Press.

Eccles, J. S., Wigfield, A., Harold, R. D., & Blumenfeld, P. (1993). Age and gender differences in children's self- and task perceptions during elementary school. *Child Development*, *64*(3), 830–847. doi:10.1111/j.1467-8624.1993.tb02946.x

Eccles, J. S. (2005). Studying gender and ethnic differences in participation in math, physical science, and information technology. In J. E. Jacobs & S. D. Simpkins (Eds.), *Leaks in the pipeline to math, science, and technology careers* (pp. 7–14). San Francisco, CA: Joseey-Bass.

Greenwald, A. G., Banaji, M. R., Rudman, L. A., Farnham, S. D., Nosek, B. A., & Mellott, D. S. (2002). A unified theory of implicit attitudes, stereotypes, self-esteem, and self-concept. *Psychological Review*, *109*, 3–25. doi:10.1037/0033-295X.109.1.3

Harter, S., & Pike, R. (1984). The pictorial scale of perceived competence and social acceptance for young children. *Child Development*, *55*(6), 1969–1982. doi:10.2307/1129772

Heider, F. (1946). Attitudes and cognitive organization. *The Journal of Psychology*, *21*, 107–112.

Liben, L. S., Bigler, R. S., & Krogh, H. R. (2001). Pink and blue collar jobs: Children's judgements of job status and job aspirations in relation to sex of worker. *Journal of Experimental Child Psychology*, *79*(4), 346–363. doi: 10.1006/jecp.2000.2611

Marsh, H. W., & Yeung, A. S. (1998). Longitudinal structural equation models of academic self-concept and achievement: Gender differences in the development of math and English constructs. *American Educational Research Journal*, *35*(4), 705–738. doi:10.3102/00028312035004705

Nosek, B. A., Banaji, M. R., & Greenwald, A. G. (2002). Math = male, me = female, therefore, math ≠ me. *Journal of Personality and Social Psychology*, *83*, 44–59. doi:10.1037/0022-3514.83.1.44

Kiefer, A. K., & Sekaquaptewa, D. (2007a). Implicit stereotypes and women's math performance: How implicit gender-math stereotypes influence women's susceptibility to stereotype threat. *Journal of Experimental Social Psychology*, *43*(5), 825–833. doi: 10.1016/j.jesp.2006.08.004

Kiefer, A. K., & Sekaquaptewa, D. (2007b). Implicit stereotypes, gender identification, and math performance: a prospective study of female college students. *Psychological Science*, *18*, 13–18. doi: 10.1111/j.1467-9280.2007.01841.x

Steffens, M. C., Jelenec, P., & Noack, P. (2010). On the leaky math pipeline: Comparing implicit math–gender stereotypes and math withdrawal in female and male children and adolescents. *Journal of Educational Psychology*, *102*, 947–963.

ABOUT THE AUTHORS

Manu KAPUR is with the National Institute of Education, Nanyang Technological University, Singapore. *Dario CVENCEK* is with the Institute of Learning & Brain Sciences, University of Washington, USA.

Contact Manu or Dario at **manu.kapur@nie.edu.sg** or **dario1@u.washington.edu** for more information about the project.

This brief was based on the project OER 12/12 MK: Implicit Social Cognition as a Predictor of Academic Performance.