The effects of self-concept on motivational behaviors in mathematics learning: The contingent roles of teacher cognitive activation and gender

Yuanhua Wang, West Virginia University

Introduction

- While mathematics has increasingly become an important domain in education, students vary in their motivations for learning mathematics (Wolters & Pintrich, 1998). To facilitate motivations in learning mathematics, research has suggested that self-beliefs, such as academic self-concept, should be promoted among students (Marsh, 2007). Mathematics self-concept reflects a student's perception of his or her ability in learning mathematics (Martin & Mullis, 2013). Though previous studies have generally demonstrated a positive relationship between math self-concept and student academic achievement (e.g., Arens et al., 2011), the underlying mechanisms through which math self-concept leads to better academic achievement are not fully explored. Moreover, despite self-concept generally leading to positive academic outcomes, students present heterogeneities in leveraging from self-concept to build their academic success. In addition, while self-concept promotes interests in learning (e.g., Arens et al., 2019; Parker et al., 2018), students are also influenced by the interaction with their teachers (Ma et al., 2018). Yet, insights are still limited in understanding how self-concept interacts with teacher instructional approach on influencing student performance. To bridge these gaps, I adopt a contingency approach to examine the impacts of math self-concept on students' motivational behaviors, including both learning effort and learning anxiety.

➢ Overall, I propose the following hypotheses:

- H1: Math self-concept is positively related to learning effort (H1a) but is negatively associated with learning anxiety (H1b).
- H2: Cognitive activation strengthens the positive relationship between math self-concept and learning effort (H2a) and strengthens the negative relationship between math self-concept and learning anxiety (H2b).
- H3: The positive relationship between math self-concept and learning effort (H3a) will be stronger for girls and the negative relationship between math self-concept and learning anxiety (H3b) will be stronger for boys.

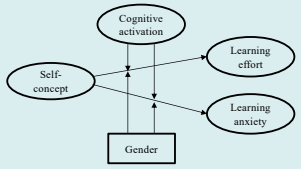

Figure 1. Theoretical framework

Method

➢ Participants and procedures

The data in this study were drawn from an international data set: the Organization for Economic Cooperation and Development's (OECD) Programme for International Student Assessment (PISA) 2012. The participants in this study were 1,592 U.S. 15-year-old high school students.

➢ Measures

The measures of the self-concept, cognitive activation, effort, and anxiety used in this study were adopted from the "PISA 2012 student questionnaire," which was a 30-minute questionnaire asking students about themselves, their attitudes toward values, and their experiences in school (Kastberg et al., 2014). All items were answered using a 4-point Likert scale (with 1= "strongly agree" and 4 = "strongly disagree").

Results

➢ **The main effects of self-concept**

In hypothesis 1, I posited that self-concept has a positive relationship with student learning effort (H1a) and a negative relationship with student learning anxiety (H1b). The result from Model 1 of Table 1 shows that the effect of self-concept on learning effort is positively significant ($\beta = 0.210$, $p < 0.001$). The result from Model 3 of Table 1 shows that the effect of self-concept on learning anxiety is negatively significant ($\beta = -0.092$, $p < 0.001$). This finding provides evidence suggesting that self-concept not only can enhance student learning effort but also reduce learning anxiety. Therefore, both H1a and H1b were supported.

➢ **The moderating effects of cognitive activation**

Hypothesis 2 suggests that teacher cognitive activation can strengthen the positive relationship between self-concept and student learning effort (H1a) and the negative relationship between self-concept and student learning anxiety (H2b). The result from Model 2 in Table 2 indicates that the interaction of cognitive activation and self-concept is positive and significantly related to student learning effort ($\beta = 0.035$, $p < 0.001$). However, the result in Model 3 of Table 1 shows that the interaction of self-concept and cognitive activation is not significantly related to student learning anxiety ($\beta = 0.020$, $p > 0.10$). This evidence indicates that cognitive activation is more effective in enhancing learning effort but not in reducing learning anxiety through better self-concept. To better interpret this result, I plot the interactive effect of self-concept and cognitive activation on learning effort in Figure 2. As shown in the figure, the regression line shows a steeper slope when teacher cognitive activation is higher (one standard deviation above the mean) than when teacher cognitive activation is lower (one standard deviation below the mean). Therefore, H2a was supported but H2b was not supported.

➢ **The moderating effects of gender**

In hypotheses 3a and 3b, I posited that the impact of self-concept on student learning effort and learning anxiety would be more prominent for girls than for boys. The result from Model 2 in Table 1 shows that the interaction of self-concept and gender is not significantly related to student learning effort ($\beta = -0.004$, $p > 0.10$). However, the result in Model 3 of Table 1 shows that the interaction of self-concept and gender (boys) is positive and significantly related to student learning anxiety ($\beta = 0.123$, $p > 0.001$). This evidence indicates that self-concept might be more effective in reducing learning anxiety for girls than for boys. I plotted the interactive effect of self-concept and gender on learning anxiety in Figure 3. Consistent with our expectation, the regression line shows a flatter slope when gender is male than when gender is female. Therefore, H2b was supported, but H2a was not supported.

Table 1. Hypotheses testing results

	Learning effort		Learning anxiety	
Variables	Model 1	Model 2	Model 3	Model 4
Constant	3.454***	3.467***	1.126	1.200
	(0.692)	(0.691)	(0.767)	(0.763)
Self-concept	0.210***	0.212***	-0.711***	-0.888***
	(0.015)	(0.040)	(0.016)	(0.045)
Cognitive activation	0.079***	0.080***	0.035*	0.037**
	(0.016)	(0.016)	(0.019)	(0.019)
Gender	-0.137***	-0.138***	-0.092***	-0.080***
	(0.024)	(0.024)	(0.028)	(0.028)
Self-concept * Cognitive activation		0.035***		0.020
		(0.012)		(0.013)
Self-concept * Gender		-0.004		0.123***
		(0.026)		(0.029)
Age	-0.054	-0.055	-0.050	-0.057
	(0.043)	(0.043)	(0.048)	(0.048)
Classroom management	0.097***	0.099***	-0.044	-0.039
	(0.027)	(0.027)	(0.031)	(0.031)
Teacher support	0.082***	0.083***	-0.014	-0.014
	(0.030)	(0.030)	(0.033)	(0.033)
Home possession	0.031***	0.029**	-0.038***	-0.038***
	(0.012)	(0.012)	(0.013)	(0.013)
Wald χ^2	513.82	541.16	2284.92	2407.82
Log likelihood	-915.81	-911.75	-1944.31	-1933.77
Number of students	1,432	1,432	2,031	2,031
Number of schools	160	160	161	161

Note: *** = $p < 0.001$, ** = $p < 0.05$, * = $p < 0.10$, two-tailed.

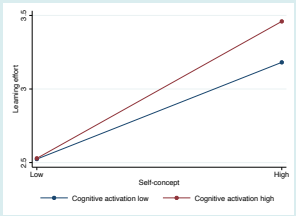

Figure 2. The moderating effect of cognitive activation

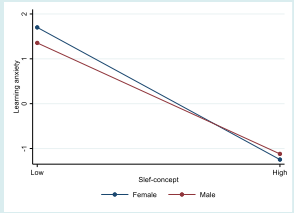

Figure 3. The moderating effect of gender

Conclusions and Discussion

➢ **Conclusions**

- Math self-concept could better promote learning effort when teachers employ cognitive activation in the classroom.
- The impact of math self-concept on mitigating learning anxiety is more prominent for girls than for boys.
- Teacher cognitive activation is primarily beneficial in facilitating learning effort while the gender effect is more significant in mitigating learning anxiety.

➢ **Potential limitations**

- Due to data limitations, we focused only on the context of high school students learning mathematics. It will be interesting to explore if our propositions would hold for other learning contexts, such as learning STEM-related subjects.

➢ **Future research directions**

- While this finding offered valuable insights for improving teaching effectiveness in the classroom, it lacked insights about influences from the environment outside the classroom. It will be important to explore whether family-related factors can potentially influence the outcomes of self-concept. When the family environment is more supportive, students may perceive more guidance from their parents and thus develop more regulated and positive perceptions of learning.

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