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Implicit theories of ability, homework behavior, and achievement

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Abstract

This study investigated how student implicit theories of math ability relate to their homework behavior and the mediational role of homework behavior in the relationship between implicit theories and math achievement. A large sample of Singapore secondary students took measures of entity (i.e., ability is fixed) and incremental (i.e., ability is modifiable through effort) theories of math ability as well as homework effort and distraction during the second term of a school year. They then took a math assessment about 3-5 months later. We did structural equation modeling and found that homework behavior partially mediated the relationships between implicit theories and math achievement. After controlling for gender and previous math achievement, an entity theory of math ability was positively associated with homework distraction, while an incremental theory of math ability was positively associated with homework effort and negatively with homework distraction. Homework effort in turn positively and homework distraction negatively predicted math achievement. An entity theory of math ability predicted negatively math achievement both directly and indirectly through homework distraction. In contrast, an incremental theory of math ability predicted positively math achievement through the mediation of homework effort and distraction. The findings and implications for homework practices are discussed in the academic context of Singapore.

Keywords: Implicit theories, homework behavior, achievement

Implicit theories and learning

Students' implicit beliefs about the fixedness or malleability of their academic ability play an important role in their motivation and learning. According to Dweck and colleagues (Dweck, 1986, 1999; Dweck & Leggett, 1988; Dweck & Molden, 2005), student implicit theories of their academic ability create a meaning system for them to approach their learning, set achievement goals, and respond to difficulties and setbacks in their study. Children with an entity theory of ability regard it as a fixed trait that cannot be changed. Thus, their goal pursuit process is built around their concerns about their ability level, and they see mistakes and failures as a sign of their deficient ability. As a result, they tend to show a maladaptive or helpless pattern of achievement behaviors, characterized by low persistence, disengagement, and challenge avoidance. In contrast, children holding an incremental theory of ability think that it is a malleable quality that can be cultivated through learning and effort. Therefore, their goal pursuit process focuses on mastery through effort, and they see setbacks as something they need to work on differently or harder. As a result, they tend to exert adaptive or mastery pattern of achievement strategies, such as seeking challenge and making more effort.

The motivation and self-regulation strategies associated with implicit theories further influence student achievement. In general, research has found that an entity theory of ability was associated with low achievement, whereas an incremental theory of ability was associated with high achievement in various subject domains (Aronson, Fried, & Good, 2002; Blackwell, Trzesniewski, & Dweck, 2007; Chen & Pajares, 2010; Good, Aronson, & Inzlicht, 2003; Stipek & Gralinski, 1996). For example, it was reported that for 5th and 6th graders, an entity theory of ability in math and social studies was negatively related to achievement in these areas directly and also through the mediation of performance goals and superficial learning strategies, e.g., guessing, copying, and memorizing (Stipek & Gralinski, 1996). A longitudinal study found that although implicit theories of intelligence at the beginning of junior high school were not related to students' math scores before their entry into junior high school, an incremental theory of intelligence predicted an upward trajectory in students' math achievement in the first two years of junior high school, which was in contrast with a flat trajectory predicted by an entity theory of intelligence (Blackwell, et al., 2007).

Homework and learning

Homework is defined as tasks assigned by school teachers intended for students to carry out during non-school hours (Cooper, 1989). As a daily routine for most students, homework is often regarded as an extension of in-school academic activities and a way to reinforce what students have learned in school. However, the effect of homework on students' academic achievement is not straightforward, and more homework is not always better (Cooper & Valentine, 2001; Corno, 1996). Although syntheses of research studies on homework suggest a generally positive relationship between homework assignment and achievement, largely inconsistent findings have been reported across studies (Cooper, 1989; Cooper, Robinson, & Patall, 2006; Trautwein & Koller, 2003). There are a multitude of potential factors that may work together to affect the effectiveness of homework, such as homework amount, purpose, and quality, teachers' facilitation and feedback, home environment (e.g., space, light, quietness, and resources), parental involvement, and also student characteristics (e.g., cognitive ability, motivation, and study habits) (Cooper, 1989; Cooper, et al., 2006). All these factors might work together to affect the outcomes of homework through student attitudes towards homework and their homework behavior. For example, it was reported that it is the proportion of homework

completed and homework effort that positively predicted student achievement, rather than simply the amount of time spent on doing homework (Cooper, Lindsay, & Nye, 1998; Trautwein, 2007; Trautwein, Ludtke, Schnyder, & Niggli, 2006).

Among these factors, student differences may play an important role in doing homework. Homework leaves much discretion to students about whether, when, and how to complete homework assignment, and thus it generally requires students to complete tasks with less supervision than do school activities (Cooper, et al., 2006). Therefore, self-regulation is necessary in homework management and it is also an important factor of homework effectiveness. For example, it has been found that for older students there is a stronger positive relationship between homework time and achievement. One explanation is that as students mature, they are better at avoiding disruptions by ignoring irrelevant information or stimulations both internally and in the environment (Cooper, 1989; Cooper, et al., 1998; Cooper, et al., 2006). Other studies reported that students' personality trait of conscientiousness predicted homework motivation (expectancy and value beliefs about homework) and homework effort across various subjects (Trautwein & Ludtke, 2009; Trautwein, et al., 2006).

The present study

Although implicit theories create a meaning system that affects student motivation and self-regulation in their study, little research has been done to examine the relationship between implicit theories and student homework behavior. Because doing homework requires self-discipline and self-management on the part of students, we think that implicit theories of academic ability are another important individual factor of homework behavior and effectiveness. For students holding an entity view of ability, although doing homework might be a way to prove their ability, any difficulties encountered in doing homework might be regarded as an indicator of inadequacy in their ability. In addition, for entity theorists, homework should have little use in changing or improving their ability level. As a result, they might tend to disengage from doing homework when they encounter difficulties and get distracted when there are other stimulations in the environment. However, for students with an incremental view of ability, doing homework can be an important way towards developing their knowledge and skills. Thus, they tend to employ self-regulated learning strategies when doing homework, such as persistence and concentration.

In this study, we examined how students' implicit theories of math ability relate to their homework behavior, including homework effort and distraction, and whether homework behavior mediates the relationship between implicit theories and math achievement. We expected that an incremental theory of math ability would be positively associated with homework effort and negatively associated with homework distraction, while the reverse would be found with an entity theory of math ability. We also hypothesized that homework effort would positively and homework distraction would negatively predict math achievement. In addition, an incremental theory would positively and an entity theory would negatively predict math achievement at least partly through the mediation of homework effort and homework distraction. We would examine these hypotheses by controlling for two covariates, gender and previous math achievement.

Method

Participants and procedure

A large sample of 2648 Secondary 2 students from 16 schools participated in this study. As part of a large project, they took an online survey on academic motivation in the second term of a

school year, including implicit theories of math ability and homework behavior in their math study. Among them, 2181 students reported their PSLE scores and also took the math assessment 3-5 months later. These 2181 students were from 100 classes, including 774 boys (35.5%) and 1407 girls (64.5%). On average, they were 13.75 years old ($SD = 0.46$), including 1526 Chinese (70%), 377 Malay (17.3%), 142 Indian (6.5%) and 136 others (6.2%).

Measures

Implicit theories of math ability. Six items assessing implicit theories of math ability were adapted from Dweck (1999). Entity theory (3 items) was measured as the belief that a student's math ability is unchangeable, including "A student has a certain level of ability in math, and there is not much one can do to change it," "A student's ability in math is something that cannot be changed much," and "A student can learn new things in math, but can't really change his/her basic ability in math." Incremental theory (3 items) was measured as the belief that a student's math ability is incremental with effort, including "If a student can work hard and persist, she/he can change her/his level of ability in math," "A student's ability in math is pretty much related to how much effort she/he has made," and "A student can become smarter in math if she/he puts effort in learning it." All the items were rated on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree). The internal consistency reliability for entity and incremental theories was .83 and .80, respectively.

Homework Behavior. Based on Trautwein, Ludtke, Schnyder, and Niggli (2006), three items were designed to measure homework effort in this study. They are, "I try to do my best on my math homework," "I always try to finish all my math homework," and "Even when my math homework is difficult, I try to complete it." Four items adapted from Trautwein, et al. (2006) were employed to measure homework distraction, such as "I often get distracted when doing my math homework," and "It often takes me longer than necessary to do my math homework because my mind is not on it." All the items were rated on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree). The internal consistency for homework effort and homework distraction was .83 and .79, respectively.

Math achievement. A short online math test with 15 multiple-choice items was used to measure student math achievement near the end of their Secondary 2 year. The items measured four content domains: number, algebra, geometry & measurement, and statistics & probability. The items were adopted from a longer math achievement test designed for a previous project to measure students' math ability at the very beginning of Secondary 3. In addition, students were also asked to report their math scores in Primary School Leaving Examination (PSLE math). As evidence of convergent validity of the 15-item math test, the correlation between the scores on it and PLSE math was .61.

Statistical analyses. We did some preliminary analyses to examine the nature of the data before testing the hypothesized mediation model. First, following Baron and Kenny's (1986) recommendations, we checked whether the predictor, mediator, and outcome variables were correlated. We also recognized that a significant correlation between the predictor and the outcome variable is not a prerequisite for a mediation effect, such as when one of the mediators works as a suppressor (MacKinnon, Krull, & Lockwood, 2000). Second, due to the hierarchical nature of the data, we calculated intra-class correlations (ICCs) to decompose the variances of the variables at student and class levels. This helped us decide whether the class level variances should be considered in the modeling. Third, we conducted confirmatory factor analysis to test the measurement model for the 5 variables with multiple indicators, including entity theory, incremental theory, homework effort, homework distraction, and math achievement. To reduce

complexity, the 15 items in the achievement test were grouped into four composite indicators according to the four content domains. With the measurement model supported, we then moved on to test the hypothesized mediation model.

Results

Correlational analysis

The correlations between variables in this study are shown in Table 1. It can be seen that boys reported a higher entity belief of math ability and also higher homework distraction than girls. There is a negative correlation between entity and incremental theories. Entity theory was positively associated with homework distraction, but negatively associated with PSLE math, homework effort, and math achievement. In contrast, incremental theory was positively associated with homework effort, but negatively associated with homework distraction. Homework effort was negatively correlated with homework distraction, with the former positively and the latter negatively correlated with both PSLE math and math achievement.

Table 1 Descriptive Statistics and Correlations Based on Raw Scores

Variables	<i>M</i>	<i>SD</i>	2)	3)	4)	5)	6)	7)
1) Gender	.65	.48	-.05	-.09*	.01	.00	-.11*	.05
2) PSLE math	4.85	1.35		-.17*	.03	.10*	-.18*	.61*
3) Entity theory	2.68	.95		--	-.12*	-.10*	.31*	-.23*
4) Incremental theory	4.09	.73			--	.31*	-.12*	.05
5) Homework effort	3.68	.78				--	-.14*	.15*
6) Homework distraction	3.00	.83					--	-.24*
7) Math achievement	8.77	3.51						--

Note. 0 = male; * $p < .01$

We also calculated the intra-class correlations (ICCs) for the two implicit theories, homework effort and distraction, PSLE math, and math achievement. A high ICC indicates a large portion of variance in a variable is at class level. We found that all the variables have ICCs smaller than .10, except for the two achievement measures (ICC for PSLE math = .55, and ICC for math achievement = .57). This might be related to the streaming practice in Singapore Secondary schools. As a result, we decided to test the measurement and mediation model only at student level in Mplus 6.11, but we took class as a cluster variable in order to have more accurate standard errors (Krull & MacKinnon, 2001).

Confirmatory factor analysis and mediational analysis

The measurement model showed a good fit to the data: $\chi^2(109) = 226.53, p < .01$; Root Mean Square Error of Approximation (RMSEA) = .022, with a 90% confidence interval (90% CI): .018 - .026; Comparative Fit Index (CFI) = .99; Tucker Lewis Index (TLI) = .98; and Standardized Root Mean Square Residual (SRMR) = .025. The standardized factor loadings ranged from .52 to .86.

In the mediation model (Model 1), we allowed both the direct paths from incremental beliefs to math achievement and the indirect effects through the mediation of homework behavior to be estimated. To control for the covariates, we also included the paths from gender and PSLE math to both homework behavior and math achievement. Correlations were allowed between all the predictors as well as all the mediators. The fit indices of Model 1 were $\chi^2(133) = 330.12, p < .01$; RMSEA = .026, 90% CI: .023 - .030; CFI = .98; TLI = .98; and SRMR = .025.

We found that in this model the path from entity theory to homework effort and the path from incremental theory to math achievement were non-significant. Therefore, in Model 2 we removed these two paths. The fit indices of Model 2 were $\chi^2(135) = 334.03, p < .01$; RMSEA = .026, 90% CI: .023 - .030; CFI = .98; TLI = .98; and SRMR = .026. Compared with Model 1, the more parsimonious Model 2 was supported: ($\Delta\chi^2 = 3.91, \Delta df = 2, p > .05$). The standardized path coefficients in Model 2 are shown in Figure 1. The indirect effects from incremental theories to math achievement were small but all statically significant: from entity theory via homework distraction, $\beta = -0.04, p < .01$; from incremental theory via homework effort, $\beta = 0.03, p < .01$; and from incremental theory via homework distraction, $\beta = 0.01, p < .01$.

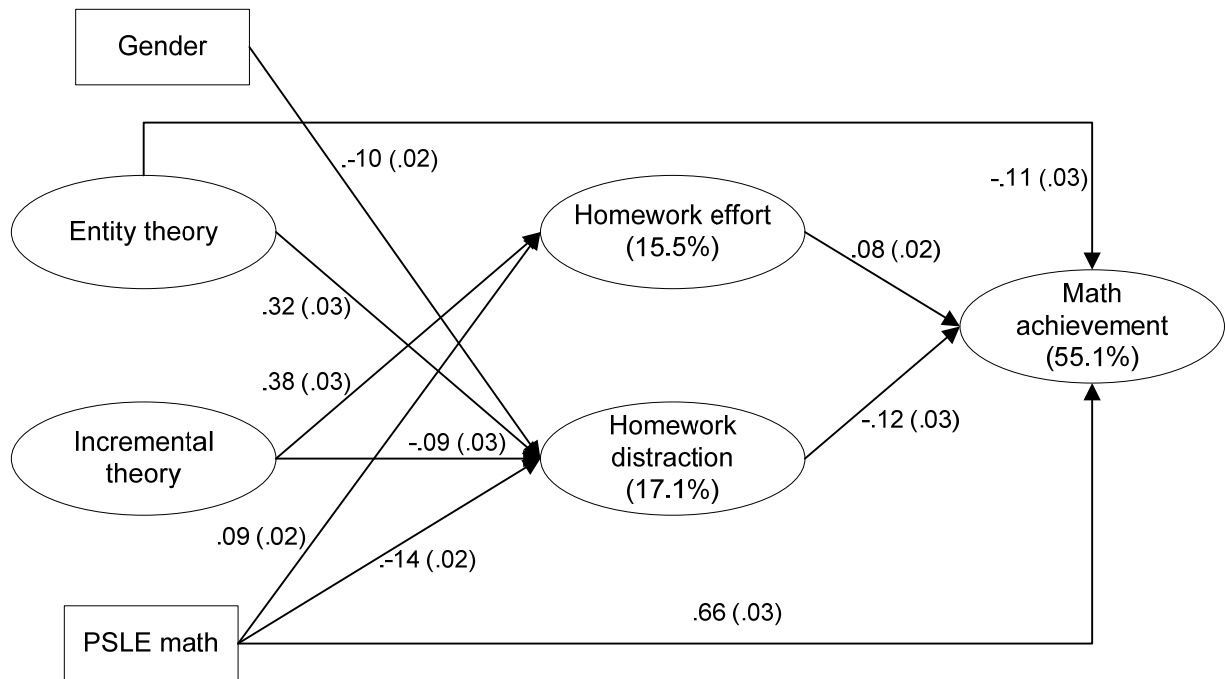


Figure 1. The mediation model of implicit theories, homework behavior, and achievement.

Note. All the paths shown in the figure are significant at $p < .01$. For gender and PSLE math, only significant paths are shown in the figure. In the parentheses are the percentage variances explained in the mediators and outcome variable. The correlation between entity and incremental theories was $r = -.18, p < .01$, and the correlation between the residuals of homework effort and distraction was $r = -.11, p < .01$.

Discussion

This study examined how Singapore secondary students' implicit theories of math ability relate to their homework behavior, and whether homework behavior mediates the relationship between implicit theories and math achievement. In general, the findings support our hypothesis that implicit theories were associated with student homework behavior. In particular, an entity theory of math ability was associated positively with homework distraction, while an incremental theory of math ability was associated positively with homework effort and negatively with homework distraction. Homework behavior in turn predicted students' math achievement a few months later after controlling for previous achievement: homework effort positively and homework distraction negatively predicted math achievement. The findings also support our

hypothesis that homework behavior at least partially mediated the relationship between implicit theories and math achievement. An entity theory of math ability predicted negatively math achievement both directly and through the mediation of homework distraction. An incremental theory of math ability predicted positively math achievement through the mediation of both homework effort and homework distraction.

The findings in this study suggest the importance of individual student role in homework behavior and effectiveness (Cooper, et al., 1998; Cooper, et al., 2006; Xu & Wu, 2013). Due to little supervision and control on doing homework, homework is said to both require and promote student self-regulated learning. When students try their best to complete their homework, homework is effective in improving achievement. However, if students cannot stay focused and manage distractions when doing homework, homework might have negative influences, such as on both achievement and study habits. There are many individual factors that may affect student homework behavior. Studies of homework behavior have found that students' personality traits, such as conscientiousness, and motivational beliefs, such as homework-related learning orientation, and expectancy and value beliefs about homework, were all associated with homework effort or management (Trautwein & Ludtke, 2009; Trautwein, et al., 2006; Xu & Wu, 2013).

The present study contributed to the research of homework by linking implicit theories and homework behavior. Students' implicit theories of ability create a meaning system for them to approach and react to homework activities. When students hold a fixed view of ability, they do not value homework as a way to improve their ability. In addition, although doing homework can be a means to validate their ability, any difficulties and frustrations experienced in doing homework might be regarded as an indicator of inadequacy. Therefore, students with an entity theory of ability are likely to get distracted when doing homework. In contrast, when students hold an incremental view of ability, homework is valued because doing homework can help them develop their competency in the subject matter, and any difficulties encountered in doing homework may suggest that they need to work harder. Therefore, students with an incremental theory of ability tend to make effort and concentrate when doing homework.

The findings of this study have important implications for homework practices. While both educators and policy makers agree that we should avoid overtaxing students by giving too much homework, student homework motivation and behavior might be more important than the time that students spend on doing homework. Compared to entity theory, an incremental theory of ability has been associated with an adaptive profile of learning, including homework behavior. Therefore, students should be encouraged to develop an incremental view of ability. This is particularly important in a very competitive learning environment where students are streamed according to their academic achievement, such as in Singapore. Although people's basic beliefs of ability are relatively stable over time, they can also be activated by powerful cues and experiences from the environment (Dweck, 2011; Dweck & Molden, 2005). To help student develop an incremental view of ability, teachers can explicitly teach them the incremental nature of academic ability, and give them more process feedback that promotes attributions to controllable factors, such as effort and learning strategies (Dweck & Molden, 2005). To enhance student motivation in doing homework, teachers can also help students see the link between doing homework and competency development through giving formative feedback in homework. To make homework effective, parents can also create a supportive home learning environment where children can concentrate on doing their homework.

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