Incremental beliefs of ability, achievement emotions, and learning of Singapore students

This study investigated the relationships of students' incremental beliefs of math ability to their achievement emotions, classroom engagement, and math achievement. A sample of 273 secondary students in Singapore were administered measures of incremental beliefs of math ability, math enjoyment, pride, boredom, and anxiety, as well as math classroom attention and disruption. In addition, students' end-of-year math achievement scores were collected from school records. The hypothesized mediation model was supported in structural equation modeling analysis. Incremental beliefs of math ability were associated positively with math enjoyment and pride, and negatively with math boredom and anxiety. Achievement emotions fully mediated the relationships of incremental beliefs of math ability to classroom engagement and math achievement. Incremental beliefs of math ability were associated positively with classroom attention through math enjoyment and pride, negatively with classroom disruption through math anxiety, and positively with math achievement through the two outcome-related emotions, math pride and anxiety. The findings and implications are discussed in the academic context of Singapore.

Keywords: incremental beliefs, achievement emotions, classroom engagement, achievement

Laypersons vary in their implicit theories about the fixedness or malleability of human attributes, such as intellectual ability, personality, and morality (Dweck & Leggett, 1988; Dweck & Molden, 2005). People holding an incremental belief of intelligence regard it as a malleable quality that can be cultivated through learning and effort, and thus they are oriented toward developing or improving their competences. In contrast, people holding an entity view of intelligence regard it as a fixed trait that cannot be changed, and thus they become highly concerned with judging or proving their competences. The extent to which people hold an entity or incremental belief can differ across attributes, such as math, verbal, and athletic abilities (Dweck, Chiu, & Hong, 1995a; Dweck & Molden, 2005). Inconsistency exists in the literature in terms of whether one or both theories were measured in the same research. [1] Among the studies that measured both theories, most reported negative correlations between the two types of implicit theories, despite that the correlation size varied across studies (e.g., Chen & Pajares, 2010; Cury, Elliot, Da Fonseca, & Moller, 2006; Doron, Stephan, Boiche, & Scanff, 2009; Elliot & McGregor, 2001; Howell & Buro, 2009). We agree that the two theories are the logical opposite of each other (Dweck, Chiu, & Hong, 1995b). In this study, we only focused on incremental theories and examined how Singapore students' incremental beliefs of math ability relate to achievement emotions, classroom engagement, and achievement in their math study.

Incremental beliefs and learning

Dweck and colleagues proposed that students' implicit beliefs about 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 (Blackwell, Trzesniewski, & Dweck, 2007; Dweck, 1986, 1999; Dweck & Leggett, 1988; Dweck & Molden, 2005; Hong, Chiu, Dweck, Lin, & Wan, 1999). Children who believe ability is a malleable quality are oriented toward developing their knowledge and skills. Therefore, their goal pursuit process focuses on mastery through effort, and they see mistakes and failures as something they need to work on differently or harder. As a result, they tend to experience positive emotions and exert adaptive or mastery pattern of achievement strategies, such as seeking challenge and making more effort.

According to Dweck's social cognitive model of motivation (Dweck, 1986), the motivation and self-regulation strategies associated with implicit theories further affect student achievement. In general, research has found that incremental theories of ability were associated with high achievement in various subject domains (Aronson, Fried, & Good, 2002; Blackwell, et al., 2007; Chen & Pajares, 2010; Good, Aronson, & Inzlicht, 2003; Stipek & Gralinski, 1996). For example, a longitudinal study found that although implicit theories of intellience at the beginning of junior high school were not related to students' math scores before entering junior high school, incremental beliefs 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 entity beliefs of intelligence (Blackwell, et al., 2007). A recent meta-analysis (Burnette, Boyle, VanEpps, & Pollack, 2013) proposed a mediation model that links implicit theories to self-regulation and achievement. The findings of this study showed that incremental beliefs of ability were associated with achievement through the mediation of goals setting (i.e., achievement goal orientations), goals operating (i.e., mastery versus helpless strategies), and goals monitoring (i.e., expectations of future success and negative emotions).

Achievement emotions and learning

Although affect is an important aspect of motivational theories and an integral part of students' learning, the role of affect has been emphasized only in the last decade. In the past, most studies on achievement emotions typically focused on emotions relating to achievement outcomes (Weiner, 1986; Zeidner, 1998). More recently, researchers have extended the definition of achievement emotions to include both activity emotions pertaining to on-going achievement activities, such as enjoyment and boredom, and outcome emotions pertaining to the outcomes of these activities, such as anxiety and pride (Pekrun, 2006). When people experience activity-related emotions, their attentional focus is on the action, rather than outcomes. For example, students can be fully absorbed in a learning activity and enjoy the learning for its own sake. According to the control-value theory of achievement emotions (Pekrun, 2006), achievement emotions play an important role in cognitive, motivational, and regulatory processes of learning. In general, research reported that positive emotions were positively linked to self-efficacy, task value, interest, effort, meta-cognitive self-regulation, and achievement, whereas negative emotions were negatively related to these variables (e.g., Ainley & Ainley, 2011; Daniels, Stupnisky, Pekrun, Haynes, & Perry, 2009; Geotz et al., 2012; Lichtenfeld, Pekrun, Stupnisky, Reis, & Murayama, 2012; Pekrun, Elliot, & Maier, 2009; Pekrun, Goetz, Frenzel, Barchfeld, & Perry, 2011; Pekrun, Goetz, Titz, & Perry, 2002).

In the control-value framework of achievement emotions, achievement emotions are instigated by two groups of cognitive appraisals: subjective control over achievement activities and outcomes, and subjective values of these activities and outcomes (Pekrun, 2006). Subjective control refers to prospective expectancies and retrospective attributions pertaining to causal relations of the self as an agent to achievement activities and outcomes, such as expectations that persistence will lead to success. The subjective values include both intrinsic and extrinsic values. Intrinsic values refer to the values of a learning activity per se or competence development as an outcome of learning. Extrinsic values relate to the instrumental usefulness of actions or outcomes for achieving other goals, such as rewards from parents and teachers. Expectancy and subjective values work together to induce various emotions (Pekrun, 2006). For example, when the outcome of an examination is important and individuals feel that they do not have enough control to avoid the outcome of failure, they will experience anxiety. When students value the success in a learning task, and also attribute their success to internal causes, they will experience pride. When students value an activity itself, and also have high control in doing the activity, they will experience enjoyment. If students do not value an activity, or if a task is too difficult or too easy relative to their ability level, they may experience boredom (Acee et al., 2010; Pekrun, Goetz, Daniels, Stupnisky, & Perry, 2010).

Linking incremental beliefs and achievement emotions

The implications of implicit theories for affective experiences are embedded in Dweck's social cognitive model of motivation, where responses to setbacks associated with implicit theories include cognitive, affective, and behavioral components (Dweck, 1986; Dweck & Leggett, 1988). Dweck and colleagues reported that compared with helpless entity theorists, mastery oriented incremental theorists were less vulnerable to negative emotions when they were given failure problems; instead, they tended to maintain or heighten their positive affect (Diener & Dweck, 1978; Dweck & Leggett, 1988). Our theoretical analyses of both the motivation model of implicit theories and the control-value theory of achievement emotions lead us to propose that these two models can be integrated. In other words, laypersons' implicit theories of ability have an impact on their achievement emotions through creating a meaning framework for cognitive appraisal. More specifically, implicit theories of ability may affect both individuals' subjective control and subjective value of achievement activities and outcomes, which arouse achievement-relevant emotions. Compared with entity theorists, incremental theorists think they can increase their competence level through hard work and they tend to make effort attribution for success

(Dweck & Leggett, 1988; Robins & Pals, 2002), and thus they should have a higher sense of subjective control over their learning and outcomes. This is supported by studies which reported that compared with entity theorists, incremental theorists had a higher sense of control and higher expectation of goal achievement (Burnette, 2010; Chen & Pajares, 2010; Martocchio, 1994; Ommundsen, Haugen, & Lund, 2005; Wang & Biddle, 2003). Implicit theories should also set up the framework for appraising the value of achievement activities and outcomes. For incremental theorists, learning itself should have intrinsic value because they are oriented toward developing their knowledge and skills, rather than competence validation. Thus, for children with incremental beliefs, “Not only is effort perceived as the means to accomplishment, it is also the factor that engenders pride and satisfaction with performance”(Dweck, 1986, p. 1043).

Although some studies examined the link between implicit theories and achievement emotions, most of them focused on single “helpless-oriented” emotions when students encounter challenge or obstacles, such as vulnerability, worry, and anxiety (for a review, see Burnette, et al., 2013). For example, in a computer training context, participants who were primed to think that computer ability is incremental with practice experienced reduced computer anxiety, while those who were primed to think computer ability is fixed did not (Martocchio, 1994). Very few studies have examined the relationship between implicit theories and different types of achievement emotions. One exception is given by Robins and Pals (2002), which reported that college students who believed that intelligence is relatively fixed tended to report more negative emotions and less positive emotions, where each emotion was measured by a single item. We agree with Dweck (2005) that more attention should be paid to the role of implicit theories and related meaning systems in emotions and emotion regulation.

The present study

This study examined the relationships of Singapore students' incremental beliefs of math ability to achievement emotions, classroom engagement, and achievement in their math study. We had three specific aims. First, we examined how incremental beliefs of math ability are related to four types of math achievement emotions: enjoyment, pride, boredom, and anxiety, where all the emotions were measured by a scale with multiple items. Second, we examined how students' incremental beliefs of math ability are related to their math classroom engagement, including classroom attention and disruption, and math achievement. Third, we examined whether achievement emotions mediate the relationship between incremental beliefs on one hand, and classroom engagement and math achievement on the other.

In general, we hypothesized that incremental beliefs of math ability would be associated with achievement emotions and learning in an adaptive manner, and achievement emotions would mediate the relationships of incremental beliefs of math ability to classroom engagement and math achievement. We expected that incremental beliefs of math ability would be associated positively with the two positive emotions (math enjoyment and pride), and negatively with the two negative emotions (math boredom and anxiety). Incremental beliefs would also predict positively classroom attention through the two positive emotions, and negatively classroom disruption through the two negative emotions. Both self-regulation strategies and achievement emotions have been reported to mediate the relationship between incremental beliefs of ability and achievement (for a review, see Burnette, et al., 2013), but little research has been done to examine the simultaneous effects of these variables in one model. In this study, we hypothesized that classroom attention would be positively and classroom disruption would be negatively associated with math achievement. Based on findings in previous studies (e.g., Pekrun, et al., 2009; Pekrun, et al., 2011), we expected that the four achievement emotions would be correlated with each other and with math achievement. Because outcome-related emotions are determined by the cumulative success or failure feedback in study (Pekrun, 2006), we also expected that the two outcome-related achievement emotions would directly and uniquely predict math achievement. More specifically, pride would positively and anxiety would negatively predict math achievement. In addition, previous studies have found that boys tend to report stronger ability and interest in math and show more disruptive behaviors in classroom than girls (Atici & Merry, 2001; Meece, Glienke, & Burg, 2006; Wheldall & Merrett, 1988). We would examine the hypothesized mediation model after controlling for gender and previous math achievement.

This study extends research of implicit theories of ability to an East Asian culture, Singapore. Singapore is a westernized East Asian country that combines elements of Confucian ethics with some Western cultural and institutional orientations (Luo, Hogan, & Paris, 2011; Tu, Hejtmanek, & Wachman, 1992). It is well known that the East Asian culture under the influence of Confucianism emphasizes the importance of effort in learning (Li, 2002; Salili & Hau, 1994). Research has also shown that Singapore students tend to ascribe academic success to internal regulation, including effort, study skills, and interest (Luo, Hogan, Yeung, Sheng, & Aye, 2013). The cultural emphasis on effort in Singapore is consistent with incremental beliefs of ability, which define ability to be malleable with effort. Therefore, we expected that adaptive learning profiles associated with incremental beliefs would be supported in Singapore.

Method

Participants and procedure

A group of 273 Secondary 2 (Grade 8) students from a school in Singapore participated in this study. Through various courses and activities, this school has a focus on enhancing students' understanding of and interest in Chinese traditions and culture. The participants of this study were all Singaporean Chinese, including 99 boys (36.3%) and 174 girls (63.7%). They were on average 14.39 years old (*SD* = 0.44). As part of a large project, they took an online survey in the middle of the last term of the school year, including the measures of incremental beliefs of math ability, four discrete math achievement emotions, and two classroom engagement behaviors. A few weeks later, their end-of-year math scores were collected from school records.

Measures

Incremental beliefs of math ability. Three items adapted from Dweck (1999) were employed to measure incremental beliefs of math ability, 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." The higher the total score, the higher are incremental beliefs of math ability. The items were rated on a five-point Likert scale (1 = strongly disagree, 5 = strongly agree). The internal consistency reliability was .83.

Achievement emotions**.** Four discrete achievement emotions were measured in this study by adapting items from the Achievement Emotions Questionnaire (Pekrun, et al., 2011). They are math enjoyment (3 items), such as "I enjoy being in my math lessons;" math pride (3 items), such as "I am proud of how well I do in math;" math boredom (3 items), such as "My math class bores me so much that I can't wait for it to end;" and math anxiety (3 items), such as "I often worry that it will be difficult for me to be in my math class." The items were rated on a five-point Likert scale (1 = strongly disagree, 5 = strongly agree). The internal consistency reliability for math enjoyment, pride, boredom, and anxiety was .76, .80, .82, and .75, respectively.

Classroom engagement. Two classroom engagement variables were measured in this study. The 3-item scale of classroom attention was adapted from VanDamme and colleagues (VanDamme, Bieke, Van Landeghem, Opdenakker, & Onghena, 2002), such as "In my math class, I pay attention well." The 3-item scale of classroom disruption was adapted from Patterns of Adaptive Learning Scales (Midgley et al., 2000), such as "I sometimes behave in ways that annoy my teacher during math class." The items were all rated on a five-point Likert scale (1 = strongly disagree, 5 = strongly agree). The internal consistency reliability for classroom attention and disruption was .84 and .77, respectively.

Achievement. Students' end-of-year math achievement scores were collected from school records (math achievement). In addition, students were also asked to report their math scores in Primary School Leaving Examination (PSLE math). In Singapore, PSLE is taken by students at the end of their primary school education (Grade 6) and their performances in PSLE will be considered in secondary school admission.

Statistical analysis

The statistical analysis included three stages. 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 a predictor and an outcome variable is not a prerequisite for a mediation effect, such as when one of the variables in a complex mediation model works as a suppressor (MacKinnon, Krull, & Lockwood, 2000; Preacher & Hayes, 2008). Second, we conducted a confirmatory factor analysis (CFA) in Mplus 6.11 to test the measurement model for the 7 variables with multiple indicators: incremental beliefs, four discrete achievement emotions, and two classroom engagement variables. Third, with the measurement model supported, we moved to employ structural equation modeling to test the proposed mediation model, in which both gender and PSLE math were controlled. We also tested the statistical significance of the total and specific indirect effects in the mediation model.

Results

Correlational analysis

As shown in Table 1, gender was not significantly correlated with incremental beliefs of math ability. PSLE math was also not related to incremental beliefs, indicating that students who held an entity versus incremental view of math ability were not different in their math achievement before they entered secondary school. Boys achieved higher in PSLE math and experienced higher enjoyment and pride in their math study, but they also reported more disruptive classroom behaviors. PSLE math was positively correlated with math pride and math achievement, but negatively correlated with math boredom and anxiety.

As expected, incremental beliefs of math ability were correlated positively with the two positive achievement emotions (math enjoyment and pride) and negatively with the two negative achievement emotions (math boredom and anxiety). Incremental beliefs of math ability also showed a positive correlation with classroom attention and math achievement. Math enjoyment and pride were positively correlated with classroom attention and math achievement, and math boredom and anxiety were negatively correlated with these two variables. In addition, math boredom and anxiety were positively correlated with classroom disruption. Classroom attention and classroom disruption were negatively correlated with each other, with the former also positively and the latter negatively correlated with school math achievement.

INSERT TABLE 1 HERE

Measurement model and mediational analysis

The measurement model showed an adequate fit to the data: χ^2 (168) = 317.37, $p < .01$; Root Mean Square Error of Approximation (RMSEA) =.057, with a 90% confidence interval (90% CI): .047 - .067; Comparative Fit Index (CFI) = .94; Tucker Lewis Index (TLI) = .93; and Standardized Root Mean Square Residual (SRMR) = .053. The standardized factor loadings ranged from .54 to .86.

Before testing the hypothesized mediation model, we started from a more complex mediation model (Model 1) that allowed the direct paths from incremental beliefs to classroom engagement and math achievement to be freely estimated. By testing the associations of the mediators with the outcome variables after controlling for the predictor, this model was important to decide whether achievement emotions function as mediators (Baron & Kenny, 1986; Preacher & Hayes, 2008). Correlations were allowed between all the predictors as well as all the mediators. The fit indices of Model 1 were χ^2 (216) = 384.24, $p < .01$; RMSEA = .053, 90% CI: .045 - .062; CFI = .94; TLI = .92; and SRMR = .051.We found that in this model the paths from classroom attention and disruption to math achievement were non-significant. Therefore, in Model 2, we only allowed these two engagement variables to be correlated with each other and they were not further related to math achievement after controlling for math pride and anxiety. The fit indices of Model 2 were χ^2 (218) = 386.00, $p < .01$; RMSEA = .053, 90% CI: .044 -.062; CFI = .94; TLI = .92; and SRMR = .052. The more parsimonious Model 2 was superior to Model 1(Δ_{χ^2} = 1.76, Δ_{df} = 2, $p > .05$). We found that between math boredom and anxiety in Model 2, only the latter was significantly associated with classroom disruption. We also noticed relatively large standard errors of these two paths, which might be due to the high correlation between math boredom and anxiety. Large standard errors typically lead to unstable parameter estimates in the model (Marsh, Dowson, Pietsch, & Walker, 2004). Therefore, in Model 3, we removed the path from math boredom to classroom disruption and only kept the path from math anxiety to classroom disruption. The fit indices of Model 3 were χ^2 (219) = 388.48, $p < .01$; RMSEA = .053, 90% CI: .045 - .062; CFI = .94; TLI = .92; and SRMR = .053. Compared with Model 2, the more restrictive Model 3 was supported (Δ_{χ^2} = 2.48, Δ_{df} = 1, $p > .05$). For comparison purpose, we also tested Model 3' in which we kept only the path from math boredom to classroom disruption. The fit indices of Model 3' were χ^2 (219) = 391.82, $p < .01$; RMSEA = .054, 90% CI: .045 -.062; CFI = .94; TLI = .92; and SRMR = .054. Although math boredom was positively associated with classroom disruption in Model 3', Model 3' had a worse fit than Model 2 (Δ_{χ^2} = 5.82, Δ_{df} = 1, $p < .05$). In addition, we also found that in Models 1-3, all the direct effects from incremental beliefs to classroom attention, classroom disruption, and math achievement were non-significant. Thus, in Model 4 we further removed the three direct paths. The fit indices of Model 4 were χ^2 (222) = 389.08, $p < .01$; RMSEA = .053, 90% CI: .044 - .061; CFI = .94; TLI = .92; and SRMR = .053.Compared with Model 3, Model 4 was supported (Δ_{χ^2} = .60, Δ_{df} = 3, $p > .05$). The standardized coefficients in Model 4 are given in Figure 1.

INSERT FIGURE 1 HERE

Test of indirect effects

The commonly used Sobel test (Sobel, 1982) assumes the normality of the sampling distribution of the indirect effect, which is calculated as the product of the path coefficients from the predictor to the meditator and from the mediator to the outcome variable. However, this assumption can only be reasonably met when the sample size is very large or the indirect effect size is large (MacKinnon, Lockwood, & Williams, 2004). Bootstrapping methods are recommended for testing the mediation effect for small to moderate sample sizes, among which the bias-corrected bootstrap method is the best choice due to its statistical power and accurate confidence intervals (MacKinnon, et al., 2004; Preacher & Hayes, 2008; Williams & MacKinnon, 2008). In this study we employed the bias-corrected bootstrap analysis in Mplus 6.11 to test the total and specific indirect effects. The analysis was set to take with replacement 5,000 samples of n = 273 from the data. The point estimate of the indirect effect was simply the mean of the indirect effects computed from the 5,000 bootstrap samples. The distribution of the indirect effects estimated from the 5,000 bootstrap samples served as the sampling distribution of the indirect effect, from which the upper and lower bounds of confidence intervals were obtained. As shown in Table 2, the indirect and total indirect effects from incremental beliefs to classroom attention, classroom disruption, and math achievement were all significant ($p < .05$) or marginally significant ($p < .10$).

INSERT TABLE 2 HERE

Discussion

In this study we examined how Singapore secondary students' incremental beliefs of math ability relate to their achievement emotions, classroom engagement, and math achievement. In general, our findings support the hypothesis that incremental beliefs of math ability are associated with an adaptive pattern of achievement emotions, classroom engagement, and math achievement. We also found support for the mediational role of achievement emotions in the relationship from incremental beliefs to classroom engagement and achievement. In particular, incremental beliefs of math ability were associated positively with math enjoyment and pride, and negatively with math boredom and anxiety. In addition, incremental beliefs of math ability were associated positively with classroom attention through the mediation of math enjoyment and pride, negatively with classroom disruption through math anxiety, and positively with math achievement through the two outcome-related emotions, math pride and anxiety.

These findings support the cross-cultural generalizability of Dweck's theoretical position that individuals' implicit views of ability create a meaning system for individuals to approach and react to their study (Dweck & Leggett, 1988; Dweck & Molden, 2005). The association between incremental beliefs and an adaptive learning profile found in this study is consistent with the research findings accumulated in the Western cultures. This is reasonable because incremental beliefs of ability are in line with the strong emphasis on the role of effort in learning in the East Asian culture, which might socialize children with a dynamic and malleable view of ability (Li, 2002; Luo, et al., 2013). It has been reported that people in the East Asian culture tend to endorse the positive rule in the relationship between ability and effort perception (Lam, Yim, & Ng, 2008; Salili & Hau, 1994). This might explain why students from the East Asian culture tend to study for long hours and outperform their Western counterparts in international assessments. The role of implicit theories in the learning of East Asian students has been supported in a recent study with Taiwanese 8^{th} graders (Shih, 2011). In this study, incremental theories of intelligence were associated positively with positive emotions and behavioral self-regulation, whereas entity theories of intelligence were related positively to negative emotions and self-handicapping strategies. The findings of the present study with Singapore Chinese students further support the positive role of incremental beliefs of ability in the academic study of East Asian students.

This study contributes to the literature of achievement motivation by linking student incremental beliefs to achievement emotions. We argue that the meaning systems created by implicit theories of ability have implications for achievement emotions in two ways. First, relative to entity theorists, incremental theorists tend to regard challenges and failures as learning opportunities and attribute their learning outcomes to controllable factors, and thus they tend to have a higher sense of control of goal pursuit activities and outcomes. Second, compared with entity theorists, incremental theorists tend to value learning intrinsically because they are concerned about competence development, rather than ability validation (Dweck & Molden, 2005). In accordance with the control-value theory of achievement emotions (Pekrun, 2006), the subjective control over learning of incremental theorists and the intrinsic value they attach to learning will instigate positive emotions, such as enjoyment and pride, rather than negative emotions, such as anxiety and boredom. Achievement emotions will further affect student self-regulation and achievement (Daniels, et al., 2009; Geotz, et al., 2012; Lichtenfeld, et al., 2012; Pekrun, et al., 2009; Pekrun, et al., 2011; Pekrun, et al., 2002). In this study, we found that incremental beliefs of math ability were associated positively with math enjoyment and pride, and negatively with math boredom and anxiety. Achievement emotions fully mediated the relationship between incremental beliefs of math ability and student classroom engagement and math achievement, and explained a considerable amount of variances in classroom engagement and achievement. In addition, after controlling for the two outcome-related achievement emotions, math pride and anxiety, classroom attention and disruption were not further related to math achievement, suggesting that the outcome-related emotions are more important predictors of achievement than classroom engagement.

Implications for teaching and learning

The findings of this study have important implications for teaching and learning. As also shown in many other studies, incremental beliefs of ability were associated with optimal motivation and learning outcomes. Therefore, students should be encouraged to hold an incremental belief of ability. This is particularly important in a competitive education environment where students are streamed according to their academic achievement, such as

Singapore. Although people's basic beliefs of ability are relatively stable over time, these beliefs can also be activated by powerful cues and experiences from the environment (Dweck, 2011; Dweck & Molden, 2005). Experimental studies have shown that implicit theories can be primed or taught, which then bring changes in student motivation and achievement (Aronson, et al., 2002; Blackwell, et al., 2007). These findings suggest that teachers can promote an incremental belief of ability in students through their daily teaching. For example, teachers can explicitly teach students the incremental nature of academic ability through reading and discussion activities, create opportunities for students to experience success through effort, and give them more process feedback that promotes attributions for both success and failure to controllable factors, such as effort and learning strategies (Dweck, 1999; Dweck & Molden, 2005).

The findings of this study suggest that incremental beliefs of ability are only one of the predictors of achievement emotions, and the latter play an important role in classroom engagement and learning. Therefore, in addition to fostering students a dynamic and malleable belief, educators are also encouraged to create an emotionally sound learning environment to promote positive achievement experiences. To this end, the control-value theory of achievement emotions and empirical research findings suggest various ways, including emphasis on learning, rather than social comparison, setting achievable learning goals and expectations, selection of optimal challenging tasks, provision of authentic learning experiences, reinforcement of success, and creating a safe and supportive learning environment that allow students to make mistakes (Acee, et al., 2010; Pekrun, 2006; Pekrun, et al., 2009).

Limitations and recommendations for future study

Some limitations in this study should be considered when readers interpret the findings. First, the design of this study was correlational in nature. Student incremental beliefs of math ability, achievement emotions, and classroom engagement were measured in the same survey a few weeks before the school achievement scores were collected. Future studies can test the mediational relationship among the variables in a longitudinal or interventional study. Second, in this study we only measured incremental beliefs of math ability. Existing studies assessing both incremental and entity theories generally reported negative relationships between these two theories, but the correlation size varied largely. The measurement issue of implicit theories should be examined in future research. Third, this study measured four achievement emotions experienced by students in their math study. We found after controlling for other emotions, math boredom was not further related to classroom engagement or math achievement. Recent studies showed boredom can be induced when students perceive task demands either too high or too low relative to their personal skills (Acee, et al., 2010; Pekrun, et al., 2010). Compared with the boredom experienced in under-challenging situations, the self-focused boredom experienced in over-challenging situations was related to more other emotions, such as anxiety, anger, and hopelessness. Future studies can examine whether the boredom induced by the two types of situations have different relationships with self-regulation strategies and achievement. In addition, since the participants of this study were from only one secondary school in Singapore which has a focus on Chinese culture, future studies can test the findings in a larger and more representative sample of Singapore students. This study can also be expanded in future by examining the relationship of implicit theories to other types of achievement emotions, such as hope, anger, and shame (Pekrun, 2006), and other self-regulatory strategies, such as persistence, metacognitive self-regulation, and help seeking.

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Footnote

Some studies either measured only one theory (e.g., Hong, et al., 1999) or reverse coded the items on one of the two theories and examined the relationships of only one theory to other variables (e.g., Blackwell, et al., 2007). Other studies measured both types of implicit theories and examined their relationships to other variables (Chen & Pajares, 2010; Elliot & McGregor, 2001). Among the studies that measured both types of implicit theories, most reported negative correlations between the two theories. However, the correlation size varied largely across studies. For example, r = .-74 in Elliot and McGregor (2001), -.52 in Chen and Pajares (2010), -.36 in Cury, et al. (2006), and -.16 in Doron, et al. (2009).

Table 1

Descriptive Statistics and Correlations Based on Raw Scores

	(Min, Max)	*M*	*SD*	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) Gender	(0, 1)	.64	48	-.27**	.00	-.22**	-.20**	.04	.05	-.08	-.29**	-.05
(2) PSLE math	(4, 7)	6.39	.59	--	.03	.11	.16**	-.15*	-.20**	.09	.09	.27**
(3) Incremental beliefs	(1, 5)	4.00	.71		--	.17**	.22**	-.15*	-.13*	.18**	-.10	.12*
(4) Math enjoyment	(1, 5)	3.16	.78			--	.57**	-.59**	-.35**	.51**	-.10	.31**
(5) Math pride	(2, 5)	3.49	.81				--	-.30**	-.33**	.51**	-.10	.41**
(6) Math boredom	(1, 5)	2.45	.83					--	.59**	-.40**	.29**	-.25**
(7) Math anxiety	(1, 5)	2.46	.79						--	-.32**	.27**	-.36**
(8) Classroom attention	(1.67, 5)	3.58	.68							--	-.30**	.25**
(9) Classroom disruption	(1, 4.33)	2.14	.74								--	-.13*
(10) Math achievement	(28, 98)	72.59	12.99									--

Note. Gender: 0 = male; *p <.05, **p < .01.

Table 2

Total and Specific Indirect Effects of Incremental Beliefs on Learning via Achievement Emotions

	Indirect effect	90%CI (lower, upper)	95%CI (lower, upper)	99%CI (lower, upper)
Classroom attention				
Total	.19**	(.074, .301)	(.052, .323)	(.010, .365)
Via math enjoyment	.09^	(.002, .180)	(-.016, .197)	(-.049, .230)
Via math pride	.10^	(.009, .184)	(-.008, .201)	(-.041, .234)
Classroom disruption				
Total	-.08*	(-.142, -.018)	(-.154, -.006)	(-.177, .017)
Via math anxiety	-.08*	(-.142, -.018)	(-.154, -.006)	(-.177, .017)
Math achievement				
Total	.14**	(.063, .206)	(.049, .220)	(.022, .247)
Via math pride	.10*	(.033, .164)	(.020, .177)	(-.004, .201)
Via math anxiety	.04^	(.006, .066)	(.000, .072)	(-.012, .084)

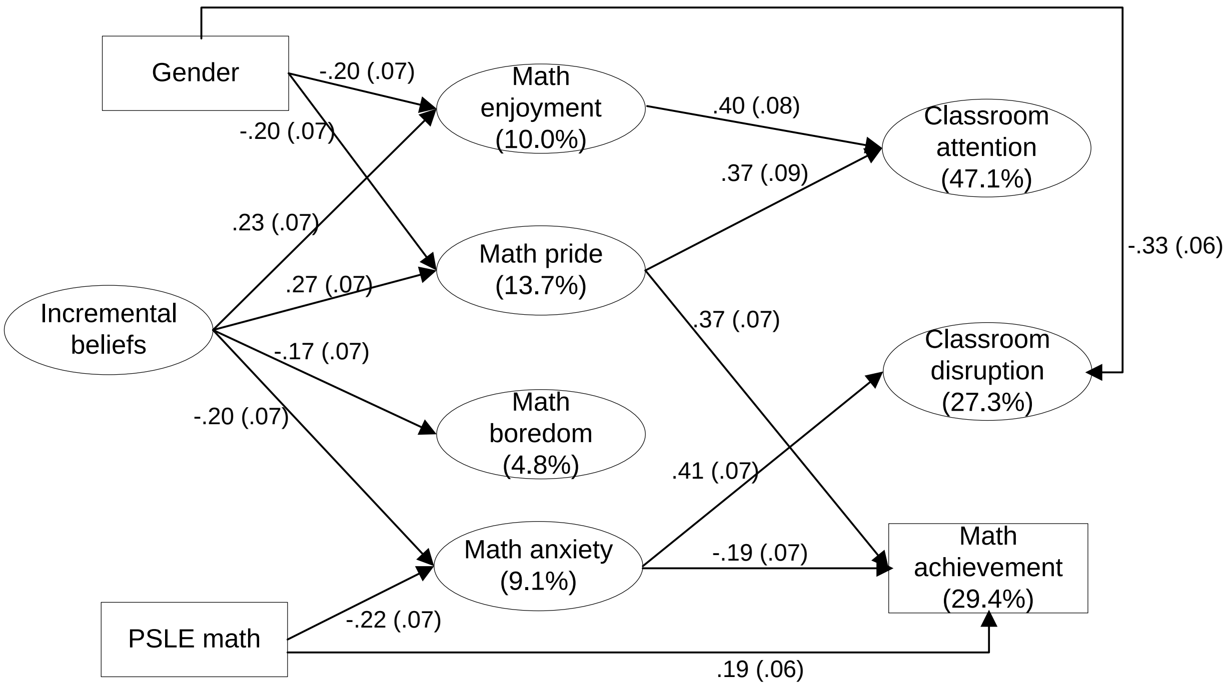
Note. ^p < .10, *p < .05, **p < .01.

Figure Caption

Figure 1. The final model of incremental beliefs, achievement emotions, and learning.

Note. All the paths shown in the figure are significant at $p < .05$ or .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 variables. The correlations between the residuals of achievement emotions are as follows: $r = .64$ ($p < .01$) between enjoyment and pride; $r = -.79$ ($p < .01$) between enjoyment and boredom; $r = -.45$ ($p < .01$) between enjoyment and anxiety; $r = -.29$ between pride and boredom; $r = -.41$ ($p < .01$) between pride and anxiety, and $r = .68$ ($p < .01$) between boredom and anxiety. In addition, $r = -.36$ ($p < .01$) between the residuals of classroom attention and disruption.

Figure 1


Gender
-.20 (.07)
Math enjoyment (10.0%)
.40 (.08)
Classroom attention (47.1%)
-.20 (.07)
.37 (.09)
.23 (.07)
Math pride (13.7%)
-.33 (.06)
.27 (.07)
Incremental beliefs
.37 (.07)
-.17 (.07)
Classroom disruption (27.3%)
-.20 (.07)
Math boredom (4.8%)
.41 (.07)
Math anxiety (9.1%)
-.19 (.07)
Math achievement (29.4%)
PSLE math
-.22 (.07)
.19 (.06)