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Do performance goals promote learning? A pattern analysis of Singapore students' achievement goals

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Abstract

This study investigated how achievement goals are combined to affect students' learning. We used a multiple goals perspective, based on mastery (i.e., mastery approach) and performance (including both approach and avoidance components) goals, to examine the achievement goal patterns of 1697 Singapore Secondary 3 students in their math study. Four types of goal clusters emerged from latent class cluster analyses: Diffuse (moderate multiple), Moderate Mastery (moderate mastery / low performance approach and avoidance), Success Oriented (moderate mastery / high performance approach and avoidance), and Approach (high mastery and performance approach / low performance avoidance). Analyses of covariance were conducted to compare these four clusters on eleven cognitive, behavioral, and affective learning outcomes. In general, students in the Success Oriented and Approach groups were higher on self-efficacy, subjective task values, class engagement, homework engagement, time management, and meta-cognitive self-regulation than those in the other two groups. In addition, students in the Approach and Moderate Mastery groups were more likely to make effort when encountering difficulties in learning math, showed lower test anxiety, lower negative affect, and achieved higher scores in math than students in the other two groups. These findings suggest that the goal profile with high mastery and performance approach goals combined with low performance avoidance goals is most beneficial for learning, whereas high performance approach goals, when associated with performance avoidance goals, have some negative effects on affective outcomes. The patterns help to refine distinctions in performance goals, and are discussed in the context of academic achievement in Singapore.

Keywords: achievement motivation, multiple goals, performance goals

1 Introduction

Educators and researchers believe that students need to be engaged actively in appropriate learning activities in order to achieve their full potential at school (Martin, 2007; Meece, Blumenfeld, & Hoyle, 1988; Pintrich & Schunk, 2002). To understand achievement motivation and students' learning behaviors, several socio-cognitive theories of achievement goals have been proposed to identify the purposes of an individual's achievement pursuits (Dweck & Leggett, 1988; Nicholls, 1984). Although theorized from different perspectives and labeled differently, two fundamental types of goals have been identified: mastery and performance. The purpose of a student pursuing mastery goals is to develop competence through the acquisition of new skills, whereas students pursue performance goals to demonstrate competence relative to others.

The literature in the 1970s and 1980s on academic achievement goals generally reported that mastery goals were more adaptive for learning than performance goals (for a review, see Ames, 1992). However, more recent reviews (Elliot & Church, 1997; Elliot & Harackiewicz, 1996; Harackiewicz, Barron, & Elliot, 1998; Urdan, 1997) showed that this is not always true; performance goals under some circumstances are appropriate and can lead to high achievement. In order to explain the discrepant findings, theories about achievement goals have been amended to incorporate both approach and avoidance components of achievement goal orientations (Elliot & Church, 1997; Elliot & McGregor, 2001; Pintrich, 2000a, 2000b). In addition, some researchers proposed a multiple goals perspective to replace the traditional mastery goals perspective, that is, individuals may endorse multiple goals simultaneously, and there are multiple ways that achievement goals affect learning (Harackiewicz, Barron, Pintrich, Elliot, & Thrash, 2002; Pintrich, 2000b).

This study adopted a multiple goals perspective to investigate how Singapore secondary students combine various goals when they learn math. These data were based on a large sample of randomly selected students in Secondary 3 (Grade 9) in Singapore. We first employed latent class cluster analyses to classify students into different groups according to three types of achievement goal orientations. By incorporating performance avoidance goals in cluster analyses, we examined not only how mastery and performance approach goals are related, but also how these "approach" goals can be combined with performance avoidance goals. Then we examined the effects of cluster membership on eleven outcome variables, including learning beliefs, learning activities and strategies, affective outcomes, and objective math achievement. The findings of the present study help to identify adaptive achievement goal patterns among students in an East Asian context.

2 Achievement goals: A framework for learning

Initial research on achievement goals concluded that mastery goals were generally adaptive and performance goals were maladaptive (e.g., Ames & Archer, 1988; Elliott & Dweck, 1988; Meece et al., 1988; Nolen, 1988). More recently, however, some studies reported that performance goals can facilitate learning. For example, positive relations were found between performance goals and adaptive learning variables, such as task values (Bong, 2001; Church, Elliot, & Gable, 2001; Wolters, Yu, & Pintrich, 1996), academic self-concept (Pajares, Britner, & Valiante, 2000; Skaalvik, 1997; Wolters et al., 1996), and graded performance (Barron & Harackiewicz, 2001; Elliot & Church, 1997; Elliot & McGregor, 2001; Elliot, McGregor, & Gable, 1999; Harackiewicz, Barron, Tauer, Carter, & Elliot, 2000; Lopez, 1999; Wentzel, 1993). In other studies, performance goals were associated with maladaptive learning behaviors, such as self-handicapping tactics and help avoidance (Middleton & Midgley, 1997; Midgley, Arunkumar, & Urdan, 1996; Ryan, Hicks, & Midgley, 1997; Ryan & Pintrich, 1997). Other studies revealed that performance goals were not associated with adaptive learning variables, such as deep processing (Elliot et al., 1999;

Harackiewicz et al., 2000) and intrinsic motivation (Church et al., 2001; Elliot & Church, 1997; Harackiewicz, Barron, Carter, Lehto, & Elliot, 1997; Harackiewicz et al., 2000).

To explain the inconsistent findings about performance goals, it has been argued that performance goals include two theoretically distinct components (Elliot & Harackiewicz, 1996; Middleton & Midgley, 1997; Skaalvik, 1997; Wolters et al., 1996). For example, Elliot and Church (1997) separated performance goals into performance approach goals, in which an individual's goal is to demonstrate being competent relative to others, and performance avoidance goals, in which an individual's goal is to avoid the appearance of incompetence. Elliot and Church (1997) posited that mastery and performance avoidance goals are relatively straightforward forms of regulation: mastery goals are driven by achievement motivation and performance avoidance goals are driven by fear of failure. In contrast, performance approach goals are driven by both achievement motivation and fear of failure.

Recently, some researchers have argued that we should revise the mastery goals perspective and accept a multiple goals perspective (Barron & Harackiewicz, 2001; Harackiewicz et al., 2002; Harackiewicz et al., 2000). From a multiple goals perspective, students may adopt multiple goals that can be adaptive in different contexts. For example, when academic competition is salient, performance approach goals may be beneficial for attaining high performance. Although there is debate about what is the most adaptive motivation orientation, most researchers agree that understanding motivational orientations as involving multiple goals represents a more complex and advanced perspective than one that treats mastery and performance goals as a dichotomy (Harackiewicz et al., 2002; Kaplan & Middleton, 2002; Midgley, Kaplan, & Middleton, 2001). This perspective is also consistent with Biggs'(1987) position that students could adopt a complex of surface, deep, and achieving motives or strategies. However, the multiple goals perspective must identify how different goals are combined and how these goal combinations affect students' learning.

Several different approaches have been employed to identify students' goal combinations. Some studies used a median-split and others used a trichotomizing procedure to classify participants based on mastery and performance approach goals (e.g., Bouffard, Vezeau, & Bordeleau, 1998; Pintrich & Garcia, 1991). For example, by using a trichotomizing procedure (median, higher quartile, and lower quartile) to classify their sample, Pintrich and Garcia (1991) found that college students who endorsed high mastery and low performance approach goals reported the highest levels of cognitive and meta-cognitive strategy use and the lowest test anxiety, but both types of goals had positive main effects on self-efficacy and task values. Some other studies (e.g., Barron & Harackiewicz, 2001; Harackiewicz et al., 1997; Harackiewicz et al., 2000) examined the two types of motivation goals and their multiplicative term in a multiple regression model and found that the two types of achievement goals were independently beneficial for different measures of academic success. In general, these studies reported that students adopting mastery goals were more interested in subject learning, but students adopting performance approach goals achieved higher levels of performance. These studies included college students in highly competitive classes, so performance goals might be explicitly valued and adopted.

Another approach to studying achievement goals is to examine the clusters of participants emerging from cluster analysis of their achievement goals. For example, by using K-means cluster analysis, Meece and Holt (1993) identified three clusters on the basis of 257 American 5th and 6th graders' mastery, performance approach, and work avoidance goals. They found that students exhibiting a pattern high on mastery and low on the other two types of goals showed the most positive achievement profile. Ainley (1993) classified 137 Australian female 11th graders based on their responses on a measure of general ability and the Learning Process Questionnaire (Biggs, 1987) into six groups. Differences were reported among the six clusters in terms of strategies used for exam preparation and school achievement. More recently, by using K-means cluster analysis, Daniels et al. (2008) classified 1002 Canadian undergraduate students according to their mastery and performance approach goals into four clusters. They found that the multiple goals, mastery, and performance clusters achieved significantly better than the low-motivation cluster, but performance-oriented students displayed a maladaptive emotional profile relative to the other three groups. On the basis of mastery, performance approach, and work avoidance goals of 208 6th graders in South Finland, Tapola and Niemivirta (2008) identified four clusters by using latent class cluster analysis: learning oriented (high mastery), achievement oriented (high mastery and performance approach), performance oriented (high performance approach), and avoidance oriented (high work avoidance). The authors also reported that each orientation group preferred the classroom goal structure that matched their motivational profiles. For example, performance-oriented students preferred public evaluation more than the other groups did, and avoidance-oriented students did not value task-focused and challenging classroom work as much as others did.

This study examined how students combine achievement goals, and how different goal combinations are related to students' learning. There are two unique features to the study. First, we included students' performance avoidance goals (Elliot & Church, 1997; Elliot & Harackiewicz, 1996) in cluster analysis to examine how three types of achievement goals—mastery (i.e., mastery approach), performance approach, and performance avoidance goals—are combined and how these combinations affect students' learning. Second, we studied the achievement goal profiles of students in Singapore.

It is worthwhile expanding the study of students' achievement goals and learning to the Singapore context for several reasons. First, Singapore students achieve very high scores in mathematics and science on international examinations, such as the Third International Mathematics and Science Study (TIMSS) (e.g., Wilkins, 2004). Second, Singapore is a westernized Eastern Asian country that has maintained some traditional Chinese values. According to some researchers (Tu, Hejtmanek, & Wachman, 1992), Singapore is a modern Confucian state where the highest values are a cluster of intertwined values denoting industry and civic harmony. For example, it has been found that collectivism and individualism correlate positively in Singapore (Chan & Koh, 2000; Luo, Hogan, & Paris, 2010). Third, the education environment in Singapore is very competitive, even in primary schools. In a small country with few natural resources, it is almost a national mantra that educational success is crucial for the future success of individuals as well as the nation. Furthermore, education in Singapore is driven by assessment, and students' performances on national high-stakes examinations determine how they will be assigned to different education tracks or streams. This learning environment may provoke competition with other students, which in turn enhances students' performance goal orientations. In other words, Singapore students may be particularly likely to exhibit a pattern of motivation that combines performance approach and avoidance goal orientations.

The present study was designed to find clusters of students' goal combinations by using an exploratory procedure of cluster analysis. Then we examined how these obtained clusters were related to eleven learning outcomes. Based on the literature review, three hypotheses were proposed. First, we expected that performance avoidance goals would contribute unique information for the classification of students. Second, information about performance avoidance goals would help to identify when performance approach goals might be adaptive or maladaptive. More specifically, we predicted that pure performance approach goals would be positive, but performance approach and avoidance goals might often co-occur and result in negative consequences for students. Third, the findings of the present study would help to identify optimal motivational patterns for Singapore secondary students in their math study.

In particular, we predicted that students with high mastery and performance approach goals but low performance avoidance goals would show the most adaptive learning patterns.

3 Method

3.1 Participants

This study was part of a large-scale research project that investigated relations between Singapore students' learning beliefs, behaviors, and outcomes. The participants were 1717 Secondary 3 students from 39 schools in Singapore. After deleting cases with missing values on some scales, there were 1697 participants in the study. They included 785 (46.26%) boys and 912 (53.74%) girls, with an average age of 15.51 years (*SD* = .55). The distribution of ethnicity was Chinese (1239, 73.01%), Malay (328, 19.33%), Indian (92, 5.42%), and others (38, 2.24%). The language medium of the research was English, which is also the medium of instruction in Singapore.

3.2 Measures

The instruments used in the present study included a survey and a math achievement test. The survey was administered first, and about one month later the achievement test was conducted. The specific measures in the survey are described below, followed by more details about the achievement test.

3.2.1 Achievement goals. We measured three achievement goal orientations in our participants' study of math: mastery goals (4 items), performance approach goals (4 items), and performance avoidance goals (4 items). The scales were adapted from the Patterns of Adaptive Learning Scale (PALS) (Midgley et al., 1998; Midgley et al., 2000). Mastery goals referred to students' orientation to learn new things and challenging ideas and thus can also be called mastery approach goals. Sample items include, "An important reason I do my math work is that I like to learn new things," and "I like the work in my math class best when it challenges me to think." The performance approach goals scale assessed students' desire to demonstrate high performance to their teachers and classmates in their math class. Sample items are, “I want to show pupils in my math class that I am smart,” and “I like to show my teacher that I am smarter than the other pupils in my math class.” The performance avoidance goals scale tapped students’ orientation to avoid demonstration of low competence in math in front of their classmates and teachers, such as “I do not participate in math class because I do not want to look stupid,” and “It is important that the other pupils in my math class do not think I am stupid.” The response categories of both scales ranged from 1 (completely disagree) to 5 (completely agree). For our sample, the internal consistency reliabilities of mastery, performance approach, and performance avoidance scales were .84, .88, and .80, respectively. In exploratory factor analysis, three factors were extracted and each item loaded on the factor it was supposed to measure.

3.2.2 Self-efficacy and subjective task values. The expectancy-value theory of achievement motivation (Eccles et al., 1983; Wigfield, 1994; Wigfield, Tonks, & Eccles, 2004) posits that self-efficacy and subjective task values are two key components for understanding students’ achievement-related engagements and performance. In the present study, self-efficacy was defined as students’ beliefs about their confidence in mastering the skills taught in their math class. This self-efficacy scale (5 items) was adapted from the Motivated Strategies and Learning Questionnaire (MSLQ) (Pintrich, Smith, Garcia, & McKeachie, 1993). Sample items include, “Even if the work in math is hard, I can learn it,” and “I am sure I can learn the skills taught in my math class well.” Subjective task values are usually defined with three components: importance to individuals, utility for individuals, and interest in the task (Eccles & Wigfield, 1995; Wigfield et al., 1997). Adapted from Wigfield et al. (1997), the subjective task values scale (3 items) asked students to describe in general how important, interesting, and useful was math or learning math. Sample items are, “What I learn in math is useful,” and “I find math is interesting.” The response categories of both scales ranged from 1 (completely disagree) to 5 (completely agree). The internal consistency reliabilities for self-efficacy and subjective task values scales were .84 and .79, respectively.

***3.2.3 Learning activities*.** We measured five types of learning activities: class engagement, homework engagement, time management, meta-cognitive self-regulation, and effort regulation. Together these variables reflected the degree to which students were involved, engaged, and strategic. Adapted from the Rochester Assessment Package for School-Students Report (Wellborn & Connell, 1987), the class engagement scale (3 items) measured the extent to which students paid attention to activities during their math class. Sample items for this scale are, "In my math class, I listen carefully when the teacher explains something," and "In my math class, I keep my attention on the work during the entire lesson." The 4-item homework engagement scale (adapted from VanDamme, Bieke, Van Landeghem, Opdenakker, & Onghena, 2002) measured the extent to which students treated their homework seriously and put effort in doing their homework. Sample questions include, "I put much effort in my math homework," and "I take my math homework seriously." Adapted from Pintrich et al. (1993), the scale of time management (3 items) measured how well students made use of their time in learning math. Sample items are, "When I learn math, I make good use of my study time," and "I make sure I keep up with my weekly work for math." The meta-cognitive self-regulation scale (4 items), adapted from the MSLQ (Pintrich et al., 1993), tapped the degree to which students used planning, monitoring, and correcting activities in their study of math. Sample items are, "I ask myself questions to make sure I understand what I study in my math class," and "When I study math, I try to determine which ideas I don't understand well." Adapted from Pintrich et al. (1993), the effort regulation scale (3 items) measured how well students controlled their effort and attention in the face of difficult and boring tasks in math. Sample items are, "When the work in math is dull and boring, I stop doing it even if it is incomplete," and "When the work in math is difficult, I give up."

All the five scales were rated on a 5-point Likert-type scale. The internal reliabilities were .87, .82, .76, .83, and .80, respectively, for class engagement, homework engagement, time management, meta-cognitive self-regulation, and effort regulation.

3.2.4 Affective outcomes. There were three affective scales. The test anxiety scale (4 items) was adapted from Pintrich et al. (1993). It assessed the degree to which students worried about doing poorly and felt nervous when taking math exams. Sample items include, "When taking math tests, I worry about doing poorly," and "I am nervous when taking math tests." The positive affect (3 items) and negative affect (3 items) scales measured general positive (happy, cheerful, and excited) and negative affect (angry, sad, and frustrated) that students experienced in the past week. Sample items are, "During the past week, how often do you feel happy," and "During the past week, how often do you feel angry?" The items were rated on a 5-point Likert-type scale, and the internal consistency reliabilities were .87 .91, and .85, respectively, for the scales of test anxiety, positive affect, and negative affect.

3.2.5 Achievement test. To measure math achievement of a large sample of Secondary 3 students, an online multiple-choice math test was developed by a panel of experienced teachers and researchers with reference to the curriculum. The test included questions assessing students' understanding of mathematical ideas and application of mathematical procedures to solve simple to complex problems. Through pilot testing and item analysis (e.g., difficulty, discrimination, and distractor analysis), 28 items with good psychometric qualities that represented the proposed content and cognitive domains were selected to measure math achievement in the main study. A three-parameter logistic model was used to fit the data and the IRT scores were obtained and used in the present study. In addition to the current math achievement measured by this multiple-choice test, we asked students to report their Primary Leaving School Examination (PSLE) scores in math taken three years earlier. The PSLE math scores ranged from 1 to 7, with higher scores indicating higher performance. As evidence of convergent validity of the current math achievement test, students' scores on it were moderately correlated (r = .53) with the scores on PSLE math.

3.3 Statistical analysis

In general, the statistical analyses in the present study consisted of three steps. In the preliminary analysis, we calculated the means, standard deviations, intra-class correlations, and inter-scale correlations. In the second step, latent class cluster analysis was conducted to identify clusters based on students' data on the three types of achievement goals. As shown below, the process to identify meaningful clusters was exploratory in nature. Third, based on the results of cluster analyses, a group of analyses of covariance were conducted to examine the cluster differences in each of the eleven learning outcome variables after controlling for previous math achievement. In view of the large sample size, we used .001 as the criterion of significance in analyses of correlation and covariance to avoid reporting many trivial effects (i.e., correlation coefficients less than .1 and the proportion of explained variance less than .01). The effect sizes were reported and interpreted according to Cohen's (1988) criteria as small, medium, or large.

4 Results

4.1 Preliminary analysis

The means and standard deviations for all the variables were calculated. From Table 1, we can see that the mastery goal orientation had a higher mean and a lower standard deviation than the two performance goal orientations. Therefore, compared with mastery goals, the two performance goals could discriminate better among the sample of students. Since we had three levels (student, class, and school) in our data set, hierarchical linear modeling (Raudenbush & Bryk, 2002) was conducted to decompose the variance at the three levels. As shown in Table 1, except for current and previous math achievement, the variances at Levels 2 and 3 were relatively small. The relatively high variance at class and school levels in achievement can be explained by the streaming system in Singapore because students were assigned to schools and classes according to their achievement.

As shown in Table 2, the correlations among the 15 variables measured in the present study were calculated. There was a low positive correlation between mastery and performance approach goals, and a moderate positive correlation between performance approach and avoidance goals. In addition, the correlation between mastery and performance avoidance goals was close to zero. The moderate correlation between performance approach and avoidance goals implies a simultaneous endorsement of both types of goals. As for college students in highly competitive classes (e.g., Barron & Harackiewicz, 2001; Harackiewicz et al., 1997; Harackiewicz et al., 2000), the concurrent adoption of performance approach and avoidance goals might be particularly meaningful for Singapore students in response to the competitive educational environment.

4.2 Cluster analysis

The model-based latent class cluster analysis was conducted to identify clusters by using the program of Latent GOLD 4.5 (Vermunt & Magidson, 2010). Latent class cluster analysis has some advantages over traditional clustering techniques such as K-means cluster analysis (Magidson & Vermunt, 2002, 2004). For example, latent class cluster analysis is less likely to misclassify respondents, and various statistics such as the BIC statistic are available to assist in choosing the number of clusters. In addition, this method allows the indicator variables to be correlated with each other, even with fairly high correlations (personal communication with Magidson, July 2010). In the latent class analyses, the three goal variables were treated as ordinal variables due to only 4 items tapping each variable on a 5-point Likert-type scale (personal communication with Magidson and Vermunt, July 2010). We explored the best fit model among ten solutions with the number of clusters from 1 to 10. Rather than using the model fit chi-squared statistics which are sensitive to sample size, we adopted BIC and CAIC values as the statistical basis for model selection. These statistics taking into account both the model fit and the model parsimony are widely used for model selection in latent class cluster analysis. The smaller these statistics, the better is the model. In addition, as described below, the cluster size and meanings were also important factors we considered when selecting the final model.

As shown in Table 3, both the BIC and CAIC statistics show that the 6-cluster model had the best fit. Since the number of cases in the last cluster was 18 in the 6-cluster model, we decided to consider the 5-cluster model. However, in the 5-cluster solution, the last cluster only had 19 cases and the other four clusters had very similar meanings as the first 4 clusters in the 6-cluster model. Thus, we turned to the 4-cluster model, in which the four clusters had very similar meanings as the first 4 clusters in both the 5-cluster and 6-cluster models. In addition, the first three clusters in the 4-cluster solution had similar meanings as the three clusters in the 3-cluster solution. Although the size of the fourth cluster (82) was still relatively small we decided to retain it due to its theoretical relevance. That is, a relatively small portion of students had very high mastery and performance approach goals but very low performance avoidance goals (see Table 4 for the raw cluster means and standard deviations). As shown in Figure 1 with standardized scores, the emergent four clusters can be labeled as Diffuse (moderate multiple), Moderate Mastery (moderate mastery / low performance approach and avoidance), Success Oriented (moderate mastery / high performance approach and avoidance), and Approach (high mastery and performance approach / low performance avoidance). Here we use “moderate” to indicate a standardized mean score falling within the range of -1 to 1, “high” over 1, and “low” below -1. Since the mastery goal orientation was measured as pure approach goals in the present study, we labeled the last cluster as Approach because it was high on both mastery and performance approach goals and low on performance avoidance goals.

To examine whether there were significant differences among the four clusters in terms of the three achievement goals, analyses of variance were conducted. It was found that the differences among the four groups in all the three types of goals were significant; mastery goals (F (3, 1693) = 77.17, p < .001, η^2 =.12), performance approach goals (F (3, 1693) = 1479.04, p < .001, η^2 =.72), and performance avoidance goals (F (3, 1693) = 1050.67, p < .001, η^2 =.65). The raw cluster means on the three achievement goals are shown in Table 4. The relatively low proportion of variance in mastery goals explained by the four clusters could be due to its higher mean score and lower standard deviation in comparison with the two performance goals.

The distribution of gender in the four clusters is shown in Table 4. There was a small correlation between cluster and gender (*phi* = .15, p <.001). Female students were slightly more likely to adopt Moderate Mastery goals, while male students were relatively more likely to adopt Success Oriented goals. This is partly consistent with previous motivation research (e.g., Elliot & Church, 1997; Pajares et al., 2000) that found girls tended to endorse mastery goals, while boys tended to endorse performance approach goals.

4.3 Analysis of covariance

In this section, we first report the results of a multivariate analysis of covariance (MANCOVA) that was conducted to examine the cluster effect on the full set of eleven outcome variables. In this analysis, both gender and cluster were entered as independent variables, and students' previous math achievement on the PSLE was treated as a covariate. Then based on the results of the MANCOVA (e.g., whether a main or interaction effect was significant), we conducted analyses of covariance (ANCOVAs) for each of the eleven outcome variables. On the variables with significant cluster effects, the Bonferroni pairwise tests which adjust the observed significance level for multiple comparisons were further conducted, and .01was used as the criterion of significance to avoid reporting many trivial group differences to be statistically significant.

By using Pillai's trace method, the results of the MANCOVA showed that previous achievement had a significant overall effect, F (11, 1678) = 64.58, $p < .001$, partial $\eta^2 = .30$; the effect of gender was significant, F (11, 1678) = 4.26, $p < .001$, partial $\eta^2 = .03$; the effect of cluster was significant, F (33, 5040) = 10.52, $p < .001$, partial $\eta^2 = .06$; and the interaction between gender and cluster was not significant. Because the interaction effect was not significant, the interaction term was removed in the ANCOVAs for each of the outcome variables. Table 5 shows the sizes of the main effects and the raw mean scores for each cluster on each of the outcome variables. To have a clear display of cluster effects and make cluster effects on different variables comparable, the standardized cluster means on each of eleven outcome variables are shown in Figure 2.

On self-efficacy, the main effects of previous achievement (F (1, 1691) = 40.21) and cluster (F (3, 1691) = 45.44) were significant, while the main effect of gender was not significant. As shown in Table 5, cluster had a larger effect size than previous achievement on students' self-efficacy in learning math. Multiple comparisons showed that there were significant differences between all the paired clusters except between the Diffuse and Moderate Mastery clusters. As shown in Table 5, the Approach group was higher in self-efficacy than the Success Oriented group, which in turn was higher than the Diffuse and the Moderate Mastery groups.

On subjective task values, the effects of previous math achievement and gender were not significant. The main effect of cluster was significant (F (3, 1691) = 35.19) with a medium effect size. Multiple comparisons showed that all paired clusters were significantly different except for the Diffuse and Moderate Mastery groups. As shown in Table 5, the Approach group valued math more than the Success Oriented group, which in turn valued math more than the Diffuse and Moderate Mastery groups.

On class engagement and homework engagement, similar patterns of results were obtained. On both variables, the effects of previous achievement and gender were not significant. The main effects of cluster were significant on both class engagement (F (3, 1691) = 18.48) and homework engagement (F (3, 1691) = 15.25) with small effect sizes. All the paired comparisons were significant except for the Moderate Mastery group with the Diffuse and Success Oriented groups on both variables. As shown in Table 5, students in the Approach group were more engaged in their math classes and homework than students in the Moderate Mastery and Success Oriented groups, and students in the Success Oriented group were engaged more than those in the Diffuse group.

Similar patterns of results were also obtained on time management and meta-cognitive self-regulation. Neither the effect of previous achievement nor that of gender was significant. The main effect of cluster was significant on both time management (F (3, 1691) = 30.14) and meta-cognitive self-regulation (F (3, 1691) = 37.30) with medium or nearly medium effect sizes. Comparisons among the four clusters showed that all the paired groups were significantly different on both variables except for the Diffuse and Moderate Mastery groups as well as the Success Oriented and Approach groups. As shown in Table 5, students in the latter two groups reported more use of these two strategies than students in the former two groups.

Regarding effort regulation, the effects of previous achievement and gender were not significant. The main effect of cluster (F (3, 1691) = 13.10) was significant with a small effect size. Multiple comparisons showed that three pairs of groups were significantly different: the Approach group was significantly higher than the Diffuse and Success Oriented groups, and the Moderate Mastery group was significantly higher than the Success Oriented group.

In terms of test anxiety, the effects of previous achievement (*F* (1, 1691) = 45.93), gender (*F* (1, 1691) = 13.38), and cluster (*F* (3, 1691) =17.13) were all significant. As shown in Table 5, the effect size of gender was very small with girls showing slightly higher test anxiety (*M* = 3.59, *SD* = .92) than boys (*M* = 3.45, *SD* =1.00). Comparisons among the four clusters showed that all the paired groups were significantly different except for the Diffuse and Success Oriented groups as well as the Moderate Mastery and Approach groups. As shown in Table 5, students in the former two clusters reported higher test anxiety than students in the latter two clusters.

With regard to positive affect, no significant effect was found with any of the three variables. In contrast, as shown in Table 5, with regard to negative affect, the main effect of cluster (*F* (3, 1691) =16.13) was significant with a small effect size. Multiple comparisons showed that students with Success Oriented goals reported significantly higher negative affect than the other three groups.

On the current math test score, the effect of previous math achievement (*F* (1, 1691) = 657.16) was significant with a large effect size. The main effects of both gender (*F* (1, 1691) = 17.19) and cluster (*F* (1, 1691) = 5.73) were significant, but the effect sizes were very small. Female students (*M* =13.63, *SD* = 5.55) achieved slightly higher than male students (*M* = 12.73, *SD* = 5.85). Multiple comparisons among the four clusters showed that the Moderate Mastery group achieved slightly higher than the Success Oriented group. Although the mean score of the Approach group was even a bit higher, due to the relatively small number of students in this cluster, it was not significantly higher than any of the other groups.

However, because of the intra-class correlations in the data of current math score, the ANCOVA test statistics on this variable might not be accurate, and the Type I error might be inflated (Barcikowski, 1981). A three-level (student, class, and school) hierarchical linear modeling analysis (Raudenbush & Bryk, 2002) was conducted with previous math scores, gender, and 3 dummy cluster variables (Success Oriented group was taken as the reference group due to its lowest mean on current math score) as predictor variables at Level 1. It was found that previous math score was a significant predictor (γ =.17, t (38) = 6.359, p = .000), gender effect was not significant, and as in the ANCOVA, students in the Moderate Mastery groups achieved significantly higher than students in the Success Oriented group (γ = .12, t (38) = 2.25, p = .03). Due to the relatively small number of classes with enough variations in the Approach cluster, we do not report the Level 2 and Level 3 variances for the slopes of the predictor variables. However, more detailed multilevel analysis about the relationship of achievement levels to achievement goals, self-efficacy, and subjective task values is beyond the scope of this article.

5 Discussion

This present study was conducted with two objectives. First we identified the primary clusters of motivational goal orientations for Singapore secondary students in their math study. Second, we examined the effects of cluster membership on eleven learning variables in order to identify the adaptive profiles of achievement goals.

5.1 Profiles of achievement goals

By using latent class cluster analyses, four clusters were obtained, that were labeled as Diffuse, Moderate Mastery, Success Oriented, and Approach. Although the Approach cluster had a much smaller number of students than the other three groups, it was retained in view of its existence in all the 4-cluster, 5-cluster, and 6-cluster solutions. As predicted, this cluster also reflected the unique contribution of performance avoidance goals to the classification of students. In addition, the present study also found that this cluster reflected the most adaptive profile of achievement goals in terms of the eleven learning variables measured in this study.

The obtained four clusters were valid both empirically and theoretically. First, the four clusters explained a significant proportion of variance in each of the three achievement orientations, especially in the two performance goals that demonstrated relatively lower means and larger variances. Based on our data set, students reported a higher mean score and were less differentiated on mastery goals than on the two performance goals. Although similar findings have been reported in other studies (e.g., Elliot & Church, 1997; Elliot & McGregor, 2001), the relatively higher level of mastery goals might also reflect the effect of the initiatives of "Thinking Schools, Learning Nation" (Goh, 1997) and "Teach Less, Learn More" (H. L. Lee, 2004) in Singapore. Both of them advocate the creation of a desirable learning environment that nurtures the new generation to engage themselves in thinking, learning, and creative activities and emphasizes the development of students to become motivated and engaged learners so as to be well prepared for new challenges.

Second, the relationships among the three types of achievement goals were reflected in the four clusters identified. This study found that the two performance goals were moderately correlated with each other, and they were relatively independent of mastery goals. The two performance goals went together in three of the four clusters, that is, both performance approach and avoidance goals were moderate, low, and high respectively in the first three clusters and only divergent in the Approach cluster. In contrast, mastery goals went together with performance approach goals only in the Diffuse and Approach clusters, and with performance avoidance goals only in the Diffuse cluster. The low positive correlation (rather than high negative correlation) between mastery and performance approach goals was consistent with the findings of previous research (e.g., Elliot & Church, 1997; Elliot & McGregor, 2001; Elliot et al., 1999), suggesting that students high on one of the two goal orientations may not be low on the other. The moderate positive correlation between performance approach and avoidance goals supports Elliot's (1997) argument that performance approach goals represent an approach form of regulation undergirded by both approach (achievement motivation) and avoidance (fear of failure) motive dispositions. In addition, the moderate correlation might be especially relevant in Singapore where the intense pressure for academic success and the streaming system might explain the high concordance between performance approach and avoidance goals.

In general, the clusters obtained in the present study differ from those obtained in previous studies (e.g., Ainley, 1993; Daniels et al., 2008; Meece & Holt, 1993; Tapola & Niemivirta, 2008). More specifically, although as found in some previous studies (e.g., Daniels et al., 2008; Tapola & Niemivirta, 2008) we had a cluster with high scores on both mastery and performance approach goals and two clusters with relatively higher scores on each of these two types of goals, the other cluster had diffuse moderate scores on all the three achievement goal orientations. However, it is difficult to make direct cross-cultural comparisons between the clusters obtained in this study and those obtained in previous studies for several reasons. First, the variables used for forming the combinations of achievement goals are different. Many studies measured only mastery goals and performance approach goals (e.g., Barron & Harackiewicz, 2001; Daniels et al., 2008; Harackiewicz et al., 2000), some measured a different third variable, such as work avoidance (e.g., Meece & Holt, 1993; Tapola & Niemivirta, 2008), and others used very different variables to create clusters (e.g., Ainley, 1993).

Second, the statistical methods used to form clusters were different. Some studies used a median-split procedure to create the combinations of achievement goals (e.g., Bouffard et al., 1998; Elliot & Church, 1997), and many other studies employed traditional K-means cluster analysis (e.g., Ainley, 1993; Daniels et al., 2008; Meece & Holt, 1993), that was found to be less accurate than latent class cluster analysis (Magidson & Vermunt, 2002). We tried using only mastery and performance approach goals to do cluster analysis by conducting both latent class cluster analysis (4-cluster solution has the best fit) and K-means cluster analysis (by setting 4 clusters), and the obtained solutions had different cluster mean scores and number of cases in each cluster. In addition, the cluster raw mean scores on the three types of achievement goals reported in this study suggest that the clusters cannot be obtained by simply using a median split procedure. Furthermore, in the present study, we referred to the standardized scores to define the clusters, so the distribution of the three achievement goals in the sample was considered. Although in general the shape and meaning of these clusters were quite similar to those defined by using the raw mean scores, there were also some differences. More specifically, when standardized scores were used, we had high performance approach and avoidance goals and moderate mastery goals in the Success Oriented group (see Figure 1), but when raw scores were used, the mean of mastery goals was slightly higher than the mean of performance avoidance goals in the same group (see Table 4). Although some studies (e.g., Ainley, 1993; Daniels et al., 2008) defined the clusters based on the standardized scores, many other studies employed the raw scores to label their obtained clusters (e.g., Meece & Holt, 1993; Tapola & Niemivirta, 2008). It is possible that in these studies the use of standardized scores and raw scores will lead to different cluster meanings. Third, the participants were different ages across studies. Achievement beliefs tend to be optimistic and variable during middle childhood, but they become more realistic and stable as children get older (Wigfield, 1994; Wigfield et al., 1997). Therefore, both the levels and the combinations of achievement goals may vary across different stages of development. Fourth, the learning environments and learning tasks change across different levels of schooling and across different countries so the tasks may also affect the achievement goal orientations of students. All these factors together confound the comparisons of achievement goal profiles from a cross-cultural perspective.

5.2 The effects of cluster membership on learning outcomes

To understand the learning profiles of students in the four clusters, we examined the differences among the four clusters on a variety of eleven learning-related variables. When previous achievement and gender were controlled, cluster was an important predictor of the eleven learning variables (with an overall medium effect size). To avoid confusion, it should be noted that in the following text, mastery goals refer to mastery approach goals, and performance goals include both the approach and avoidance components.

The patterns of cluster effects on the two learning belief variables and four of the five learning activity variables (except for effort regulation) were similar. In general, on these six variables, students with Approach goals were higher than students with Success Oriented goals, followed by students with Moderate Mastery goals and with Diffuse goals. In general, the combination of mastery and performance goals (especially performance approach goals) was associated with students' beliefs about their learning abilities, the values they attach to learning, the engagement in learning activities, and the use of learning strategies. In this sense, it is an adaptive and beneficial orientation to learning.

The effect of cluster on effort regulation showed a different profile. Students with Approach goals were the highest while students with Success Oriented goals were the lowest on this variable. Effort regulation was measured as the extent to which students persisted and controlled their attention when they encountered difficult or boring tasks in learning math. The relatively low level of effort regulation of students endorsing Success Oriented goals was consistent with previous findings that performance-oriented students tended to avoid challenging tasks (e.g., Dweck, 1986; Dweck & Leggett, 1988). In contrast, when performance approach and avoidance goals were lower such as in the Moderate Mastery cluster, students' effort-regulation level was higher, that was consistent with previous findings that mastery-oriented students believed that effort leads to success, persisted in the face of difficulty, and preferred challenging tasks (Ames & Archer, 1988; Elliott & Dweck, 1988). Furthermore, when only performance avoidance goals were lower, such as in the Approach cluster, students were most likely to put effort in their study when encountering difficulties, which implies that performance approach goal orientation *per se* is not associated with the use of avoidance strategies. The key to understanding these patterns may be the fear of failure and anxiety for students who pursue both performance approach and avoidance goals. When students are oriented to outperform other students and avoid appearing stupid simultaneously, they may worry about making mistakes and failing examinations, as a result they are likely to protect their self-worth by giving less effort when the task is challenging and the probability of success is relatively low.

Analysis of the three emotional variables lends support to this interpretation. The effect of cluster was not significant on positive affect, but was significant and similar on the two negatively-valenced emotions. In general, students with Success Oriented goals showed the highest test anxiety and negative affect, followed by students in the Diffuse cluster, and then by students in the Moderate Mastery cluster. Students in the Approach group were the lowest on the two negative emotional variables. Comparisons in the first three clusters above suggest that performance goals are detrimental to students' feelings about their math examinations and to school in general. This is consistent with the finding in recent studies that students with higher performance goals are more psychologically vulnerable, and they exhibit higher test anxiety, less enjoyment, and more boredom (e.g., Daniels et al., 2008). After controlling for performance avoidance goals, as in the Approach group, however, the negative emotions were significantly reduced. This suggests that the psychological vulnerability of students who adopt high performance goals is due to its avoidance component.

On the math test, students pursuing Moderate Mastery and Approach goals achieved slightly higher than those endorsing Diffuse and Success Oriented goals. The results indicate that performance avoidance goals were detrimental to achievement, while mastery goals are beneficial for achievement regardless of whether combined with performance approach goals.

The findings of this study help to explain how performance goals impact students' learning. When high performance approach goals were accompanied with high performance avoidance goals, students showed high levels of achievement-related beliefs, engagement in their class and homework, and use of learning strategies. However, these students were less likely to control their effort and attention in the face of difficult and boring tasks in their study and they were relatively lower achieving and psychologically more vulnerable. This indicates that the avoidance aspect of performance goals affects students' learning outcomes in a maladaptive way (e.g., Elliot & Church, 1997; Elliot & McGregor, 2001; Middleton & Midgley, 1997; Pekrun, Elliot, & Maier, 2006). According to Elliot (Elliot & Church, 1997; Elliot & Harackiewicz, 1996), performance approach goals represent an approach form of regulation undergirded by both approach (achievement motivation) and avoidance (fear of failure) motive dispositions. The precise motivational nature of a performance approach goal in a given situation is presumably determined by the relative strength or accessibility of the two underlying motive dispositions activated by the situations. In everyday achievement situations, such as classroom settings, students face both challenges and threats, thus both motive dispositions may be activated and performance approach goals represent a combination of approach and avoidance tendencies. This position is supported by the moderate positive correlation between performance approach and avoidance goals and the relatively small number of students in the Approach cluster. However, if the avoidance component can be eliminated, such as in the Approach group, performance approach goals would represent pure approach tendencies in order to demonstrate competence and be generally beneficial for learning.

The findings of this study are particularly meaningful in the Singapore context. Singapore students pursue educational goals strongly because their success has very high instrumental value for their future success. Furthermore, education in Singapore is driven by assessment that identifies students by ability and offers them different education tracks. Although mastery of new knowledge and skills is very important for personal development, it is also crucial to outperform other students and succeed in examinations in order to get the opportunities and financial support for further education. In this educational environment, students, especially those who have experienced low achievement by Secondary 3, are likely to exhibit considerable anxiety about educational failure and negative affect about school. In addition, this anxiety and avoidance tendency may be reinforced by students' striving to achieve in order to satisfy their social needs in the Confucian culture, including both affiliation and comparison (Ang & Chang, 1997; Chang & Wong, 2008). Therefore performance approach and avoidance goals often go hand in hand for Singapore students; a relatively small portion of students pursue high mastery and performance approach goals. At the same time, the findings are also congruent with international studies that found students in some East Asian countries achieved relatively higher scores but also demonstrated relatively higher anxiety and lower self-concept than students from Western countries (e.g., J. Lee, 2009; Wilkins, 2004).

The present study also advances our understanding of the multiple goals perspective of achievement goal orientation. Researchers who advocate this perspective (Barron & Harackiewicz, 2001; Elliot & Harackiewicz, 1996; Harackiewicz et al., 2002; Harackiewicz et al., 2000) have proposed that there may be unique effects of both mastery and performance goals across multiple outcomes, that is, mastery goals may be adaptive for interest and emotional well-being and performance goals may be adaptive for achievement. In the present study students pursuing mastery and strong performance goals showed adaptive learning patterns in terms of learning beliefs, engagement, and strategies, but they were emotionally disadvantaged and likely to withdraw effort in the face of challenges. In contrast, students having high mastery and performance approach goals plus low performance avoidance goals demonstrated the most adaptive learning profiles: they were highest on math self-efficacy, subjective task values, class engagement, homework engagement, time management, meta-cognitive self-regulation, effort regulation, and achievement, and lowest on test anxiety and negative affect. Therefore, it is a combination of mastery and pure performance approach goals that constructs the most adaptive profile of achievement goals.

In general, the data in the present study suggests that the optimal motivational profile for Singapore secondary students in their math study is the simultaneous adoption of mastery and performance approach goals coupled with the absence of a performance avoidance orientation. The implications of the findings in the present study for educators are to encourage the adoption of mastery goals, support the adoption of performance approach goals that focus on the attainment of positive outcomes, and minimize the adoption of performance avoidance goals. This instrumental orientation may be more realistic and adaptive than simply encouraging mastery goals in competitive academic environments.

5.3 Limitations and future directions

The present study had several limitations. First, the design described students at one grade level and was not longitudinal so the data could not reveal whether achievement goals were causes or consequences of the eleven learning outcome variables. For example, although we treated motivational goals as predictors of self-efficacy, the latter could also be an antecedent of motivational goals (e.g., Elliot & Church, 1997). Some researchers posit that a student’s perceived task values might affect the student’s goal orientation (Wigfield, 1994; Wigfield & Eccles, 2002). More specifically, when individuals value a task primarily for intrinsic reasons, they may approach the task with a mastery goal orientation, whereas when they value the task primarily for utilitarian reasons, they may approach it with a performance orientation. It is also possible that motivational goals, learning beliefs, achievement, and emotional variables mutually affect each other in a dynamic process. Therefore, longitudinal studies should be conducted in the future to closely reveal the motivation process in self-regulated learning.

Second, this study examined the profiles of achievement goals of Singapore secondary students in their study of math. Further studies should be conducted to test the generalizability of the findings in other subjects and for other populations, e.g., at different ages and from different countries. In addition, in recent years, researchers have suggested that the approach/avoidance distinction may also apply to mastery goals (Elliot & McGregor, 2001; Pintrich, 2000a). There may be occasions when students are focused on avoiding misunderstanding or avoiding not learning or not mastering a task. However the avoidance component of mastery goals warrants more research in order to establish its construct validity (Pintrich, Conley, & Kempler, 2003). In the future, researchers are recommended to measure the avoidance components of both mastery and performance goals. Furthermore, more studies should be conducted to examine whether culture affects the levels and combinations of achievement goals. The role of culture in goal adoption is just beginning to be investigated. For example, Dekker and Fischer (2008) examined the relations between societal-level values and achievement goals. They found that embeddedness, a strong emphasis on maintaining the order and prestige of a group, was associated with performance goals, while egalitarianism, an emphasis on taking care of others and feeling a strong commitment to the well-being of other human beings, was associated with mastery goals. In the current study, we found that Singapore students had high mastery goals and they tended to endorse performance approach and avoidance goals simultaneously. This pattern may be found in other East Asian countries too.

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References

Ainley, M. D. (1993). Styles of engagement with learning: Multidimensional assessment of their relationship with strategy use and school achievement. *Journal of Educational Psychology, 85,* 395-405.

Ames, C. (1992). Classrooms: Goals, structures, and student motivation. *Journal of Educational Psychology, 84,* 261-271.

Ames, C., & Archer, J. (1988). Achievement goals in the classroom: Students' learning strategies and motivation processes. *Journal of Educational Psychology, 80*, 260-267.

Ang, R. P., & Chang, W. C. (1997). Impact of domain-specific and affiliation. *The Journal of Social Psychology*, *139*, 527-530.

Barcikowski, R. S. (1981). Statistical power with group mean as the unit of analysis. *Journal of Educational Statistics*, *6*(3), 267-285.

Barron, K. E., & Harackiewicz, J. M. (2001). Achievement goals and optimal motivation: Testing multiple goal models. *Journal of Personality and Social Psychology, 80*, 706-722.

Biggs, J. B. (1987). Student Approaches to Learning and Studying. *Research Monograph*, Australian Council for Educational Research.

Bong, M. (2001). Between- and within-domain relations of academic motivation among middle and high school students: Self-efficacy, task value, and achievement goals. *Journal of Educational Psychology, 93,* 23-24.

Bouffard, T., Vezeau, C., & Bordeleau, L. (1998). A developmental study of the relation between combined learning and performance goals and students' self-regulated learning. *British Journal of Educational Psychology, 68*, 309-319.

Chan, P. U., & Koh, J. B. K. (2000). Individualism and collectivism in Singapore. *Asian Psychologist, 2*(1), 15.

Chang, W. C., & Wong, K. (2008). Socially oriented achievement goals of Chinese university students in Singapore: Structure and relationships with achievement motives, goals and affective outcomes. *International Journal of Psychology, 43*(5), 880-885.

Church, M. A., Elliot, A. J., & Gable, S. L. (2001). Perceptions of classroom environment, achievement goals, and achievement outcomes. *Journal of Educational Psychology, 93*, 43-54.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences*. Hillsdale, NJ: Lawrence Erlbaum.

Daniels, L. M., Haynes, T. L., Stupnisky, R. H., Perry, R. P., Newall, N. E., & Pekrun, R. (2008). Individual differences in achievement goals: A longitudinal study of cognitive, emotional, and achievement outcomes. *Contemporary Educational Psychology, 2008*, 584-608.

Dekker, D., & Fischer, R. (2008). Cultural differences in academic motivation goals: A meta-analysis across 13 societies. *The Journal of Educational Research, 102*(2), 99-110.

Dweck, C. S. (1986). Motivational processes affecting learning. *American Psychologists, 41*, 1040-1048.

Dweck, C. S., & Leggett, E. (1988). A social-cognitive approach to motivation and personality. *Psychological Review, 95,* 256-273.

Eccles, J. S., Adler, T. F., Futterman, R., Goff, S. B., Kaczala, C. M., Meece, J. L., et al. (1983). Expectancies, values and academic behaviors. In J. T. Spence (Ed.), *Achievement and achievement motives* (pp. 75-146). San Francisco: W. H. Freemen.

Eccles, J. S., & Wigfield, A. (1995). In the mind of the actor: The structure of adolescents' achievement task values and expectancy-related beliefs. *Personality and Social Psychology Bulletin*, *21*, 215-225.

Elliot, A. J., & Church, M. (1997). A hierarchical model of approach and avoidance achievement motivation. *Journal of Personality and Social Psychology, 72*, 218-232.

Elliot, A. J., & Harackiewicz, J. M. (1996). Approach and avoidance achievement goals and intrinsic motivation: A mediational analysis. *Journal of Personality and Social Psychology, 72*, 218-232.

Elliot, A. J., & McGregor, H. A. (2001). A 2 X 2 achievement goal framework. *Journal of Personality and Social Psychology, 80*(3), 501-519.

Elliot, A. J., McGregor, H. A., & Gable, S. L. (1999). Achievement goals, study strategies, and exam performance: A mediational analysis. *Journal of Educational Psychology, 91*(3), 549-563.

Elliott, E. S., & Dweck, C. S. (1988). Goals: An approach to motivation and achievement. *Journal of Personality and Social Psychology, 54,* 5-12.

Goh, C. T. (1997). *Shaping our future: Thinking schools, learning nation.* Speech presented at the opening of the 7th international conference of thinking, Singapore.

Harackiewicz, J. M., Barron, K. E., Carter, S. M., Lehto, A. T., & Elliot, A. J. (1997). Predictors and consequences of achievement goals in the college classroom: Maintaining interest and making the grade. *Journal of Personality and Social Psychology, 73*, 1284-1295.

Harackiewicz, J. M., Barron, K. E., & Elliot, A. J. (1998). Rethinking achievement goals: When they are adaptive for college students and why? *Educational Psychologist, 33*, 1-21.

Harackiewicz, J. M., Barron, K. E., Pintrich, P. R., Elliot, A. J., & Thrash, T. M. (2002). Revision of achievement goal theory: Necessary and illuminating. *Journal of Educational Psychology, 94*, 638-645.

Harackiewicz, J. M., Barron, K. E., Tauer, J. M., Carter, S. M., & Elliot, A. J. (2000). Short-term and long-term consequences of achievement goals in college: Predicting continued interest and performance over time. *Journal of Educational Psychology, 92,* 316-330.

Kaplan, A., & Middleton, M. J. (2002). Should childhood be a journal or a race? A response to Harackiewicz et al. (2002). *Journal of Educational Psychology, 96,* 646-648.

Lee, H. L. (2004). *Our future of opportunity and promise*. Speech presented at the 2004 National Day Rally, Singapore.

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.

Lopez, D. F. (1999). Social cognitive influences on self-regulated learning: The impact of action-control beliefs and academic goals on achievement related outcomes. *Learning and Individual Differences, 11*, 301-319.

Luo, W., Hogan, D., & Paris, S. G. (2010). Predicting Singapore students' achievement goals in their English study: Self-construal and classroom goal structure. *Mamuscipt submitted for publication.*

Magidson, J., & Vermunt, J. K. (2002). Latent class models for clustering: A comparison with K-means. *Canadian Journal of Marketing Research, 20*, 37-44.

Magidson, J., & Vermunt, J. K. (2004). Latent class models. In D. Kaplan (Ed.), *The Sage handbook of quantitative methodology for the social sciences* (pp. 175-198). Thousand Oaks: Sage Publications.

Martin, A. J. (2007). Enhancing student motivation and engagement: The effects of a multidimensional intervention. *Contemporary Educational Psychology, 33*, 239-269.

Meece, J. L., Blumenfeld, P. C., & Hoyle, R. H. (1988). Students' goal orientations and cognitive engagement in classroom activities. *Journal of Educational Psychology, 80,* 514-523.

Meece, J. L., & Holt, K. (1993). A pattern analysis of students' achievement goals. *Journal of Educational Psychology, 85*, 582-590.

Middleton, M., & Midgley, C. (1997). Avoiding the demonstration of lack of ability: An underexplored aspect of goal theory. *Journal of Educational Psychology, 89*, 710-718.

Midgley, C., Arunkumar, R., & Urdan, T. (1996). If I don't do well tomorrow, there's a reason: Predictors of adolescents' use of academic self-handicapping behavior. *Journal of Educational Psychology, 88,* 423-434.

Midgley, C., Kaplan, A., & Middleton, M. (2001). Performance approach goals: good for what, for whom, under what circumstances, and at what cost? *Journal of Educational Psychology, 93*, 77-86.

Midgley, C., Kaplan, A., Middleton, M., Maehr, M. L., Urdan, T., Anderman, L. H., et al. (1998). The development and validation of scales assessing students' achievement goal orientations. *Contemporary Educational Psychology, 23*, 113-131.

Midgley, C., Maehr, M. L., Hruda, L. Z., Anderman, E., Anderman, L., & Freeman, K. E. (2000). *Manual for the Patterns of Adaptive Learning Scales (PALS).* Ann Arbor: University of Michigan.

Nicholls, J. G. (1984). Achievement motivation: Conceptions of ability, subjective experience, task choice, and performance. *Psychological Review, 91*, 328-346.

Nolen, S. B. (1988). Reasons for studying: Motivation orientation and study strategies. *Cognition and Instruction, 5,* 269-287.

Pajares, F., Britner, S. L., & Valiante, G. (2000). Relation between achievement goals and self-beliefs of middle school students in writing and science. *Contemporary Educational Psychology, 25*, 406-422.

Pekrun, R., Elliot, A. J., & Maier, M. A. (2006). Achievement goals and discrete emotions: A theoretical model and prospective test. *Journal of Educational Psychology, 98*, 583-597.

Pintrich, P. R. (2000a). An achievement goal theory perspective on issues in motivation terminology, theory, and research. *Contemporary Educational Psychology, 25*, 92-104.

Pintrich, P. R. (2000b). Multiple goals, multiple pathways: The role of goal orientation in learning and achievement. *Journal of Educational Psychology, 92*, 544-555.

Pintrich, P. R., Conley, A. M., & Kempler, T. M. (2003). Current issues in achievement goal theory and research. *International Journal of Educational Research, 39*, 319-337.

Pintrich, P. R., & Garcia, T. (1991). Student goal orientation and self-regulation in the college classroom. In M. L. Maehr & P. R. Pintrich (Eds.), *Advances in motivation and achievement: Goals and self-regulatory processes* (Vol. 7, pp. 371-402). Greenwich, CT: JAI.

Pintrich, P. R., & Schunk, D. H. (2002). *Motivation in education: Theory, research, and applications*. Upper Saddle River, NJ: Prentice Hall.

Pintrich, P. R., Smith, D. A. F., Garcia, T., & McKeachie, W. J. (1993). Reliability and predictive validity of the motivated strategies for learning questionnaire (MSLQ). *Educational and Psychological Measurement, 53*, 801-813.

Raudenbush, S. W., & Bryk, A. S. (2002). *Hierarchical linear models: Application and data analysis methods* (2 ed.). Newbury Park, CA: Sage.

Ryan, A. M., Hicks, L., & Midgley, C. (1997). Social goals, academic goals, and avoiding seeking help in the classroom. *Journal of Early Adolescence, 17*, 152-171.

Ryan, A. M., & Pintrich, P. R. (1997). "Should I ask for help?" The role of motivation and attitudes in adolescents' help seeking in math class. *Journal of Educational Psychology, 89*, 329-341.

Skaalvik, E. M. (1997). Self-enhancing and self-defeating ego orientation: Relations with task and avoidance orientation, achievement, self-perceptions, and anxiety. *Journal of Educational Psychology, 89*, 71-81.

Tapola, A., & Niemivirta, M. (2008). The role of achievement goal orientations in students' perceptions of and preferences for classroom environment. *British Journal of Educational Psychology, 78*, 291-312.

Tu, W., Hejtmanek, M., & Wachman, A. (1992). *The Confucian world observed: A contemporary discussion of Confucian humanism in East Asia*. Honolulu, Hawaii: East-West Center.

Urdan, T. (1997). Achievement goal theory: Past results, future directions. In M. L. Maehr & P. R. Pintrich (Eds.), *Advances in motivation and achievement* (Vol. 10, pp. 99-141). Greenwich, CT: JAI Press.

VanDamme, J., Bieke, D. F., Van Landeghem, G., Opdenakker, M. G., & Onghena, P. (2002). A new study on educational effectiveness in secondary schools in Flanders: An introduction. *School Effectiveness and School Improvement, 13*(4), 383-397.

Vermunt, J. K., & Magidson, J. (2010). Latent GOLD 4.5: Statistical Innovations.

Wellborn, J. G., & Connell, J. P. (1987). *Manual for the Rochester assessment package for schools*. Rochester, NY: University of Rochester.

Wentzel, K. R. (1993). Motivation and achievement in early adolescence: The role of multiple classroom goals. *Journal of Early Adolescence, 13*, 4-20.

Wigfield, A. (1994). Expectancy-value theory of achievement motivation: A developmental perspective. *Educational Psychology Review, 6*, 49-78.

Wigfield, A., & Eccles, J. S. (2002). The development of competence beliefs, expectancies for sucssess, and achievement values from childhood through adolescence. In A. Wigfield & J. S. Eccles (Eds.), *Development of achievement motivation* (pp. 91-120).

Wigfield, A., Eccles, J. S., Yoon, K. S., Harold, R. D., Arbreton, A. J. A., Freedman-Doan, C., et al. (1997). Changes in children's competence beliefs and subjective task values across the elementary school years: A 3-year study. *Journal of Educational Psychology*, *89*(3), 451-469.

Wigfield, A., Tonks, S., & Eccles, J. S. (2004). Expectancy-value theory in cross-cultural perspective. In D. M. McInerney & S. V. Etten (Eds.), *Big theories revisited* (pp. 165-198). Greenwich, CT: Information Age Publishing.

Wilkins, J. M. (2004). Mathematics and science self-concept: An international investigation. *The Journal of Experimental Education, 72*(4), 331-346.

Wolters, C. A., Yu, S. L., & Pintrich, P. R. (1996). The relation between goal orientation and students' motivational beliefs and self-regulated learning. *Learning and Individual Differences*, *8*, 211-238.

Table 1

Descriptive Statistics and Variance Decomposition across Levels

Variables	*M*	*SD*	Level 1 Variance	Level 2 Variance	Level 3 Variance	Level 2 /Total	Level 3 /Total
Mastery goals	3.62	.74	.90	.09	.00	.09	.00
Performance approach goals	3.09	.98	.98	.02	.01	.02	.01
Performance avoidance goals	2.71	.90	.93	.04	.03	.04	.03
Self-efficacy	3.77	.70	.93	.06	.01	.06	.01
Subjective task values	3.90	.78	.91	.08	.01	.08	.01
Class engagement	3.83	.75	.92	.08	.00	.08	.00
Homework engagement	3.38	.72	.94	.06	.00	.06	.00
Time management	3.55	.86	.97	.03	.00	.03	.00
Meta-cognitive self-regulation	3.47	.82	.97	.03	.00	.03	.00
Effort regulation	3.23	.94	.90	.06	.03	.06	.03
Test anxiety	3.53	.96	.99	.01	.00	.01	.00
Positive affect	3.70	.93	.96	.01	.02	.01	.02
Negative affect	2.91	.93	1.00	.00	.00	.00	.00
Current math score	13.21	5.71	.32	.44	.18	.47	.19
Previous math score	5.25	1.20	.61	.19	.16	.20	.17

Table 2

Correlation Coefficients between the 15 Measured Variables

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1 Mastery goals	--													
2 Performance approach goals	.24*	--												
3 Performance avoidance goals	.07	.55*	--											
4 Self-efficacy	.62*	.24*	.00	--										
5 Subjective task values	.70*	.12*	-.00	.55*	--									
6 Class engagement	.52*	.10*	-.05	.45*	.43*	--								
7 Homework engagement	.56*	.10*	-.02	.43*	.47*	.66*	--							
8 Time management	.48*	.17*	.07	.41*	.39*	.55*	.60*	--						
9 Meta-cognitive self-regulation	.53*	.22*	.09*	.48*	.42*	.48*	.49*	.60*	--					
10 Effort regulation	.22*	-.07	-.21*	.21*	.21*	.24*	.29*	.15*	.18*	--				
11 Test anxiety	-.10*	.10*	.21*	-.18*	-.08*	-.02	-.04	.01	-.03	-.23*	--			
12 Positive affect	.18*	.09*	.04	.15*	.14*	.16*	.14*	.21*	.19*	.03	-.05	--		
13 Negative affect	-.03	.10*	.15*	-.05	-.05	-.05	-.03	-.02	-.02	-.18*	.17*	-.23*	--	
14 Current math score	.10*	-.05	-.19*	.19*	.09*	.12*	.11*	.09*	.11*	.08*	-.15*	-.06	-.09*	--
15 Previous math score	.05	.01	-.10*	.15*	.05	.01	.03	.01	.06	.04	-.17*	-.07	-.06	.53*

Note. * $p < .001$

Table 3

Information Criteria Values for the 10 Models

Models	No of parameters	BIC	CAIC
1-Cluster	60	26883.35	26943.35
2-Cluster	64	26385.25	26449.25
3-cluster	68	26267.67	26335.67
4-cluster	72	26201.55	26273.55
5-cluster	76	26168.91	26244.91
6-cluster	80	26152.97	26232.97
7-cluster	84	26156.93	26240.93
8-cluster	88	26168.39	26256.39
9-cluster	92	26182.93	26274.93
10-cluster	96	26196.95	26292.95

Note. BIC = Bayesian information criterion; CAIC = consistent Akaike information criterion.

Table 4

Frequency and Means for Each Cluster

Clusters	**Frequency**			**Mastery goals**		**Performance approach goals**		**Performance avoidance goals**	
	Total	Male	Female	*M*	*SD*	*M*	*SD*	*M*	*SD*
Diffuse	792	355	437	3.46	.68	3.03	.51	2.84	.53
Moderate Mastery	446	167	279	3.52	.79	2.00	.57	1.76	.52
Success Oriented	377	223	154	3.94	.66	4.30	.47	3.76	.58
Approach	82	40	42	4.39	.48	4.13	.43	1.78	.43
Total	1697	785	912	3.62	.74	3.09	.98	2.71	.90

Table 5

Effect Sizes and Significances of Previous Achievement, Gender, and Cluster and Cluster Means

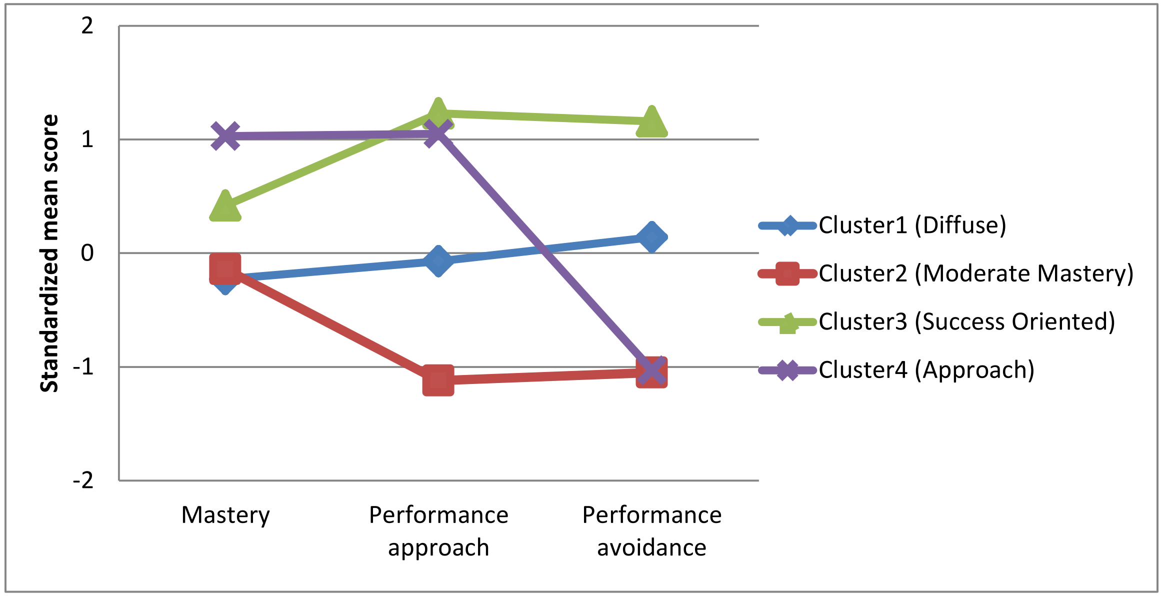
	Partial η^2			***M (SD)* for each cluster**			
	PSLE math	Gender	Cluster	Diffuse	Moderate Mastery	Success Oriented	Approach
Self-efficacy	.02*	.00	.08*	3.63 (.67)[a]	3.69 (.69)[a]	4.01 (.66)	4.34 (.56)
Subjective task values	.00	.01	.06*	3.75 (.77)[a]	3.89 (.78)[a]	4.10 (.72)	4.51 (.59)
Class engagement	.00	.00	.03*	3.73 (.73)[a]	3.84 (.78)[ab]	3.94 (.76)[b]	4.27 (.59)
Homework engagement	.00	.00	.03*	3.29 (.66)[a]	3.38 (.77)[ab]	3.50 (.74)[b]	3.74 (.73)
Time management	.00	.00	.05*	3.41 (.78)[a]	3.47 (.92)[a]	3.85 (.85)[b]	3.89 (.75)[b]
Meta-cognitive self-regulation	.00	.00	.06*	3.34 (.75)[a]	3.35 (.84)[a]	3.76 (.83)[b]	3.96 (.72)[b]
Effort regulation	.00	.00	.02*	3.20 (.88)[ab]	3.36 (.92)[ac]	3.03 (1.05)[b]	3.64 (.95)[c]
Test anxiety	.03*	.01*	.03*	3.57 (.90)[a]	3.36 (.96)[b]	3.72 (1.00)[a]	3.07 (1.07)[b]
Positive affect	.00	.00	.01	3.65 (.89)[a]	3.65 (.95)[a]	3.85 (.96)[a]	3.70 (1.03)[a]
Negative affect	.00	.00	.03*	2.90 (.87)[a]	2.77 (.94)[a]	3.15 (.97)	2.72 (.93)[a]
Current math score	.28*	.01*	.01*	12.97 (5.74)[ab]	14.17 (5.52)[a]	12.32 (5.52)[b]	14.48 (6.32)[ab]

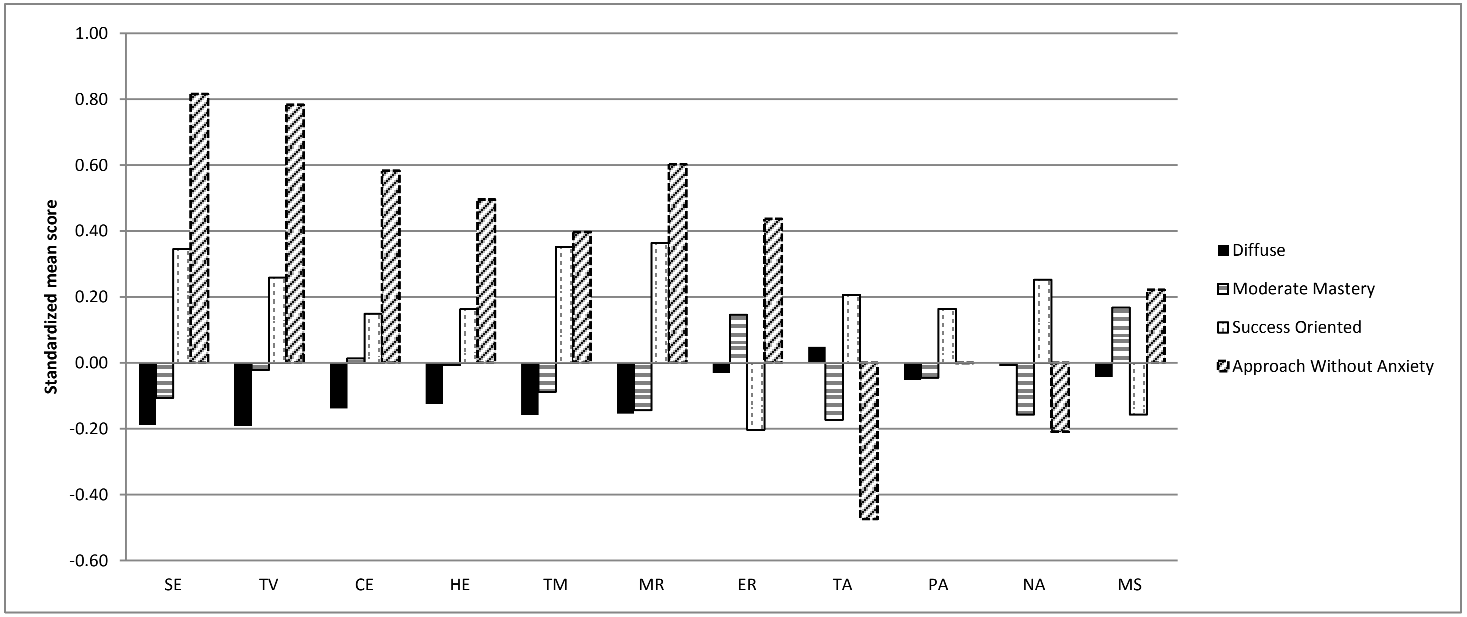
Note. * $p < .001$. The clusters with the same superscript of [a], [b] or [c] are not significantly different from each other on the outcome variables.

Figure Captions

Figure 1. The standardized mean scores on achievement goals across the four clusters.

Figure 2. The standardized mean scores on learning outcomes across the four clusters.


2
1
0
-1
-2
Standardized mean score
Mastery
Performance approach
Performance avoidance
Cluster1 (Diffuse)
Cluster2 (Moderate Mastery)
Cluster3 (Success Oriented)
Cluster4 (Approach)



Note. SE = self-efficacy; TV = subjective task values; CE = class engagement; HE = homework engagement; TM = time management; MR = meta-cognitive self-regulation; ER = effort regulation; TA = test anxiety; PA = positive affect; NA = negative affect; MS = current math achievement.