The Measurement Structure, Stability and Mediating Effects of Achievement Goals in Math with Middle-School Student Data

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Published online: 14 Nov 2012.

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This study examined the measurement structure, cross-year stability of achievement goals, and mediating effects of achievement goals between self-efficacy and math grades in a national sample of Taiwan middle school students. The measurement model with factorial structure showed good fit to the data. In the panel data (N = 343), four achievement goals showed strong measurement invariance, suggesting factor loadings and intercepts of the items remained invariant across a year. Though mean scores of the four latent achievement goals held quite stable, the rank order of students across two time-points changed more profoundly in the two avoidance goals than in the approached goals. In the cross-sectional data (N = 748), we found approach-based goals were positive mediators between self-efficacy and math grades while avoidance-based goals were negative mediators. This result could be relevant for middle-school students in learning mathematics. Some instructional implications are provided.

Keywords: achievement goals, self-efficacy, math grades, measurement invariance, stability

In recent decades, researchers in education have paid increasing attention to the important role of learning motivation in students' academic engagement (e.g., Elliot & Church, 1997; Metallidou & Vlachou, 2010; Pintrich, Conley, & Kempler, 2003), with the two pivotal concepts in achievement motivation theories being self-efficacy (Bandura, 1993; 1997) and achievement goals (Elliot & Church, 1997; Elliot & McGregor, 2001). According to Bandura (1993), self-efficacy contributes to motivation and determines the goals that individuals set for themselves. Achievement goals refer to the purpose (Maehr, 1989), or cognitive-dynamic focus (Elliot, 1999), of task engagement and competence-relevant behavior. According to Elliot and Church (1997), achievement goals can be conceptualized as midlevel constructs that are situated structurally between global motivational dispositions

(e.g., achievement motivation) and specific behaviors (e.g., achievement attainment). Empirical research has shown that perceived competence (which can also be described as self-efficacy) influences achievement goals and learning outcomes (e.g., Ames & Archer, 1988; Elliot & McGregor, 2001). Other studies have examined the time stability of the achievement goal model (e.g., Fryer & Elliot, 2007; Muis & Edwards, 2009) by exploring the longitudinal relations between achievement goals and their related outcome variables (e.g., Halvari, Skjesol & Bagøien, 2011; Mägi et al., 2010). Following these research directions, we examined the measurement structure, the cross-year stability of the 2×2 achievement goal model (Elliot & McGregor, 2001), and the mediating effects of achievement goals on the relationship between a motive (self-efficacy) and a learning outcome (course grades) in a sample of Taiwanese middle-school students.

In this study, we focused on the motivation and goals of middle-school students in math learning. According to the 2007 Trends in International Math and Science Study (TIMSS 2007), the Taiwanese eighth-graders ranked first in math among the middle-school students in participating countries. However, based on the TIMSS 2007 findings, only 37% of Taiwanese students expressed a high level of positive affect toward math ("I enjoy learning math"). This figure is far below the average (54%) of all participating countries. Furthermore, less than 30% of the Taiwanese middle school students surveyed expressed a high level of self-confidence in their math achievement ("I usually do well in math"), compared to the international average of 43%. A similar report published by the National Science Council of Taiwan revealed that 46–58% of Taiwanese eighth graders have reported a dislike for math in the past five years (Taiwan National Science Council press release, 2005). Thus, our study represented an opportunity to examine the degree to which the 2×2 achievement goal model (Elliot & McGregor, 2001) applies to this unique sample.

Achievement Goals and Their Measurement

With competence as the core concept underlying achievement goals, the 2×2 achievement goal framework proposed by Elliot and McGregor (2001) comprises two fundamental and independent dimensions: (1) how competence is defined (mastery versus performance), and (2) the valence of competence (approach versus avoidance). These two dimensions result in the 2×2 achievement goal framework (four goals): Mastery-approach goals (with a focus on developing task-based or intrapersonal competence), mastery-avoidance goals (with a focus on avoiding task-based or intrapersonal incompetence), performance-approach goals (with a focus on attaining normative competence), and performance-avoidance goals (with a focus on avoiding normative incompetence) (Elliot & McGregor, 2001; Elliot & Murayama, 2008). The concept of mastery-based goals in the trichotomous achievement goal model (Elliot & Church, 1997) corresponds closely to the concept of mastery-approach goals in the 2×2 achievement goal model (Elliot & McGregor, 2001).

The achievement goal questionnaire (AGQ) was developed by Elliot and McGregor (2001) to assess the four types of goals in the 2×2 achievement goal framework in a series of studies that examined the feasibility of the four-goal model. Exploratory and confirmatory factor analyses were used to provide empirical support for goal differentiation in American university students. In the current study, we tested the measurement model for AGQ-C (Chinese version), the stability of achievement goal endorsement from one year to the next, and the mediating effects of achievement goals (as described in the 2×2 model) in a sample of Taiwanese middle-school students.

Stability of Achievement Goal Endorsement

According to Fryer and Elliot (2007), achievement goals emerge from stable factors (e.g., personality traits such as achievement motives and temperament) and remain grounded in these factors throughout the processes of goal pursuit and regulation. There are at least three types of stability that can be examined using longitudinal panel data: These are structural stability, differential stability, and mean-level stability (Fryer & Elliot, 2007; Sayer & Cumsille, 2001; Zimprich & Mascherek, 2010). Structural stability refers to the constancy of covariances among a set of constructs across time. Several degrees of measurement invariance must be examined (Meredith, 1993). Configural invariance demands that the number of factors and associated significant and non-significant loadings be equal over time, which guarantees identical dimensionality across the goals. For weak measurement invariance (MI) to hold, factor loadings must be equal across two measurement occasions. In such a case, factor variances and covariances can be compared. If, in addition, the intercepts of the observed indicators are equal, then strong MI will result and, in turn, allow the comparison of factor means. Furthermore, if residual variances are equal, then strict MI holds, implying that all inter-individual differences in observed variables stem from the same underlying factors (Bollen, 1989; Meredith & Horn, 2001). Fryer and Elliot (2007) conducted a confirmatory factor analysis to compare the MI corresponding to the achievement goals of college students over a period of several weeks. Fit indices were tested in a series of four nested models with increasing constraints: Configural invariance, weak MI, strong MI, and strict MI. The fit indices were compared across the models, with a significant decrease in model fit seen as an indicator that the model with fewer constraints should be chosen (Conroy, Elliot, & Hofer, 2003). Strong MI is considered sufficient for the comparison of scores across time points (Sayer & Cumsille, 2001; Zimprich & Mascherek, 2010). Fryer and Elliot (2007) found no significant decrease in model fit when the constraints were added to form weak and strong MIs. However, when the constraints were further increased to form strict MI, a significant reduction in model fit was observed. In this case, changes in achievement goals over time can be interpreted as true changes, rather than measurement errors due to the strong MI. Similarly, examining the MI between comparison and nested models with a sample of 179 Estonian primary school students, Mägi et al. (2011) found that achievement goals in the math domain were invariant over the course of a year.

Differential stability concerns the preservation of an individual's relative placement (rank order) within a group across time. In other words, the construct refers to the consistency of individual differences in terms of a particular attribute in a group of people over time. Different people may change to varying extents across time. Researchers studying achievement goals have examined differential stability with the Pearson product–moment correlation (e.g., Fryer & Elliot, 2007; Anderman & Midgley, 1997). For example, Fryer and Elliot (2007) reported intercorrelations among the four goals ranging from .57 to .75, with the correlation coefficients being significant and positive with moderate to high magnitudes. Moderate-to-high correlations indicate that, when college students complete sequence of similar tasks over a relatively short learning period, individuals' relative placement (goal endorsement) tends to be consistent.

Mean-level stability describes the extent to which the mean level of a construct changes over time within a sample (Fryer & Elliot, 2007). In terms of achievement goal endorsement, mean-level stability refers to the sample-level change between two time points and is typically examined with a paired-samples t test. This index provides information regarding the

absolute amount of change in a construct. Comparing across three time points, Fryer and Elliot (2007) provided evidence of mean-level stability for performance–approach and mastery–avoidance goals, but reported significant shifts for mastery–approach and perform-ance–avoidance goals.

Achievement Goals, Self-Efficacy and Grades

According to Bandura (1986, p. 391), self-efficacy is defined as "people's judgments of their capabilities to organize and execute courses of action required to attain designated types of performances". Social cognitive theorists (Pintrich & DeGroot, 1990; Schunk, 1981) suggest that self-efficacy has motivational influences that are especially germane to student achievement. In particular, students with low self-efficacy for learning tend to adopt avoid-ance goals and expend less effort than they could afford, whereas students with high self-efficacy for learning tend to adopt approach goals and actively participate in tasks in which they can succeed (Bandura, 1986; Schunk, 1990). Furthermore, Elliot's (1999) hierarchical model of achievement motivation suggests that self- and competence-based vari-ables (e.g., competence expectancy or self-efficacy) have a direct impact on achievement goals, which, in turn, serve as proximal precursors to achievement-related processes and outcomes.

In the past, the effect of self-efficacy on achievement goals (e.g., Liem, Lau, & Nie, 2008) and the effect of achievement goals on academic performance (e.g., Zusho, Pintrich, & Cortina, 2005) were often examined separately. Pajares, Britner, & Valiante (2000) and Liem, Lau, & Nie (2008) reported positive relationships between self-efficacy and mastery (-approach) goals and between self-efficacy and performance-approach goals, but a negative relationship between self-efficacy and performance-avoidance goals. Consistent results were found among high-school students in Sydney (Smith, Sinclair, & Chapman, 2002), Korean middle/high-school students (Bong, 2001), and American middle-school students (Wolters, 2004). Recently, Diseth (2011) examined the roles of self-efficacy and achievement goals as mediators between initial and final academic achievement among Norwegian undergradu-ate students. Findings suggest that self-efficacy exerts positive effects on both mastery goals and performance-approach goals, whereas only performance-approach goals served as a mediator between self-efficacy and grades.

With respect to the effect of achievement goals on academic performance, research find-ings have been mixed (Linnenbrink-Garcia, Tyson, & Patall, 2008; Hulleman, Schrager, Bodmann, & Harackiewicz, 2010). The majority of findings show that performance-approach goals are positive predictors and performance-avoidance goals are negative predictors of student achievement (e.g., Elliot & McGregor, 2001; Zusho, Pintrich, & Cortina, 2005). Mastery-avoidance goals have not been found to be predictive of performance (e.g., Cury, Elliot, Fonseca & Moller, 2006; Elliot & McGregor, 2001), and the predictive effects of mastery(-approach) goals on achievement are also mixed. Specifically, although some studies did not find mastery(-approach) goals to predict performance (Elliot & McGregor, 2001; Zusho, Pintrich, & Cortina, 2005), others found the opposite (e.g., Chan, 2008; Shih, 2005; Tanaka, Takehara & Yamauchi, 2006). Studying Estonian primary school students' performance in the math domain, Mägi et al. (2011) reported that only perform-ance-avoidance goals (among the trichotomous goals) had a negative effect on grades. In the current research, we examined the effects of the 2×2 achievement goals on math grades.

Overview and Hypotheses

The aim of this study was to analyze the adequacy of factor structures, the cross-year stability of the 2×2 achievement goals, and the mediating effects of the 2×2 achievement goals on self-efficacy and grades in math based on data from Taiwanese middle-school students. First, a confirmatory factor analysis was performed to examine the factorial structure of the 2×2 achievement goals. We expected the hypothesized factorial model to provide a good fit to the data.

Second, three types of stability—structural stability, differential stability, and mean-level stability (Fryer & Elliot, 2007; Sayer & Cumsille, 2001; Zimprich & Mascherek, 2010)—were tested to examine the stability of achievement goals from one year (seventh grade) to the next (eighth grade). We expected the structural stability of achievement goals to be confirmed and the AGQ-C to demonstrate at least strong measurement invariance (Sayer & Cumsille, 2001; Zimprich & Mascherek, 2010). Moderate to high correlations were expected to account for the differential stability over time. We also expected the mean-level stability to be confirmed, with paired *t*-tests showing no significant differences between two time points for all four achievement goals.

Finally, we investigated a structural model to test the role of the four achievement goals as mediators of the relationship between math self-efficacy and math grades. We expected math self-efficacy to have a positive effect on both mastery-approach goals and performance-approach goals, which, in turn, would positively predict math grades. Additionally, we expected math self-efficacy to have a negative effect on performance-avoidance goals and mastery-avoidance goals, which, in turn, would negatively predict math grades.

Methods

Participants and Procedure

We compiled data on Taiwanese adolescent students' schooling performance and physical and mental development (PAMD) in 2007 and 2008. A total of 38 middle schools from four regions in Taiwan were randomly selected, with one class from each school randomly selected to participate.

The test of factorial structure and the mediation analyses were based on the 2007 sample. This sample consisted of 748 seventh graders who were between 13 and 14 years of age (mean age = 13.4), of whom 389 were girls (52%) and 359 boys (48%). Participants completed questionnaires assessing math self-efficacy in the first week of the study and questionnaires assessing achievement goals (AGQ-C) two weeks later. Semester grades in math were obtained from schools at the end of the semester.

The goal stability analyses were performed across two consecutive years on 343 students (170 girls 49.6% and 173 boys 50.4%) from the original 748 middle school students sampled in 2007. The seventh-graders in 2007 became the eighth-graders in the following academic year. The students were instructed to complete the AGQ-C during the mid-spring semester in 2007 (Time 1) and during the mid-spring in semester 2008 (Time 2).

Measures

Achievement Goal Questionnaire. Elliot and McGregor (2001)'s Achievement Goal Questionnaire (AGQ) was translated into Chinese and tailored to math learning (AGQ-Cm). The questionnaire consists of 12 items (with three items for each achievement goal), to which

participants responded using a 5-point scale. An expert on educational measurement back-translated the AGQ-Cm into English and found the result satisfactory. Reliability (alpha coefficients of internal consistency) for the four achievement goal subscales ranged from .72 to .85 (see Table 1). Confirmatory factor analyses were used to validate the scales. The factorial structure of achievement goals is described in the results section.

Math self-efficacy scale. We translated and adapted the self-efficacy subscale in Pintrich and DeGroot's (1990) Motivated Strategies for Learning Questionnaire (MSLQ) for use in this study. Back-translation suggested that the MSLQ-Chinese is of good quality. The math self-efficacy scale evaluates whether participants are confidently mastering the concepts and skills taught in their math classes. A sample item is "I am sure that I can do an excellent job in my math class". Participants responded to each item using a 5-point scale. The measurement model was specified as all items loaded on a single latent factor—math self-efficacy. The Cronbach's alpha was high (.90). A confirmatory factor analysis was conducted, yielding fit indices of $\chi^2_{(20, N=748)} = 239.23$ ($p < .01$), RMSEA = .01, CFI = .98, IFI = .98, AGFI = .94. Although it was possible for the significant Chi-square value to have resulted from the large sample size (N = 784), all the other indices suggested an acceptable model fit.

Math grades. Semester grades in math were used to represent participants' overall math performance. In Taiwan, the "Grade 1–9 Curriculum" (implemented since 2003—a detailed description is available at http://teach.eje.edu.tw/9CC/) is the unified curriculum framework guiding instructional practices from grade one (primary school) to nine (middle school) across the whole country. All schools are required to follow the content progression mandated by the framework. Grade evaluation policies, though regulated by Education Administration Bureaus at the county/city level, are very similar across the whole country. This is because at the end of the ninth grade, a unified entrance examination is used as a selection mechanism for high-school entry. Math grades were obtained from the official student record storage system in each school district and converted to T scores based on class norms.

Table 1

Descriptive statistics, alpha coefficients of and zero-order correlations among math self-efficacy, achievement goals, and math grades (N =748, in year 2007)

	M	SD	1	2	3	4	5	6
1. Mathematics self-efficacy	2.92	.97	(.90)					
2. Mastery-approach goals	3.55	.92	.44**	(.85)				
3. Mastery-avoidance goals	3.16	.94	−.17**	.25**	(.77)			
4. Performance-approach goals	3.12	.99	.49**	.61**	.19**	(.80)		
5. Performance-avoidance goals	2.96	.95	−.15**	.10**	.32**	.14**	(.72)	
6. Math grades	50.00	9.75	.52**	.31**	−.11**	.36**	−.11**	–

Note. * $p < .05$; ** $p < .01$; ( ) alpha coefficients of internal consistency

Results

Descriptive Analyses and Zero-Order Correlations in the Cross-Sectional Sample

Table 1 presents the intercorrelations among all variables and descriptive statistics. The mean math self-efficacy (MSE) was 2.92, with the means ranging from 2.96 to 3.55 for the four achievement goals. The intercorrelations among four latent achievement goals were all significant and positive ($p < .01$). Moderate to large positive correlations were found between mastery-approach (MA) goals and performance-approach (PA) goals (r = .61, $p < .01$) and between mastery-avoidance (MV) goals and performance-avoidance (PV) goals (r = .32, $p < .01$). Several low intercorrelations were observed, such as that between MA and PV goals (r = .10, $p < .01$). Significant positive correlations were also found between the following latent variables: MSE and MA goals (r = .49, $p < .01$), MSE and PA goals (r = .44, $p < .01$), and MSE and math grades (r = .52, $p < .01$).

Factorial Structure of Achievement Goals

Confirmatory factor analyses were conducted on AGQ-Cm using LISREL 8.80 according to procedures described by Jöreskog and Sörbom (1993). The hypothetical model was specified with each set of three items (of the 12 items) loading on its respective latent factor: MA goals, MV goals, PA goals, and PV goals. Four types of fit indices were used to assess the overall fit of the model. The criteria adopted to examine the adequacy of model fit were: RMSEA≦.08 (Steiger, 1989; Browne & Mels, 1990), CFI≧.95 (Bentler, 1990; Hu & Bentler, 1995), IFI≧.90 (Browne & Cudeck, 1993), AGFI≧.80 (Marsh, Balla, & McDonald, 1988). All of the factor loadings were high (ranging from .57 to .89, $p < .01$), lending support for the hypothetical model. Although the significant Chi-square value may have been caused by our large sample size (West, Finch, & Curran, 1995), $\chi^2_{(48,\ N=748)} = 131.13$, $p < .01$, all of the other indices indicated an acceptable model fit: RMSEA = .05; CFI = .98; IFI = .98; AGFI = .91. Thus, our results demonstrated a fairly acceptable fit between the model and data. In other words, Taiwanese seventh-graders viewed the four achievement goals as distinct in the context of math learning.

Stability of Achievement Goal Endorsement in the Panel Sample

Reliability coefficients for the four achievement goal subscales at Time 1 and Time 2 were .83/.88, .77/.85, .88/.80, and .69/.82. Table 2 presents descriptive statistics, alpha coefficients, and zero-order correlations of indicators with respect to the four achievement goals between Time 1 and Time 2.

We examined the structural stability, differential stability and mean-level stability of goal endorsement in middle school students. CFA was used to compare the fit indices for a series of nested models with increasing constraints.

Structural stability. Model comparison was performed on a series of nested models with increasing constraints: Configural invariance (Model 1), weak measurement invariance (MI) (Model 2), strong MI (Model 3), and strict MI (Model 4). The difference between Model 1 and Model 2 (as measured by the Chi-square statistic) was not significant, indicating that weak MI was held. The difference between Model 2 and Model 3 was also non-

Table 2

Descriptive statistics, alpha coefficients of and zero order correlations of indicators of achievement goals over Time 1 and Time 2 (N = 343)

		M	SD	1	2	3	4	5	6	7	8
T1	1. Ma	3.41	.96	(.83)							
	2. Mv	2.98	.93	.31**	(.77)						
	3. Pa	3.01	1.03	.69**	.18**	(.88)					
	4. Pv	2.88	.89	.17**	.28**	.22**	(.69)				
T2	5. Ma	3.38	1.00	.55**	.07**	.54**	.09	(.88)			
	6. Mv	3.00	.96	.15**	.39**	.09**	.23**	.35**	.85)		
	7. Pa	3.03	1.02	.42**	.04**	.56**	.11	.73**	.27**	.90)	
	8. Pv	2.92	.95	.10**	.16**	.16**	.30**	.30**	.52**	.26**	.82)

Note. T1: Time 1; T2: Time2

Ma = Mastery-approach goal; Mv= Mastery-avoidance goal;

Pa =Performance-approach goal; Pv =Performance-avoidance goal

$p < .01$; ( ) : alpha coefficients of internal consistency

significant, indicating that strong MI was held. In contrast, a significant difference was observed between Model 3 and Model 4, suggesting that strict MI was not held. Given past suggestions (Meredith, 1993; Meredith & Horn, 2001) of the sufficiency of strong MI for stability examination, we considered achievement goal endorsement to be invariant across Times 1 and 2 (Table 3).

Differential stability. Pearson product–moment correlations were calculated to examine differential stability over time. Table 4 shows that the four latent achievement goals at Time 1 were significantly and positively related to their respective goals at Time 2. Small to moderate correlation coefficients 0.56 ($PA_{time1-time2}$), 0.55 ($MA_{time1-time2}$), .39 ($MV_{time1-time2}$), and .30 ($PV_{time1-time2}$) were found, indicating a relatively profound change in the rank order of students with regard to their endorsement of avoidance goals from one year to the next. In contrast, the endorsement of approach goals appeared more stable in terms of inter-individual differences across time.

Mean-level stability. Table 4 also presents the descriptive statistics corresponding to each latent achievement goal. Paired t-tests were performed to test the differences in mean

Table 3

Invariance analyses of four measurement invariance models across a year

Model	df	χ^2	GFI	CFI	IFI	$\Delta\chi^2$	Δdf	p	$\Delta\chi^2/\Delta df$
Model 1 Configural invariance	212	347.33	0.922	0.984	0.985			–	
Model 2 weak factorial invariance	220	354.12	0.921	0.985	0.985	6.79	8	0.559	0.849
Model 3 strong factorial invariance	232	360.53	0.920	0.985	0.985	6.41	12	0.894	0.534
Model 4 strict factorial invariance	244	425.02	0.907	0.978	0.978	64.49	12	0.000*	5.374

Note. $* p < 0.005$

Table 4

Descriptive statistics, mean-level stability (paired t test), and differential stability Pearson correlation

Achievement goals	T1		T2		T1/T2	
	M	SD	M	SD	t	r
Mastery-approach goals	3.41	.96	3.38	1.00	.68	.55**
Mastery-avoidance goals	2.98	.93	3.00	.96	−.33	.39**
Performance-approach goals	3.01	1.03	3.03	1.02	−.32	.56**
Performance-avoidance goals	2.88	.89	2.92	.95	−.76	.30**

Note. T1: Time 1; T2: Time 2 * $p < .05$; ** $p < .01$.

endorsement across time for each achievement goal. The four latent factor means remained quite stable across the year.

Testing the Structural Model with Achievement Goals as Mediators

In our mediation model, the four achievement goals were predicted to mediate the relationship between math self-efficacy (the antecedent) and math grades (the consequence). The findings showed that our large sample size (N = 784) may have resulted in a significant Chi-Square value: $\chi^2_{(182, \ N=784)} = 1162.74$ ($p < .01$), but all of the other alternative indices indicated an acceptable model fit: RMSEA = .08, CFI = .96, IFI = .96, AGFI = .84. Thus, there was an acceptable fit between the mediation model and the data (Figure 1).

We used the PRODCLIN program (MacKinnon, Fritz, Williams, & Lockwood, 2007) to obtain the confidence limits for the indirect effects of four latent goals. The results yielded four sets of lower and upper bounds of 95% confidence limits that did not contain zero. In addition, Sobel tests (Sobel, 1982) were conducted to test the significance of mediation effects on the following relationships: MSE → MA goals → math grades (z = 5.99, $p < .01$); MSE → MV goals → math grades (z = 3.62, $p < .01$); MSE → PA goals → math grades (z = 6.01, $p < .01$); and MSE → PV goals → math grades (z = 2.63, $p < .01$). The results supported the presence of mediation effects.

The four achievement goals effectively mediated the relationship between math self-efficacy and math grades in our sample of Taiwan middle-school students. MSE was a positive predictor of MA goals (β = .52, $p < .01$), which was, in turn, a positive predictor of math grades (β = .12, $p < .01$). MSE was a negative predictor of MV goals (β = -.21, $p < .01$), which was, in turn, a negative predictor of math grades (β = -.20, $p < .01$). MSE was a positive predictor of PA goals (β = .53, $p < .01$), which was, in turn, a positive predictor of math grades (β = .27, $p < .01$). MSE was a negative predictor of PV goals (β = -.16, $p < .01$), which was, in turn, a negative predictor of math grades (β = -.14, $p < .01$).

Discussion

Our study examined the measurement structure, cross-year stability of achievement goals, and mediating effects of achievement goals on the relationship between math self-efficacy and math grade in a sample of Taiwan middle-school students. International comparisons have recognized Taiwan middle-school students as high in math achievement but low in
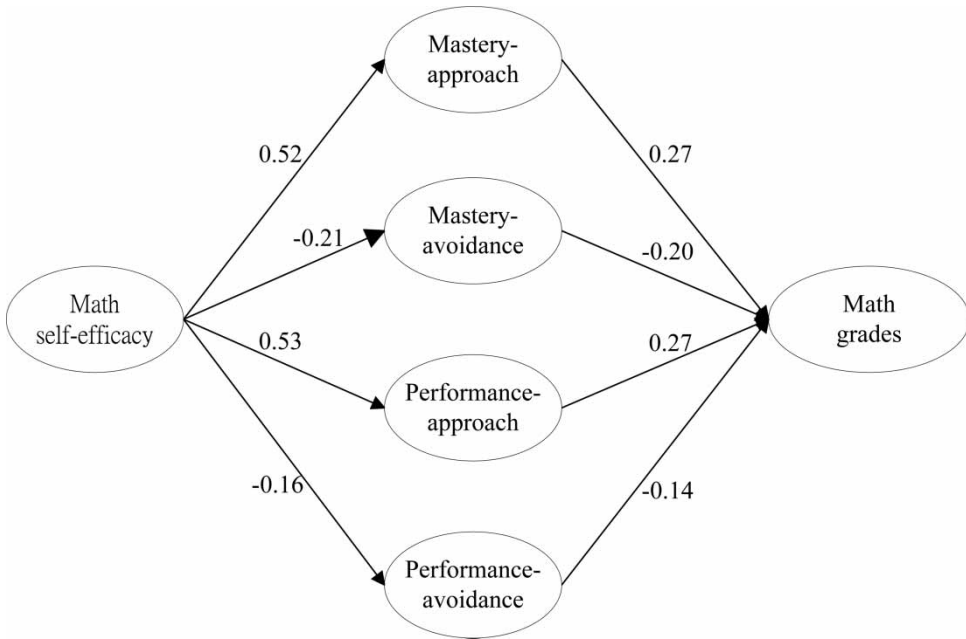
Figure 1. The structural model of factorial achievement goals with math self-efficacy and math grades. $\chi^2_{(182, \ N=748)} = 1162.74$ ($p = .000$), RMSEA = .08, CFI = .96, IFI =.96, AGFI= .84
Note. Estimates are standardized. All coefficients presented in the figure are significant (p< .01). Indicator variables and error variables are not represented in order to simplify the presentation.

positive attitude toward math (TIMSS 2007; Taiwan NSC press release, 2005). Thus, the goal of this study was to examine the motivational process of Taiwanese middle-school students, particularly in relation to the effect of precedent motivational reason (self-efficacy) and achievement goals on learning outcomes.

The Measurement and Structural Models of AGQ-C

The results of this study confirmed the 2×2 achievement goal model's relevance to math learning at the middle-school level. The factorial structure showed a good fit between the model and the data. Therefore, the 2×2 achievement goals—mastery-approach goals, mastery-avoidance goals, performance-approach goals, and performance-avoidance goals —are recognized as distinct by Taiwanese middle school students in math learning.

The Stability of 2×2 Achievement Goal Endorsement from Seventh to Eighth Grade

Our longitudinal analysis of panel data showed that achievement goals were stable from one year to the next. A significant decrease in model fit was found only when the strict invariance model constraints were added. Given that strong measurement invariance is considered sufficient for the comparison of scores across time points, our results are consistent with the findings of Fryer and Elliot (2007) and Mägi et al. (2010).

We examined the differential stability concerning the preservation of an individual's relative placement within a group across time. In a sample of American university students, Fryer and Elliot (2007) reported intercorrelations among four goals as ranging from .57 to .75 across three time points (approximately five weeks apart and in relation to a sequence of tasks). In contrast, our results based on Taiwanese middle-school students showed that the intercorrelations among the four goals ranged from .30 to .56 from one year to the next. The low-to-medium intercorrelations suggested that the relative placement of many students changed across the seventh and eighth grades. The performance-avoidance goals were least stable compared to the other three goals in the 2×2 framework. We attributed this finding to the considerable changes in the nature of the middle-school phase for students and the much longer time interval used in our study (with a larger variety of tasks) compared with the Fryer and Elliot (2007) study. In our analyses of mean-level stability, paired t-tests showed no significant differences in mean endorsement across two time points for all four achievement goals. This result showed the stability of achievement goal endorsement in our sample.

The Mediating Effects of Achievement Goals

The examination of the structural model and the Sobel test of mediating effects both suggested that the four achievement goals effectively mediated the relationship between math self-efficacy and math grades in Taiwanese middle-school students. Math self-efficacy was the antecedent of the four achievement goals, which, in turn, served as the proximal predictors of math grades. Specifically, self-efficacy exerted positive effects on both mastery-approach goals and performance-approach goals as well as negative effects on both mastery-avoidance goals and performance-avoidance goals. The results were in line with previous studies regarding the effects of self-efficacy and achievement goals in the trichotomous model (e.g., Diseth, 2011; Liem, Lau, & Nie, 2008; Pajares et al., 2000; Pintrich et al., 2003). Our findings further indicated that math self-efficacy had a significant negative effect on mastery-avoidance goals among middle-school students in the context of learning math.

Regarding the predictive effects of the 2×2 achievement goals on math grades, mastery-approach goals and performance-approach goals were positive predictors of math grades, whereas mastery-avoidance goals and performance-avoidance goals were negative predictors. Our results were in partial conflict with the findings of Elliot and McGregor (2001) and Elliot and Murayama (2008). Their results were obtained from American college students and showed that neither mastery-approach goals nor mastery-avoidance goals significantly affected general academic performance. In contrast, in investigations of achievement goals among younger students attending primary to high school (Cury, Elliot, Da Fonseca, & Moller, 2006; Chan, 2008), the results tended to be consistent with our findings. Specifically, both mastery-approach goals and performance-approach goals were positive predictors of grade, whereas performance-avoidance goals were negative predictors and mastery-avoidance goals were not significant predictors. Our results were also similar to Shih's (2005) findings based on a sample of Taiwan elementary-school students, which showed both mastery-based goals and performance-approach goals having a positive impact on overall final semester grades.

Conclusions

In our panel data of Taiwanese middle-school students, the analysis of structural stability, differential stability, and mean-level stability converged to show the stability of achievement

goal endorsement over time. Specifically, the mean endorsement level of the four goals was relatively stable from seventh grade to eighth grade. In terms of individual placement (relative to the whole sample), the endorsement of avoidance-based goals appeared less stable than that of approach-based goals. We believe that the less stable the motivation, the more the teachers should be involved in the improvement and guidance of students. For example, teachers can observe the motivational behaviors of their students and identify those with a greater tendency for avoidance-based goals.

In our cross-sectional data, the structural validity and predictive utility results yielded strong support for the application of the Achievement Goal Questionnaire Chinese version in the math domain. The use of this measure appears both empirically and conceptually sound among Taiwanese middle-school students. The current results also demonstrate the cross-cultural generalizability of the 2×2 achievement goal framework that was originally conceptualized and theorized by Elliot and McGregor (2001) based on empirical evidence from American college students. In terms of predictive utility, the four achievement goals were found to be effective mediators of the relationship between self-efficacy and math grades. Further empirical modeling and examination of achievement goals using a developmental approach will enable us to understand the causal relationships between achievement goals and academic performance.

Limitations

Several limitations of this study should be noted. First, several studies have previously tested the longitudinal relations among achievement goals, their antecedents and their outcomes (e.g., Halvari, Skjesol, & Bagøien, 2011; Mägi et al., 2011). We believe it is meaningful to explore the stability of achievement goals in panel data before examining the predictive utility of achievement goals. Future studies need to provide more detailed results on the stability and predictive utility of achievement goals in longitudinal samples. Second, although students may adopt multiple goals (e.g., Horowitz, 2010; Pintrich, 2000), in our model we treated the four goals as independent to examine whether they were empirically separable and possessed differential predictive utility. Future research is therefore necessary to determine the mediating role of multiple goals between their antecedents and consequences.

Third, past studies have found that classroom climate affects learners' achievement goals, which, in turn, affect learning outcomes (e.g., Halvari, Skjesol, & Bagøien, 2011; Sheridan & Williams, 2011). Future research should explore in detail the hierarchical relationships among students' achievement goals and the social environment (school or classroom structures) using hierarchical linear modeling. Finally, Elliot and Murayama (2008) noted problems in the original measures of achievement goals (Elliot & McGregor 2001). Examples include failing to assess goals, collapsing together the goal and the underlying motivation, and certain items being applicable to both mastery-based and performance-based goals. We recognize these concerns as equally important in the interpretation of the present findings. The potential use of the AGQ-Cm in the Taiwanese educational context clearly needs further validation. Finally, there is a lack of experimental control in this study of the relations between the variables and temporality. Therefore, the assumption of a causal direction from self-efficacy to achievement via goals may require further support.

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