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Personal Best Goal and Self-Regulation as Predictors of Mathematics Achievement: A Multilevel Structural Equation Model

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Abstract

This study aimed to identify personal best goal and self-regulation as predictors of mathematics achievement for primary students. The sample comprised 3,821 (2,021 males and 1,800 females) students between Grades 3 to Grade 5 at 26 primary schools in Hong Kong. Students' personal best goals and self-regulation were used to predict their mathematics achievement six months later. Multilevel structural equation models were fitted to the data using the MPLUS software. Results showed that after controlling for student gender and grade level, students' personal best goal predicted their subsequent mathematics achievement. In contrast, self-regulation had no direct effect on students' mathematics achievement. Self-regulation affected mathematics achievement only indirectly via students' personal best goals.

Keywords: learning goals, self-regulation, mathematics achievement, primary

1 Introduction

Academic achievement at primary years has significant implications for subsequent learning and learning opportunities of students. The identification of predictors of academic achievement of primary students, particularly those that can be changed through intervention programmes, is naturally of interest to educators. To this aim, recent research has drawn attention to the importance of learning goal orientation (Ames, 1984; Ames & Archer, 1988; Martin & Liem, 2010; Pintrich, 2000; Wolters, Yu, & Pintrich, 1996), and of self-regulated learning (Bjork, Dunlosky, & Kornell, 2013; Graham, Harris, & Mason, 2005; Kosnin, 2007; Paris & Paris, 2001; Zimmerman, 2002). This study examined goal orientation, in particular students' personal best goal (Martin, 2006; Martin & Liem, 2010), and self-regulation as possible predictors of academic achievement of primary students.

1.1 Personal Best Goal

The notion of personal best goal refers to one's attempt to out-compete or match his/her previous best standard of performance (Martin, 2006; Martin & Liem, 2010). In essence, it denotes a goal in which one views his/her previous best as a self-referenced yardstick for improving or, at the very least, upholding the standard of performance that deemed attainable. This concept originated from sports science research (Hopkins & Green, 1995; Imlay, Carda, Stanbrough, & Dreiling, 1995; Oishi, Kimura, Yasukawa, Yoneda, & Maeshima, 1994) and was only recently introduced to the education domain by Martin (2006).

In the field of education, personal best goal has been argued to be conducive to students' long-term academic growth (Martin, 2006; Martin & Liem, 2010). It has been stressed that such orientation allows self-paced progress and safeguards students from the detrimental effects of social comparisons (Liem, Ginns, Martin, Stone, & Herrett, 2012; Martin, 2006). Whist attention is on mastery, comparisons still take place in personal best goal but are shifted from an interpersonal to an intrapersonal level. Previous research on goals orientation focused predominantly on the dichotomy between mastery-goal orientation (Dweck, 1986; Nicholls, 1984) and performance-goal orientation (Harackiewicz, Barron, & Elliot, 1998; Harackiewicz & Elliot, 1993). In this regard, personal best goal serves as a constructive intermediary between the two by emphasizing on both self-improvement and comparison (Martin, 2006; Martin & Liem, 2010).

In the conceptualisation of personal best goals, it is important to distinguish it from the concept of mastery goals since they do share common denotations and can be easily confused. Herein we examine commonalities and differences between the two conceptions. An individual is said to adopt mastery goals if she/he engages in achievement behavior with the purpose to develop competence in the task rather than to demonstrate her/his competence (Elliot, 2006, p. 632). Elliot (2006) identified two different connotations of "purpose" in mastery goals,

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namely, the *reason* for doing a task, and the intended *aim* of engagement in the task. Both mastery and personal best goals refer to the latter connotation, i.e., the desired aim, of achievement behavior. Later, Elliot, Murayama, and Pekrun (2011) further elaborated that three standards, namely, *task*, *self*, and *other*, could be used as referent to decide if one has achieved well. Mastery goals can be either self-based or task-based in judging attainments (Elliot et al., p. 633). Individuals holding self-based goals "use one's own intrapersonal trajectory as the evaluative referent," whereas those holding task-based goals "use the absolute demands of the task as the evaluative referent (Elliot et al., p. 633)," and Elliot et al. (2011) argued for the separation of these two goal constructs. In contrast, personal best goals use self as the only standard for evaluation. Importantly, people holding personal best goals, as opposed to those having mastery goals, aim to go beyond mastery. That is, the aim of engaging in achievement behaviour is to attain improvement beyond what had already been achieved at this moment by the self (Martin, 2006; Martin & Liem, 2010). Whereas individuals holding mastery goals ask themselves, "have I learned this? Do I really understanding this?" In the learning process, people holding personal best goals ask themselves, "how can I have breakthroughs in my learning? How can I do better the next time?" In summary then, mastery goals and personal best goals are two distinct concepts, both ground on self as referent for standards. Students who are mastery-oriented tend to compare their current (mastery) and previous (non-mastery) levels of attainment. Students who are personal best-oriented tend to compare their current (mastery or not-yet-mastery) and future (improved) levels of attainment.

The conception of personal best goal was found to be consistent between genders and across grade levels, as demonstrated by the invariance across gender and grade levels of factor structures of items constructed to measure the construct (Martin, 2006). Gender differences were reported (Martin, 2006), favouring females, in personal best goals. In addition, research found that personal best goal predicted educational aspirations, positive attitudes toward school life, participation in class, and persistence, all of which were in turn predictors of school achievement found in previous studies (Martin, 2006; Martin & Lien, 2010).

Personal best goal is underpinned by the learning goal that the learner sets for himself/herself. It is hypothesized that personal best goal is most likely to be adopted when certain types of learning goals have been set (Martin, 2006). First, these goals are clear and specific to the learning task or situation. Such clarity and specificity do not apply only to the formulation of the goals but also to the ways in which they can be actualized and assessed. Second, these goals are challenging enough but yet achievable. Note that the extent to which the goals are challenging is highly subjective and individualized, determined solely by the students who set them. Third, these goals are set with reference to one's previous best performance. In this sense, the students with such goals are not competing with the performance of others but that of themselves. Last, the purpose of these goals is to bring about self-improvement. This improvement is brought about by students' attempt to perform better than before or at their very best. Taken together, these four dimensions are considered the cornerstones for personal best goal (Martin, 2006).

For the current study, only the dimension on self-improvement goals of personal best was looked into. The recent educational policies in Hong Kong emphasize on self-initiated improvement and development both at the school (Education Bureau, 2013) and student level (Education and Manpower Bureau, 2005). At the student level, self-improvement is closely related to the notion of self-regulated learning which will be discussed in the next section. It has been demonstrated that personal best goal predicts academic engagement and achievement better than when academic engagement and achievement are used to predict personal best orientation (Martin & Liem, 2010). This substantiates the beneficial effect of personal best on academic achievement.

1.2 Self-Regulated Learning

Self-regulated learning has been an extensively-researched topic in the area of learning and teaching for the past two decades (Bjork et al., 2013; Graham et al., 2005; Paris & Paris, 2001; Pintrich & De Groot, 1990; Zimmerman, 1986, 2000, 2002; Zimmerman & Martinez-Pons, 1988). According to Boekaerts and Corno (2005), although there is no single definition of self-regulated learning used by all researchers because different researchers highlighted different aspects of self-regulation, it is commonly agreed that self-regulated learning refers to the learning process in which the learner is proactively involved in the thoughts, feeling, and action of learning (Pintrich & Zusho, 2002; Zimmerman, 1989, 2002). Specifically, self-regulated learning underscores one's decision of planning, monitoring, adjusting, and controlling actions towards the learning goals through conscious and autonomous means (Paris & Paris, 2001; Zimmerman, 2000, 2002). Building on this definition, various models and frameworks have been proposed to conceptualize self-regulated learning including Boekaerts' (1992) adaptable learning model, Borkowski's (1996) metacognition model, Pintrich's (2000) general framework, Winne and Hadwin's (1998) four-stage model and Zimmerman's (2000) social cognitive model. These models are instrumental in guiding and promoting self-regulated learning in different pedagogical contexts and for different educational purposes.

From a theoretical perspective, the ability to self-regulate is a characteristic that by its very nature enhances the quality of learning. Self-regulation is essentially a combination of self-awareness, self-motivation, self-discipline, self-reflection, and self-control (Zimmerman, 2002). As such, self-regulated learners are thus aware of their strengths and weaknesses, motivated and disciplined to improve, and are cognizant of the learning outcomes.

Empirically, self-regulated learning has been shown to have positive correlations with academic performance (Kosnin, 2007; Law, Chan, & Sachs, 2008; Van Den Hurk, 2006) and that high-achievers are more likely to adopt self-regulated learning strategies than low achievers (Pintrich & De Groot, 1990). Substantial research evidence has indicated the centrality of self-regulated learning on achievement (Bong, 2001; Paris & Paris, 2007; Schneider & Artelt, 2010; Schunk & Zimmerman, 2007). Of particular note is the positive impact of self-regulation on students' mathematics achievement (Camahalam, 2006; Desoete, 2008; Desoete, Roeyers, & De Clercq, 2003; Dignath, Buettner, & Langfeldt, 2008; Fuchs et al., 2003; Labuhn, Zimmerman, & Hasselhorn, 2010; Ross, Hogaboam-Gray, & Rolheiser, 2002).

Given that self-regulated learning is not considered a fixed cognitive skill, it is believed that students' academic achievement can be improved through intervention programs which train students to be self-regulated learners (Bjork et al., 2013; Graham et al., 2005; Kosnin, 2007; Paris & Paris, 2001; Zimmerman, 2002).

1.3 The Conceptual Model

In this study we examined the effects of academic personal best goal and self-regulation on primary students' subsequent achievement in mathematics. The effects of gender and grade level were controlled statistically by including these two variables in the model. Based on the literature, a conceptual model was developed (Figure 1).

In the model, both personal best goal and self-regulated learning were hypothesized to affect mathematics achievement for primary students. Gender was conceptualized in the model as having both direct and indirect effects on mathematics achievement. In addition, gender was also conceptualized to have an effect on students' goal orientation and their self-regulation, which in turn were modeled to affect mathematics achievement. Although gender was not the focus of this study, extensive research, including large scale international studies, has reported on its effect on mathematics achievement (Winkelmann, 2008). Gender was included in the model with the aim to partial out variances of other variables in the model attributable to gender effect, such that the effect of goal orientation and self-regulation on mathematics achievement could be more clearly identified.

Grade level was not explicitly modeled in this study. Instead, grade level was considered a class- rather than individual-level variable. The conceptual model was tested for each grade level in the study. In order to establish meaning of mathematics achievement across grade levels, mathematics achievement was assessed using three curriculum-based mathematics tests with cross-level linkage items.

2 Method

2.1 Participants

Data were obtained from 4,687 students currently enrolled at Grade 3 (median age 8 years) through Grade 5 (median age 10 years) at 26 primary schools in Hong Kong. The schools were representative in terms of geographical location of government subsidized schools in Hong Kong. Since not all of the sampled students participated at all data collection exercises, the analytic sample comprised 3,821 students (81.5% of the original sample) (2,021 males and 1,800 females) with complete data on the variables. Eight hundred and sixty (866) students were excluded because of missing data on one of the variables. The sample distribution by gender and grade level is presented in Table 1. The last column of Table 1 shows that there was a decreasing averaged class size in terms of grade level, which reflects the effect of decreasing birthrate and class size in the local school population.

2.2 Measures

2.2.1 Personal Best Goals

Students' commitment to personal best goals was measured using a 6-item Likert-type Personal Best Scale, which was modified from Martin's (2006) Academic Personal Best Goals Scale. Whereas Martin's (2006) original Academic Personal Best Goals Scale had four dimensions, namely, persistence, class participation, educational aspirations, and enjoyment of school, the Personal Best Scale used in this study focused attention on the persistent self-improvement dimension. Students were consulted with regard to the extent to which they persisted in academic improvement, basing on a self-referenced frame of reference, despite difficulties in the pursuit (Martin, 2011, 2006). An example item is, "I do not compare myself with others but just do my best." Students responded to each item in the Personal Best Scale by selecting one of four Likert-type options: "Strongly Disagree (coded as 1)," "Disagree (coded as 2)," "Agree (coded as 3)," and "Strongly Agree (coded as 4)."

Exploratory Factor Analysis was undertaken using SPSS (Version 21.0) on the questionnaire items in order to ascertain factor structures of items for the Personal

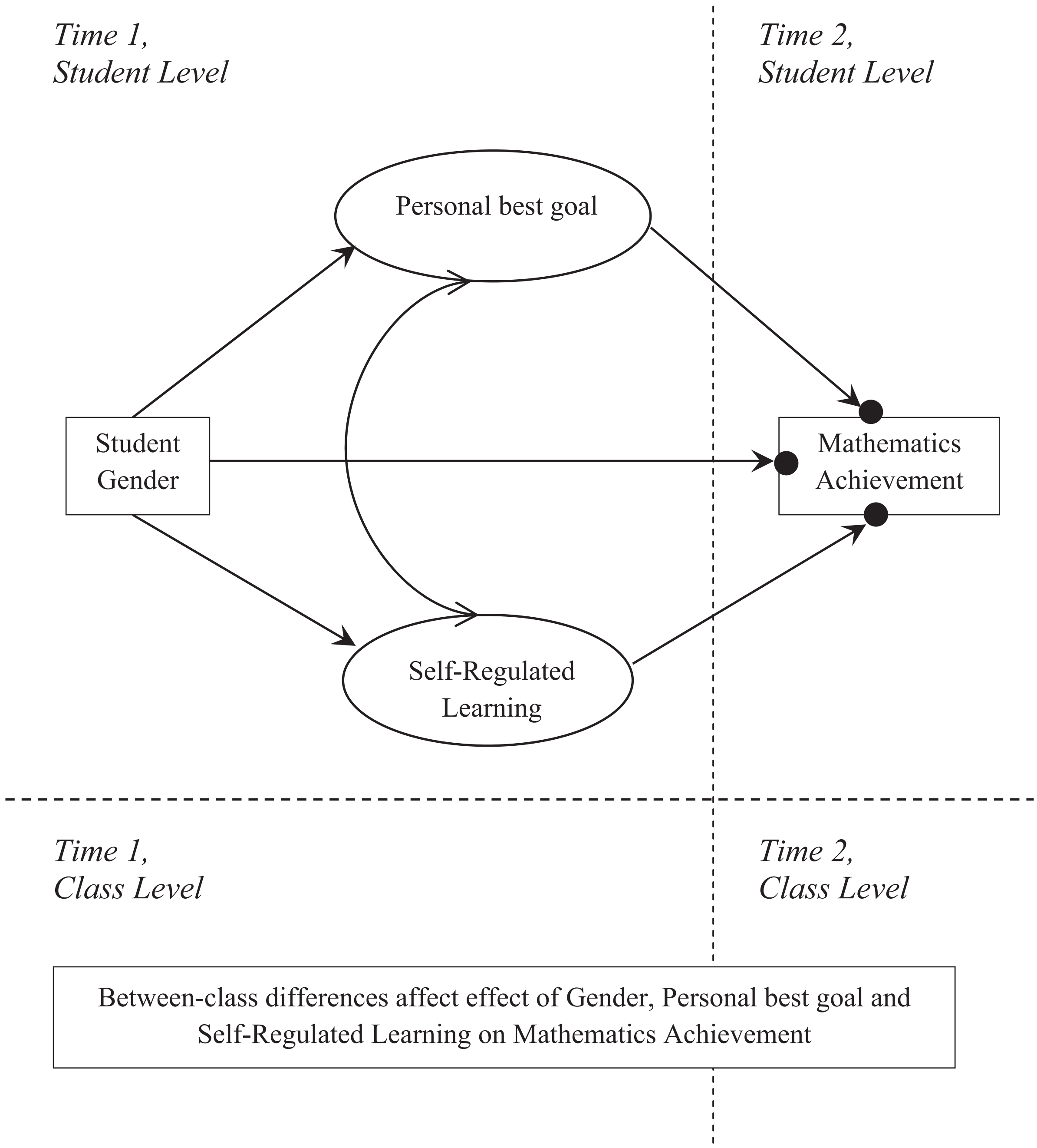

Figure 1 Conceptual Model of Relationship between Predictors of Mathematics Achievement at Student- and Class-levels

Table 1 Sample Distribution (n = 3,821)

Grade Level	Male	Female	n	No. of Classes	Average Class Size
Grade 3	633 (48.3%)	678 (51.7%)	1,311	60	21.85
Grade 4	761 (58.8%)	534 (41.2%)	1,295	54	23.98
Grade 5	627 (51.6%)	588 (48.4%)	1,215	49	27.80

Best scale and the Self-Regulation scale. The Maximum Likelihood method of extraction, followed by an oblique rotation (procedure Oblimin in SPSS) was used in the Exploratory Factor Analysis (Costello & Osborne, 2005). The results show that two distinct factors with eigenvalues greater than one were extracted and accounted for 49.59% of the variance in the items. The items loaded on two separate factors pertaining to Personal Best and Self-Regulation as intended in the construction. Factor loadings of all items had factor loadings greater than 0.33 on the intended factor, with only one exception, namely Item 5 designed to measure Personal Best. No item had cross-loading of 0.32 or more on both factors (Table 2). The two factors were strongly correlated, with zero order Pearson Correlation Coefficient of 0.73.

Psychometric properties of the Personal Best scale will be discussed in this section, followed by discussions in the next section on the psychometric properties of the Self-Regulation scale. The Personal Best Scale was found to have good psychometric properties in this study. Cronbach's Alpha was 0.84, which indicated good internal consistency of the Personal Best items. Rasch Rating Scale analysis (Wright & Masters, 1982) using Winsteps computer software (Version 3.72.3) (Linacre, 2011) found that residual variance in the first contrast was 1.8, which was lower than the cut-off criterion value of 2.0 recommended in the literature (Linacre, 2012, p. 376). This result indicated that the items measured a single-dimension construct. In this single dimension, there was a reasonable range of item difficulty levels from -0.35 logits for the easiest item "I will be happy for improved results" to 0.65 logits for the most difficult item "I do not compare myself with others but just do my best." The item weighted (InFit MNSQ, column 3, Table 3) and unweighted (OutFit MNSQ, columns 4, Table 3) goodness of fit indices ranged between 0.77 and 1.45, which were within the acceptable range of 0.5 to 1.5 (Linacre, 2012, p. 596), indicating that the data fitted the Rasch model well. Rasch item reliability for the Personal best goal Scale was 0.99. There is practically no gender Differential Item Functioning (DIF) and no grade-level DIF. All the DIF contrasts were less than 0.5 logits (Linacre, 2012). An item with no DIF means that given two persons, one male and the other female, who are of equal ability, they are equally likely to endorse the item. The results mean that items in the Personal Best Scale were unbiased for gender and for grade levels. Rasch reliability of the Personal Best Scale was 0.99. Linacre (2014) highlighted that Rasch item reliability increases with increase in the range of item difficulty levels, and with large sample size, but is basically unaffected by test length or model fit. In this study, the large range of item difficulty levels and the large sample size are most likely to be accountable for the very high Rasch reliability of the Personal Best Scale.

2.2.2 Self-Regulation

Self-regulation in the context of school learning refers to processes that an individual adjust their learning behaviour and strategies in order to achieve their learning goals (Sitzmann & Ely, 2011). Assessment feedback provides a basis for self-regulation in this study. A Self-

Table 2 Pattern Matrix from Exploratory Factor Analysis of the Personal Best and Self-regulation Scales

	Item	Factor 1	Factor 2
1	I make extra effort to improve my study results	.832	-.062
2	I work hard to do better in my schoolwork	.861	-.064
3	My target is beyond my own	.681	.026
4	I keep striving for breakthroughs in my learning	.578	.157
5	I do not compare myself with others but just do my best	.282	.218
6	I seek to achieve my personal best in every aspect	.337	.315
7	After I get back my test papers, I try to understand the reasons for me to make the mistakes	.095	.631
8	When I find that I am doing less well in my study, I change my learning methods	-.052	.790
9	I modify the way I complete my assignments according to different requirements	-.017	.745
10	I modify my learning methods according to teachers' comments	.021	.698

Note: n = 3,821 cases.

Table 3 Psychometric Properties of Scales

Scale	No. of Items	INFIT Range	OUTFIT Range	Items Misfit[1]	Rasch Item Reliability	Separation Index	Cronbach's Alpha
Personal Best	6	0.77 ~ 1.41	0.77 ~ 1.45	0	0.99	13.30	0.87
Self-Regulation	4	0.79 ~ 1.15	0.80 ~ 1.16	0	0.98	7.86	0.88
Grade 3 Math Ach	34	0.87 ~ 1.23	0.76 ~ 1.99	2	1.00	15.44	0.82
Grade 4 Math Ach	37	0.87 ~ 1.22	0.85 ~ 1.80	1	1.00	16.92	0.82
Grade 5 Math Ach	35	0.91 ~ 1.09	0.89 ~ 1.70	1	0.98	6.56	0.81

Note: [1] Number of items with OUTFIT outside 0.5 ~ 1.5 range.

Regulation Scale comprising four Likert-type items was constructed to measure self-regulation practices of primary students. An example item is: "When I find that I am doing less well in my study, I change my learning methods." Students responded to each Self-Regulation Scale item by selecting one of four selecting one of four Likert-type options: "Strongly Disagree (coded as 1)," "Disagree (coded as 2)," "Agree (coded as 3)," and "Strongly Agree (coded as 4)."

The Self-Regulation Scale was found to have good psychometric properties in this study. Cronbach's Alpha was 0.87, which indicated good internal consistency of the Self-Regulation items. Rasch Rating Scale analysis (Wright & Masters, 1982) using Winsteps computer software (Version 3.72.3) (Linacre, 2011) found residual variance in the first contrast to be 1.3, which was lower than the cut-off criterion value of 2.0 (Linacre, 2012, p. 376). This result indicated that the items measured a single-dimension construct. In this single dimension, there was a reasonable range of item difficulty levels from -0.36 logits for the easiest item "After I get back my test papers, I try to understand the reasons for me to make the mistakes" to 0.39 logits for the most difficult item "I focus on the mistakes I made frequently, and make repeat practices until I get them right." The item weighted (InFit MNSQ, column 3, Table 3) and unweighted (OutFit MNSQ, columns 4, Table 3) goodness of fit indices ranged between 0.79 and 1.16, which were within the acceptable range of 0.5 to 1.5 (Linacre, 2012, p. 596). This means that the data fitted the Rasch model well. Rasch item reliability for the Self-Regulation Scale was 0.98. There is practically no gender Differential Item Functioning (DIF) and no grade-level DIF. Gender DIF contrasts were not statistically significant, and ranged from -0.14 to 0.14. Level DIF contrasts were not statistically significant either and ranged from -0.14 to 0.19. The results mean that items in the Self-Regulation Scale were unbiased for gender and for grade levels. Rasch reliability of the Self-Regulation Scale was 0.98. The large range of item difficulty levels and the large sample size are most likely to be accountable for the very high Rasch reliability of the Self-Regulation Scale in this study (Linacre, 2014).

2.2.3 Mathematics Achievement

Mathematics achievements at Grade 3 to Grade 5 were measured by three respective curriculum-based achievement tests designed by the researchers in consultation with school teachers. Common items were used to link the three tests across grade levels and a vertical scale was established using the Rasch model (Rasch, 1980). The tests comprised multiple choice items with three wrong options and one correct option. There were 34, 37, and 35 items in the tests for Grades 3, 4, and 5 respectively. Students' responses to the items were scored either right or wrong. Example items for each grade level were presented in Table 4.

Mathematics teachers of the participating schools were consulted to ensure that the mathematics achievement tests were valid in terms of alignment with contents and levels of difficulty for their students. Since different mathematics achievement items were used for different grade levels except for the linkage items, the psychometric analysis of achievement items were conducted separately for individual grade levels. The achievements tests were found to have good psychometric properties in this study. Cronbach's Alphas of the items were 0.82, 0.82, and 0.81 at Grades 3, 4, and 5 respectively. These results attested to the strong internal consistency of the test items. Rasch Rating Scale analysis (Wright & Masters, 1982) using Winsteps computer software (Version 3.72.3) (Linacre, 2011) found that residual variances in the first contrast were 1.6, 1.6, 1.6 for Grades 3, 4, and 5 respectively, all of which were lower than the cut-off criterion value of 2.0 recommended in the literature (Linacre, 2012, p. 376). These results indicated that the each batch of mathematics achievement items for Grades 3, 4, and 5 measured a single-dimension construct. In this single dimension in Grade 3, there was a reasonable range of item difficulty levels from -1.74 logits for the easiest item to 2.70 logits for the most difficult item. In Grade 4, item difficulty levels ranged from -2.70 logits for the easiest item to 3.11 logits for the most difficult item. In Grade 5, item difficulty levels ranged from -2.52 logits for the easiest item to 2.27 logits for the most difficult item. The item weighted (InFit MNSQ, columns 3, Table 3) goodness of fit indices ranged between 0.87 and 1.23, which were within the acceptable range between 0.5 and 1.5 (Linacre, 2012, p. 596). In Grade 3, the unweighted (OutFit MNSQ, columns 4, Table 3) goodness of fit indices ranged between 0.76 and 1.99. Two items in Grade 3 were more than the cut off value of 1.5. In Grade 4, the unweighted (OutFit MNSQ, columns 4, Table 3) goodness of fit indices ranged between 0.85 and 1.80. One item in Grade 4 was more than the cut off value of 1.5. In Grade 5, the unweighted (OutFit MNSQ, columns 4, Table 3) goodness of fit indices ranged between 0.89 and 1.70. One item in Grade 5 was more than the cut off value of 1.5. These results show that except for the four identified misfit items, the data fitted the Rasch model well. The DIF contrasts for the majority of items were less than 0.5 logits (Linacre, 2012), except one item in Grade 3 (DIF contrast -0.59), two items in Grade 4 (DIF contrasts -0.51 and -0.56), and one item in Grade 5 (DIF contrast -0.77). All the items exhibiting DIF favoured male students. The Educational Testing Service (ETS) used the Mantel Haenszel delta difference procedure and classified dichotomous items into Category A: Items with little or no DIF; Category B: Noticeable but small to moderate DIF;

Table 4 Example Mathematics Achievement Items

	Example Item
Grade 3	9 7563 – 3174 = ? A. 4389 B. 4411 C. 4489 D. 4499
Grade 4	18 Referring to the equation 14 × 6 = 84, which of the following statements about factor and multiple is incorrect? A. 14 is a factor of 84 B. 84 is a multiple of 14 C. 14 is a multiple of 6 D. 6 is a factor of 84
Grade 5	19 A train travels from place A to place B. In the first hour, it travels $\frac{3}{5}$ of the journey. In the second hour, it travels $\frac{1}{3}$ of the journey. Which of the following best represents the remaining journey? A. $\frac{1}{5}$ B. $\frac{4}{15}$ C. $\frac{14}{15}$ D. $\frac{1}{15}$

and Category C: Large DIF (Zwick, 2012). Zieky's (1993) research showed that Category B items can still be used in a test, but Category C items should be removed from the test. In this study, all the items belong to either Category A or Category B according to the ETS classification and hence could be used in assessing students' mathematics achievement. These results mean that the achievement items were unbiased or with only small bias for gender within each grade. Rasch reliabilities of the mathematics achievement scales were 0.99, 0.99 and 1.00 for Grade 3, Grade 4, and Grade 5 students respectively. The very high Rasch reliabilities of items at Grades 3, 4, and 5 in this study were most likely due to the wide item difficulty range and the large sample size (Linacre, 2014).

2.3 Procedures

Invitation letters were distributed to sampled primary schools for their voluntary participation. Data were collected from students of participating schools through anonymous self-report questionnaire and mathematics achievement test during normal class-time. Student response rate was 96.5%. Students were able to complete the questionnaire within one class session, and the mathematics achievement test was completed within another class session six months later. The study was conducted adhering to the research procedures and data collection protocols approved by the Ethical Reviews Committee of the university where the research project was located.

Questionnaire and mathematics achievement test scripts were captured via Optical Mark Recognition method by an independent scanning company. All data were checked by two technical people at the company to ensure data accuracy. Initial analyses, including frequency and descriptive statistics, were undertaken to identify possible anomalies.

2.4 Data-Analysis

The hypothesized model was tested using a multilevel structural equation modeling. The multilevel structural equation modeling framework enables examination of the pattern of directional and non-directional correlational and covariance relationships among variables in the model (Kline, 2011). Multilevel structural equation modeling was used to account for students nested within classes within schools and to account for measurement error (Preacher, Zyphur, & Zhang, 2010).

Initial analysis of a two-level (level 1: Student, level 2: Class) null model with no explanatory variables included was undertaken using the MLwiN software package (Rasbash, Steele, Browne, & Goldstein, 2012). The analysis found class-level variances to be statistically significant, with class-level intraclass correlation coefficients of mathematics achievement at 3.69%, 15.03%, and 17.18% for Grade 3, Grade 4 and Grade 5 respectively. Class-level design effect ranged from 1.7 at the Grade 3 level to 6.0 at Grade 5. These results show that mathematics achievement of students might due to differences between classes at each grade level, and analysis could not ignore clustering effect in the data.

On basis of the initial analysis, two-level structural equation modeling was used to analyse the effect of students' personal best goal and self-regulation on their mathematics achievement six months later, after controlling for student gender and grade level. Differences between classes and differences among students within classes were taken as sources of between- and within-level variations in students' mathematics achievement. Predictors at the beginning of the semester tested in the model were students' gender, their personal best goal, self-regulation practices, and between-class variations.

The hypothesized 2-level structural equation model (Figure 1) was tested using the Mplus statistical software package (Version 7) (Muthén & Muthén, 1998-2012) for each grade level. Overall model fit was evaluated in terms of a number of indicators for model good fit, namely, Chi-squared value, the ratio of Chi-squared value to its degrees of freedom with criterion of the ratio being less than 3 (Chou & Bentler, 1995; Kline, 2011), Comparative Fit Index (CFI) and Tucker Lewis Index (TLI), with criterion of these two indices being greater than 0.95 (Hu & Bentler, 1999; McDonald & Ho, 2002), Root Mean Square Error of Approximation (RMSEA) with the criterion of its value being less than 0.07 (Steiger, 2007), and Standardised Root Mean Square Residual (SRMR) (Muthén & Muthén, 1998-2012) with the criterion of its value being less than 0.08 (Hu & Bentler, 1999; Kline, 2011). Path coefficients and other parameters were tested for their statistical significance at 5% level.

3 Results

3.1 Initial Descriptive Statistics

Descriptive statistics for each grade level are presented in Table 5. The descriptive statistics indicated the possibility of a cohort effect in the sense that Grade 5 students scored even lower on average than students at Grades 3 and 4. Decision was made to analyse the data separately for different grades in order to manage the cohort effect.

Table 5 also showed that the predictor variables Personal Best and Self-Regulation were negatively skewed, meaning that most of the responses for these two scales loaded on the positive end. Further, it can be seen that all predictors had significant and positive correlation with mathematics achievement. Gender (male coded as 1, female

Table 5 Descriptive Statistics and Zero-order Pearson Product Moment Correlations

Variable	Mean	SD	Skewness	Kurtosis	Correlation Math	Gender	PB
Grade 3 (n = 1,311)							
Math (logit)	2.710	1.030	0.085	0.689			
Gender	1.480	0.500	0.090	-1.994	-0.560		
PB	0.000	0.926	-1.205	1.339	0.191	0.099	
SR	0.000	0.902	-0.933	0.564	0.102	0.115	0.611
Grade 4 (n = 1,295)							
Math (logit)	3.333	1.019	-0.180	0.257			
Gender	1.580	0.494	-0.328	-1.895	0.095		
PB	0.000	0.922	-1.114	1.329	0.232	0.121	
SR	0.000	0.903	-0.799	0.540	0.173	0.120	0.657
Grade 5 (n = 1,215)							
Math (logit)	1.126	1.018	0.553	1.658			
Gender	1.520	0.500	-0.096	-1.993	-0.012		
PB	0.000	0.929	-0.781	0.500	0.145	0.080	
SR	0.000	0.906	-0.714	0.723	0.123	0.064	0.629

Note: Math stands for Mathematics achievement. PB stands for Personal Best. SR stands for Self-Regulated Learning. Gender is student gender (male coded as 1, female coded as 2).

coded as 2) had positive correlation with personal best goal and with self-regulation, meaning that females were more inclined toward personal best goal had self-regulation than were males. Correlations between gender and mathematics achievement at Grade 3 and Grade 5 were negative but positive at Grade 4. These results mean that females scored higher than males did at Grades 3 and 5, but lower than males at did Grade 4. Zero-order correlation coefficients between personal best goal and self-regulation ranged from 0.611 to 0.657, meaning that there is considerable shared variance between the two predictors.

3.2 Predictors of Mathematics Achievement

Results of the analysis are presented in Table 6. The multilevel structural equation model fitted the data well at each grade level. There was substantial drop in Chi-squared value of the final model compared to the baseline model at each grade level. The ratios of Chi-square of the model to its degrees of freedom equal to 2.35, 1.91, and 2.96 for Grades 3, 4, and 5 respectively. The CFI and TLI indices were larger than 0.98, RMSEA and SRMR (within) less than 0.05 (Table 6a).

It can be seen from Table 6b that after controlling for all predictors in the model, personal best goal predicted mathematics achievement six months later at all grade levels (i.e., Grades 3, 4, and 5) in the study after controlling for gender effect. There was also significant (at 5% level) direct gender effect on mathematics achievement in Grades 3 and 4 but not in Grade 5. Gender also affected mathematics achievement indirectly through students' personal best goal (at all grade levels), and their self-regulation (for students in Grades 3 and 4). Nevertheless, after controlling for personal best goal and for gender, there was no significant direct effect of self-regulation on mathematics achievement at any grade level. Self-regulation affected mathematics achievement only indirectly via its correlation with personal best goal. Correlation coefficient was in the order of 0.8 between the two predictors after controlling for gender in the model. Despite statistical significance, however, the effect size for mathematics achievement was found to be small in this study. Within-level R-square ranged from 0.024 (Grade 5) to 0.061 (Grade 4).

Table 6b also shows that the measurement models for personal best goal and self-regulation were healthy. Factor loadings ranged from 0.463 to 0.864 for the personal best goal items, and from 0.752 to 0.800 for the self-regulation items across the grade levels.

4 Discussion

This study sought to investigate the possibility of personal best goal and self-regulation as predicators of mathematics achievement of primary students. Personal best goal is defined as "specific, challenging, competitively self-referenced targets towards which students strive" (Martin, 2013). Personal best goal is an attractive alternative to performance or other norm-reference goals as it refers to setting targets on one's own progress and on one's continuous improvement, rather than on competing with others. Recent research (Martin, 2006; Martin & Liem, 2010) found positive impact of personal best goals on students' academic achievement. Goal setting is the first step of the self-regulatory process. Self-regulation is the other important component in the process for goal attainment. In this study, the combined effect of personal best goal and self-regulation on mathematics achievement was investigated. Using multilevel structural equation modelling, the study showed that personal best goal has direct and positive effect on primary students' mathematics achievement, after taking into account their gender and grade level. This result corroborates the findings from the study of Martin and Liem (2010).

By pursuing a personal best goal, the student aims to perform a little bit better than his/her previous performance each time, irrespective of how the other students are doing, and irrespective of any absolute standard. In this way, the student is better protected from pressure arising from social comparison or learned helplessness arising from the external standard being unreachably high compared to the student's current status. The students is thus in a better position to strive for his/her personal potential. Using one's own attainment as a yardstick for the next strives is concrete and realistic for the student. Hattie's (2009) meta-analysis found only low effect size for goals that were too difficult or ambiguous to attain, but effect size for goals that are more realistic and specific was much higher.

While personal best goal has a direct effect on mathematics achievement, this study found that self-regulation only had indirect effect on mathematics achievement via personal best goal. This finding is not consistent with our hypothesized model but nonetheless is an important finding. Self-regulation in this study was measured in terms of the extent to which students made adjustments to their their learning behaviour and strategies so as to achieve their learning goals. The finding in this study that self-regulation had no direct effect on mathematics achievement means that merely changing learning strategies without referencing one's previous achievement would not lead to increase in achievement. Instead, one has to reflect upon one's performance and reconsiders the effectiveness of the learning strategies before their application.

This study provides insights into personal best goal and self-regulation as predictors, after controlling for

Table 6

(a) Model Fit of Multilevel Structural Equation Modelling

Model Fit	Grade 3	Grade 4	Grade 5
Chi-square model	222.964	181.196	281.506
df	95	95	95
Chi-square model Prob.	< 0.001	< 0.001	< 0.001
Chi-square model/*df* Ratio	2.35	1.91	2.96
Chi-square baseline	10,683.954	13,001.903	12,895.624
Degrees of freedom	111	111	111
CFI	0.998	0.993	0.985
TLI	0.986	0.992	0.982
RMSEA	0.029	0.024	0.036
SRMR (within)	0.039	0.045	0.049
SRMR (between)	0.614	0.533	0.691

(b) Path Coefficients, Factor Loadings, and R-square

	Grade 3			Grade 4			Grade 5		
Path Coefficients	Est.	S.E.	Prob.	Est.	S.E.	Prob.	Est.	S.E.	Prob.
Math on PB	0.286	0.050	< 0.001	0.236	0.056	< 0.001	0.163	0.066	0.013
Math on SR	-0.091	0.054	0.093	-0.009	0.060	0.886	-0.012	0.064	0.850
Math on Gender	-0.072	0.027	0.009	0.069	0.021	0.001	-0.023	0.025	0.359
PB on Gender	0.098	0.031	0.001	0.114	0.030	< 0.001	0.070	0.031	0.022
SR on Gender	0.128	0.031	< 0.001	0.121	0.029	< 0.001	0.057	0.032	0.076
PB with SR	0.754	0.017	< 0.001	0.790	0.011	< 0.001	0.785	0.013	< 0.001

	Grade 3			Grade 4			Grade 5		
Within-level Stand. Factor Loadings	Est.	S.E.	Prob.	Est.	S.E.	Prob.	Est.	S.E.	Prob.
PB									
PB1	0.845	0.009	< 0.001	0.854	0.011	< 0.001	0.840	0.012	< 0.001
PB2	0.841	0.010	< 0.001	0.858	0.011	< 0.001	0.864	0.010	< 0.001
PB3	0.790	0.013	< 0.001	0.803	0.014	< 0.001	0.773	0.012	< 0.001
PB4	0.797	0.011	< 0.001	0.783	0.012	< 0.001	0.792	0.012	< 0.001
PB5	0.606	0.021	< 0.001	0.550	0.017	< 0.001	0.463	0.024	< 0.001
PB6	0.720	0.016	< 0.001	0.699	0.135	< 0.001	0.656	0.017	< 0.001
SR									
SR1	0.786	0.015	< 0.001	0.781	0.012	< 0.001	0.795	0.011	< 0.001
SR2	0.776	0.013	< 0.001	0.785	0.011	< 0.001	0.792	0.012	< 0.001
SR3	0.799	0.013	< 0.001	0.766	0.013	< 0.001	0.779	0.013	< 0.001
SR4	0.752	0.017	< 0.001	0.800	0.013	< 0.001	0.768	0.011	< 0.001
Within-level R-sq									
Math	0.053	0.012	< 0.000	0.061	0.012	< 0.000	0.024	0.009	0.011
PB	0.010	0.006	0.109	0.013	0.007	0.056	0.005	0.004	0.251
SR	0.016	0.008	0.042	0.015	0.007	0.039	0.003	0.004	0.375

Notes: Math stands for Mathematics achievement. PB stands for Personal Best. PB was measured by six items represented by PB1, …PB6. SR stands for Self-Regulated Learning. SR was measured by four items represented by SR1,…SR4. Gender is student gender (male coded as 1, female coded as 2).

gender and grade level, of mathematics achievement of primary students in Hong Kong. Results of the study must be interpreted in the contexts of study limitations. First, data on personal best goal and self-regulation were collected using self-report questionnaire of students. Self-report questionnaires have inherent limitations including the possibility of response sets, and responses made in accordance with social desirability. For future studies, qualitative data such as interview or diary writing should be included to provide more details on students' thoughts. Second, although achievement data were collected six months after students completed questionnaires on personal best goals and self-regulation, the effect of goal setting and self-regulation on mathematics achievement might take much longer than six months. It is recommended that longitudinal studies of over several academic year with more data collection incidences should be conducted to elucidate the interplay between personal best goals, self-regulation, and mathematics achievement.

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