Testing interest and self-efficacy as predictors of academic self-regulation and achievement

Woogul Lee, Myung-Jin Lee, Mimi Bong

Abstract

We examined whether individual interest, as an affective motivational variable, could predict academic self-regulation and achievement, above and beyond what academic self-efficacy predicted. We tested the relationships between academic self-efficacy, individual interest, grade goals, self-regulation, and achievement of Korean middle school students (N = 500) in four different subject areas. Consistent with previous findings, self-efficacy predicted achievement both directly and indirectly via grade goals. Self-efficacy also predicted self-regulation, but only when grade goals mediated the relationship. Supporting our hypothesis, individual interest functioned as a correlated yet independent and direct predictor of self-regulation. It also predicted achievement, but only when self-regulation mediated the relationship. We thus suggest that academic self-regulation could be encouraged through the promotion of two distinct motivational sources, academic self-efficacy and individual interest. We further suggest that the pathways linking individual interest to academic self-regulation and achievement may differ from those linking academic self-efficacy to the same variables.

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1. Introduction

Academic self-regulation is a powerful predictor of academic achievement (Zimmerman, 1990). It represents the active and systematic utilization of self-processes to attain academic goals (Pintrich, 2000; Zimmerman, 2000) and is characterized by deep cognitive and motivational engagement during the act of learning (Schunk, 1991; Schunk & Pajares, 2005). Learners carry out academic self-regulation more effectively when they are highly motivated (Zimmerman & Schunk, 2008). They are more likely to plan, monitor, and reflect their goal attainment and adjust their regulatory processes accordingly, when they have strong beliefs about their competence, high values for their academic goals, or both.

Many researchers have reported that motivation indeed determines the degree to which students invest in academic self-regulation, which in turn predicts their subsequent academic achievement (Pintrich & De Groot, 1990; Zimmerman & Schunk, 2008). Abundant evidence has accumulated in the literature that attests to the importance of motivational constructs, which are primarily cognitive in nature, as facilitators of academic self-regulation and achievement. These constructs include academic self-efficacy, academic grade goals, task value, and mastery goals, to name a few (Hsieh, Sullivan, Sass, & Guerra, 2012; Pintrich, 1999; Zimmerman & Bandura, 1994; Zimmerman, Bandura, & Martinez-Pons, 1992). Researchers have also considered motivational constructs that are largely affective in nature, such as interest and anxiety, as a possible intervening mechanism in self-regulatory processes (Hidi & Renninger, 2006; Pekrun, Goetz, Titz, & Perry, 2002; Sansone & Thoman, 2005). However, these affective perspectives have received relatively little attention to date.

Not surprisingly, it is rare to find studies that have simultaneously addressed both cognitive and affective motivational constructs in relation to academic self-regulation. This is a serious shortcoming in our view, a tradition that could lead to an incomplete conclusion about how motivation, self-regulation, and achievement are interrelated. Self-regulatory processes triggered by the affective responses of learners toward a particular task or subject domain, as well as by the moment-to-moment fluctuations in their emotional states, can be qualitatively different from those triggered by cognitive constructs such as goals (Boekaerts & Corno, 2005). Nevertheless, the independent function affect plays in...
academic self-regulation and achievement, above and beyond that associated with cognitive constructs, remains to be demonstrated. The primary purpose of the present research was to explore whether individual interest, as an affective motivational construct, could predict academic self-regulation and subsequent achievement. More specifically, we tested whether individual interest could make an independent contribution to academic self-regulation and achievement in the presence of cognitive motivational constructs such as academic self-efficacy and academic goals, whose roles in self-regulatory processes have been clearly established (Pintrich, 1999; Zimmerman, 2002). We examined these relationships in the contexts of four different subject areas.

1.1. Academic self-regulation theories

Most representative theories of academic self-regulation divide the regulatory processes into several connected yet independent sub-processes. Zimmerman (2000), for example, defines academic self-regulation as a cyclical process consisting of the four phases, i.e., setting goals and plans, monitoring and controlling strategies, self-evaluation phases. His conceptualization is rooted in a social-cognitive perspective that emphasizes reciprocal interactions between person, behavior, and environment (Bandura, 1997). Pintrich (2000) proposes a similar framework for academic self-regulation, dividing it into four sub-processes: planning, monitoring, control, and reflection. What makes his theory comprehensive is his specification of four domains—cognition, motivation/afford, behavior, and environment—as targets of self-regulation. Winne’s (2001) model prescribes four phases of academic self-regulation from the information processing perspective and, as such, represents a cognitive approach to self-regulation. The four phases include understanding the task, setting goals and plans, monitoring and controlling strategies, and reflecting on studying.

Due to the goal-directedness shared by motivation and self-regulation, many researchers have examined the interrelationships between academic motivation, self-regulation, and achievement (Greene & Azevedo, 2007; Hsieh et al., 2012; Pintrich, 1999; Pintrich & De Groot, 1990; Zimmerman & Bandura, 1994; Zimmerman et al., 1992). Although these investigations leave little question that motivation is an indispensable component of the academic self-regulatory process, the constructs and approaches have been mostly cognitive without explicit provision of the role affective constructs play in this process (Hidi & Renninger, 2006).

1.2. Role of self-efficacy and goal-setting in academic self-regulation and achievement

Among the cognitive motivational constructs, academic self-efficacy has proven to be a particularly vital component in successful self-regulation of the learning process (Pintrich, 1999; Zimmerman & Schunk, 2008). Self-efficacy refers to the subjective conviction that one can successfully execute the behavior required to attain a desired outcome (Bandura, 1997). Academic self-efficacy more specifically refers to the conviction of learners that they can successfully perform a given academic task to a desired level (Schunk, 1991). Academic self-efficacy has established itself as a strong predictor for a diverse range of academic performance indexes (Mullt, Brown, & Lent, 1991; Schunk & Pajares, 2005). It is also closely linked to academic self-regulation, such that students with strong self-efficacy beliefs are also better self-regulated learners (Bandura, 1991; Schunk & Pajares, 2005).

Goal-setting is a crucial link that ties academic self-efficacy with successful academic self-regulation and achievement (Locke & Latham, 2002; Zimmerman & Bandura, 1994). Wood and Locke (1987) demonstrated that academic self-efficacy related to academic performance not only directly but also indirectly through the mediation of academic grade goals. In repeated tests of the hypothesized connections between self-regulatory self-efficacy, academic self-efficacy, grade goals, and achievement, Zimmerman and colleagues likewise reported that academic grade goals partially mediated the relationship between perceived self-efficacy for academic achievement and actual academic achievement. Perceived self-efficacy for academic achievement depended in part on perceived self-efficacy for self-regulated learning (Zimmerman & Bandura, 1994; Zimmerman et al., 1992).

These studies, therefore, successfully demonstrated the tight connection between self-regulatory efficacy, academic self-efficacy, grade goals, and achievement. They did not, however, directly test the role of actual self-regulation, as opposed to self-efficacy for self-regulation, as a mediator in the relationships between academic self-efficacy, grade goals, and achievement. We examined these mediational paths in the present study.

1.3. Role of individual interest in academic self-regulation and achievement

As described above, stronger beliefs of the students about their own academic competence help them set challenging academic goals, which in turn lead to better academic self-regulation and performance. This cognitive, or social cognitive, perspective on academic self-regulation, however, could run the risk of neglecting a potential influence from affective motivational constructs in self-regulatory processes (Boekaerts & Corno, 2005). Affective states of the students, such as anxiety, boredom, enjoyment, and pride, have been related significantly to the use of cognitive and self-regulatory strategies as well as achievement (Ahmed, van der Werf, Kuyper, & Minnaert, 2013; Pekrun et al., 2002). Theories of academic self-regulation without affective antecedents may hence be only a partial representation of the phenomenon.

In the present research, we examined the contribution of interest, as an affective motivational construct, to academic self-regulation and achievement. Unlike self-efficacy, few researchers have directly considered interest in the regulatory process. When they did, they often assessed broader constructs that included or were related to interest rather than interest per se. The most commonly assessed construct with an interest component is task value. Task value refers to learners’ subjective evaluation of a given task, activity, or domain, which consists of attainment value (i.e., perceived importance), intrinsic value (i.e., interest), utility value (i.e., perceived usefulness), and cost (Eccles & Wigfield, 2002). Although interest is conceptually distinct and often functions differently from other value components (see, e.g., Bong, 2001), many researchers have nonetheless treated task value as a unitary construct and examined its relationship with academic self-regulation (Berger & Karabenick, 2011; Pintrich & De Groot, 1990). Due to this empirical practice, the unique contribution of interest in academic self-regulation cannot be determined because it is confounded with other value components.

Although interest has both cognitive and affective aspects, its inherent affectivity most clearly distinguishes it from other motivational constructs (Hidi, 2006). Interest can be differentiated into individual interest and situational interest (Hidi, 1990; Hidi & Harackiewicz, 2000). Individual interest refers to learners’ positive affective representations of an academic task, activity, or subject domain. Situational interest, in comparison, refers to emotional reactions to particular learning episodes, which may be positive or negative in valence (Hidi, 1990). Individual interest is similar but distinguishable from intrinsic motivation, which possibly encompasses both individual and situational interest components. The positive feelings associated with individual interest typically precede the cognitive recognition that one desires to pursue the activity for its own sake (Hidi & Harackiewicz, 2000).
Our focus in this research was on individual interest, rather than situational interest, for several reasons. First, individual interest in a specific subject area is formed through positive experiences during prolonged participation in the tasks and activities related to that subject domain. As such, it represents a relatively enduring and well-developed form of interest, unlike situational interest that may be transient (Hidi & Harackiewicz, 2000; Hidi & Renninger, 2006). Second, strong evidence exists that individual interest of the learners plays a facilitative role in academic self-regulation, as it maintains positive relationships with students’ use of cognitive strategies, perceptions of skills, and academic achievement (Sansone & Thoman, 2005; Schiefele, 1991; Schiefele, Krapp, & Winteler, 1992). Third, all constructs had to be assessed in reference to subject matter domains, to avoid artificial differences in construct relations caused by differences in assessment specificity (Pajares, 1996). This condition required assessment of individual interest.

In traditional theories of motivation, affective motivational constructs such as interest have been considered as outcomes of cognitive and social cognitive motivational constructs such as self-efficacy (Hidi & Renninger, 2006). Several researchers have argued, however, that the relationship between the two classes of motivation would more likely be reciprocal (Hidi, 2006). In addition, a meta-analysis has shown that individual interest makes a significant contribution to various aspects of the learning process (Schiefele et al., 1992). Individual interest displays a significant link to academic achievement, which does not vanish even after controlling for the effects of student ability (Eccles & Wigfield, 2002; Schiefele et al., 1992). Further, affective states appear to influence students’ learning processes independently, regardless of the strengths of cognitive motivational constructs. For example, even when students possess strong beliefs of self-efficacy and set challenging academic goals, their self-regulatory processes are nevertheless interrupted by negative affect such as boredom and anxiety (Ahmed et al., 2013; Boekaerts & Corno, 2005; Pekrun et al., 2002). These results suggest that individual interest in particular activities or domains could enhance or deteriorate self-regulatory functions, independently of the motivational effects of goals or self-efficacy.

Recently, there have been attempts to directly incorporate interest into the model of academic self-regulation. However, in most of these studies, interest was viewed as a target or an outcome of regulation rather than a facilitator of the process (Hidi & Ainley, 2008; Sansone & Thoman, 2005). Based on the evidence documenting the independent role of affect from cognitive motivation (Ahmed et al., 2013; Pekrun et al., 2002), we hypothesized that individual interest would be an important motivational facilitator of academic self-regulation and achievement in conjunction with academic self-efficacy.

1.4. Role of gender in academic motivation, self-regulation, and achievement

In addition to testing the role of self-regulation as a mediator between academic self-efficacy and achievement, and the role of individual interest as an additional motivational predictor of academic self-regulation, we examined the role of gender in the overall pathways associated with academic self-regulation. According to the extant literature, the relationship between academic motivation and gender depends on the nature of the motivational constructs and the type of academic subject under investigation.

Gender differences in academic self-efficacy, for example, vary across academic subjects. Boys exhibit stronger academic self-efficacy in mathematics and science (Eccles, Wigfield, Harold, & Blumenfeld, 1993; Jacobs, Lanza, Osgood, Eccles, & Wigfield, 2002; Linn & Hyde, 1989; Pajares, 2002), while in reading, writing, and language arts, the pattern is less clear. Some studies demonstrate no gender difference in academic self-efficacy for these subject areas (Pajares, 2002, 2003), while others report that girls express stronger academic self-efficacy in these domains (Eccles et al., 1993; Jacobs et al., 2002). Gender differences in individual interest also vary across academic subjects. Boys show greater interest in mathematics and science, while girls show greater interest in English and literature (Linn & Hyde, 1989; Schiefele et al., 1992).

These motivational advantages for a particular gender in certain subject areas, however, do not necessarily yield comparable advantages in academic performance. Meta-analytic studies on gender differences show that there is almost no difference between girls and boys in verbal ability and mathematical performance in recent years, at least before they reach high school (Hyde, Femmema, & Lamon, 1990; Hyde & Linn, 1988). Few remaining differences in the indexes of academic ability and performance, albeit statistically significant, are negligible in effect sizes. While gender differences in motivation across academic subjects have been frequently observed, those in academic self-regulation are a rare occurrence. When they do occur, girls tend to display significantly better self-regulation than boys in many academic subject areas (Ablard & Lipschultz, 1998; Pajares, 2002; Zimmerman & Martinez-Pons, 1990). There is also evidence that this pattern holds true in academic subjects where boys show stronger academic self-efficacy and task value, such as mathematics (Meece & Painter, 2008).

That the stronger self-efficacy and interest of boys in mathematics and science do not necessarily result in better academic performance or self-regulation of boys in these areas suggests that other differences either negate boys’ motivational advantages, compensate for girls’ motivational disadvantages, or both, in the course of academic engagement. Compared to boys with similar strengths of self-efficacy in the subject, girls may set higher goals (Wood & Locke, 1987; Zimmerman & Bandura, 1994; Zimmerman et al., 1992), be better at maintaining positive emotional states during learning (Ahmed et al., 2013; Boekaerts & Corno, 2005; Pekrun et al., 2002), or simply invest more effort (Schiefele et al., 1992). Whereas tests of mean-level differences between genders could disclose whether girls and boys differ in the strengths of academic motivation, degrees of self-regulation, or levels of academic performance, they often cannot unveil where the differences originate from. When the directions of gender differences across closely connected constructs are not consistent with each other, as is the case with academic motivation and self-regulation or achievement, gender differences in how one construct relates to the others are strongly suspected. To obtain clues to the relative advantage of the girls in academic self-regulation witnessed in previous research, we systematically compared the strengths of the associations among the constructs between the genders.

1.5. Present study

Before testing the structural relationships between constructs, we tried to identify mean-level differences in student motivation and academic self-regulation between genders and academic subjects. Based on the existing evidence (Eccles et al., 1993; Jacobs et al., 2002; Linn & Hyde, 1989; Pajares, 2002), we hypothesized that boys would exhibit stronger self-efficacy and interest in mathematics and science, while girls would exhibit stronger self-efficacy and interest in verbal subjects. We hypothesized that these motivational differences would not necessarily result in significant differences in achievement according to gender, in keeping with previous research (Hyde & Linn, 1988; Hyde et al., 1990). We expected girls to demonstrate better academic self-regulation than...

To address our main research questions in this research, we specified academic self-efficacy and individual interest as two correlated yet independent motivational predictors of academic self-regulation and achievement (Hidi, 2006). In testing the complex interrelations between academic self-efficacy, interest, grade goals, self-regulation, and achievement, we first tested a model with \textit{a priori} paths only, confirmed by or generated based on previous findings. These paths are indicated by solid lines in Fig. 1.

Specifically, we hypothesized that academic self-efficacy would predict academic self-regulation and achievement directly as well as indirectly with academic grade goals as a mediator (Wood & Locke, 1987; Zimmerman & Bandura, 1994; Zimmerman et al., 1992). Based on the theoretical accounts of self-regulatory processes (Pintrich & De Groot, 1990; Zimmerman & Schunk, 2008), we also hypothesized that the relationship between academic grade goals and achievement would be mediated by academic self-regulation. Based on previous findings that task value, including interest, correlates with academic self-regulation and that academic self-regulation predicts achievement (Pintrich, 1999; Pintrich & De Groot, 1990), we further hypothesized that the relationship between individual interest and achievement would be mediated by academic self-regulation.

Next, we tested three alternative models, each of which included a single additional path to the hypothesized model with \textit{a priori} paths described above. These alternative models considered the possibility of (a) a direct path from academic self-efficacy to academic self-regulation, not mediated by academic grade goals, (b) a direct path from individual interest to academic grade goals, or (c) a direct path from individual interest to academic achievement, not mediated by academic self-regulation. These paths are indicated by dotted lines in Fig. 1. Path ‘a’ ascertains the assumption that goal-setting is indeed an indispensable step in the self-regulatory process (Pintrich, 2000; Winne, 2001), even for highly self-efficacious learners (Locke & Latham, 2002; Zimmerman, 2000), whereas Path ‘b’ examines if goal-setting is also required for learners with strong individual interest before they start engaging in academic self-regulation. Path ‘c’ tests whether individual interest could lead to higher achievement (Schiefelle et al., 1992), without the help of academic self-regulation as a mediating process. We tested alternative models with these additional paths in four subject areas—Korean, mathematics, English, and science—and determined the best-fitting model by consulting multiple fit indexes and comparing the model fit between the hypothesized and alternative models.

Finally, we examined whether the hypothesized self-regulatory pathways differed according to gender. Schiefelle et al.’s (1992) meta-analysis showed that individual interest predicted academic achievement of boys better than it predicted academic achievement of girls across multiple subjects. Based on this finding, we hypothesized that interest would link more strongly to other constructs among boys than it would among girls. In light of the evidence attesting to better academic self-regulation (Ablard & Lipschultz, 1998; Pajares, 2002; Zimmerman & Martinez-Pons, 1990) and comparable academic performance (Hyde & Linn, 1988; Hyde et al., 1990) of girls compared to boys even in areas where they are short of academic motivation, we suspected other paths in the model such as those from academic self-efficacy and grade goals to academic self-regulation and achievement might be stronger among girls than among boys. However, evidence was not sufficient for generating specific hypotheses regarding individual paths.

Therefore, we took a two-step approach to systematically address this issue. First, we fitted a measurement invariance model in which all factor loadings were constrained to be equal in the girl and the boy group for each academic subject. This was a necessary step to ensure that any difference in the structural paths later observed was not simply due to different meaning girls and boys attached to relevant items. We hypothesized that these models with equality constraints would fit the data well because there was no reason to expect the two genders to interpret the items differently. Second, when the measurement invariance models demonstrated an acceptable fit to the data, thus indicating that the items functioned comparably with regards to gender, we imposed additional invariance constraints on the structural paths of interest. By evaluating deterioration in the model fit caused by the forced equality in relation to the degrees of freedom acquired, we made decisions regarding whether any of the paths differed significantly for girls and boys. Structural invariance models should demonstrate a significantly poorer fit compared to the fit of the original model, if they contain a path that is significantly different between girls and boys.

2. Method

2.1. Participants and procedure

Five hundred middle school students (132 from the 7th grade, 239 from the 8th grade, and 129 from the 9th grade) from two middle schools in two suburban cities near Seoul, Korea, participated in two separate surveys. The surveys took place once each semester within an academic year during designated school hours, after approximately two months into the semester. Students took around forty minutes on average to complete each survey.

The two surveys addressed different sets of research questions and hence consisted of different sets of items. Data from the
first-semester survey, which focused on achievement goal orientations, were analyzed as part of research published elsewhere (Bong, 2009). In the present research, we analyzed data from the second-semester survey, which focused on academic self-regulation. The sample for this study included 253 girls, 246 boys, and one who did not indicate gender. The schools provided the participating students’ scores for the final examinations of the semester in the academic subjects under investigation. These scores served as the index for achievement.

2.2. Measures

The survey measured academic self-efficacy and grade goals as primarily cognitive motivational constructs, individual interest as an affective motivational construct, and the use of self-regulatory strategies as an index of academic self-regulation in four academic subjects: Korean as a native language, mathematics, English as a foreign language, and science. We used parallel items to assess these variables, which were consistent with other scales. A 5-point Likert-type response scale with appropriate verbal descriptors, ranging from 1 (not at all confident) to 5 (very confident). Reliability estimates of the academic self-efficacy scale were acceptable for all four academic subjects ($\alpha = .88, .92, .92,$ and .92 in Korean, mathematics, English, and science, respectively).

2.2.2. Individual interest

The individual interest measure consisted of one item (“How interested am I in the content taught in Korean?”) adopted from the Motivated Strategies for Learning Questionnaire (MSLQ; Pintrich, Smith, Garcia, & McKeachie, 1991) and two items (“How much do I look forward to English classes?” and “How much do I enjoy studying English?”) adopted from Marsh, Trautwein, Lüdtke, Köller, and Baumert (2005) measure of class-specific interest. The individual interest items asked participants to report their relatively-stable affective orientations to each of the four subject domains, rather than their spontaneous and momentary emotional reactions (Hidi, 1990). We changed the format of the items from questions to statements (e.g., “I enjoy studying English”) to make them consistent with other scales. A 5-point Likert-type response scale was provided with appropriate verbal descriptors, ranging from 1 (not at all true) to 5 (very true). Reliability estimates of the individual interest scale were acceptable for all four academic subjects ($\alpha = .81, .87, .89,$ and .85 in Korean, mathematics, English, and science, respectively).

2.2.3. Academic grade goals

We adopted two items from Zimmerman and Bandura (1994) for assessing academic grade goals. In their original research, one

### Table 1

Descriptive and difference statistics across gender and academic subjects.

<table>
<thead>
<tr>
<th>Variable</th>
<th>No. of items</th>
<th>Alpha</th>
<th>Girls (n = 253) Mean (SD)</th>
<th>Boys (n = 246) Mean (SD)</th>
<th>t</th>
<th>Cohen's $d$</th>
</tr>
</thead>
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<tr>
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<td>4</td>
<td>.88</td>
<td>3.81 (.96)</td>
<td>3.88 (1.03)</td>
<td>–.79</td>
<td>–.07</td>
</tr>
<tr>
<td>Mathematics</td>
<td>4</td>
<td>.92</td>
<td>3.56 (1.16)</td>
<td>3.81 (1.14)</td>
<td>–.50*</td>
<td>–.22</td>
</tr>
<tr>
<td>English</td>
<td>4</td>
<td>.92</td>
<td>3.77 (1.11)</td>
<td>3.82 (1.15)</td>
<td>–.46</td>
<td>–.04</td>
</tr>
<tr>
<td>Science</td>
<td>4</td>
<td>.92</td>
<td>3.46 (1.13)</td>
<td>3.74 (1.12)</td>
<td>–.78*</td>
<td>–.25</td>
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<td>F(df)</td>
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<td></td>
<td>19.78(3)*</td>
<td>5.70(3)*</td>
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<td></td>
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<tr>
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<td></td>
<td></td>
<td>.19</td>
<td>.07</td>
<td></td>
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<tr>
<td>Academic grade goal</td>
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</tr>
<tr>
<td>Korean</td>
<td>2</td>
<td>.81</td>
<td>3.49 (.62)</td>
<td>3.40 (.71)</td>
<td>1.48</td>
<td>.14</td>
</tr>
<tr>
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<td>.84</td>
<td>3.36 (.74)</td>
<td>3.41 (.77)</td>
<td>–.66</td>
<td>.07</td>
</tr>
<tr>
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<td>3.48 (.72)</td>
<td>3.42 (.76)</td>
<td>.84</td>
<td>.08</td>
</tr>
<tr>
<td>Science</td>
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<td>3.34 (.78)</td>
<td>–.08</td>
<td>.00</td>
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<td>9.82(3)*</td>
<td>2.25(3)</td>
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<td>.11</td>
<td>.03</td>
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<tr>
<td>Individual interest</td>
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<td>Korean</td>
<td>3</td>
<td>.81</td>
<td>2.85 (.91)</td>
<td>2.87 (.93)</td>
<td>–.16</td>
<td>–.01</td>
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<td>.87</td>
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<td>3.19 (1.14)</td>
<td>–.43*</td>
<td>–.38</td>
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<td>–.15</td>
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<td>Science</td>
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<td>2.95 (.99)</td>
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<td>11.03(3)</td>
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<td>Partial $\eta^2$</td>
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<td>.03</td>
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<td>Korean</td>
<td>3</td>
<td>.64</td>
<td>3.31 (.86)</td>
<td>3.20 (.89)</td>
<td>1.40</td>
<td>.13</td>
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<td>Mathematics</td>
<td>3</td>
<td>.74</td>
<td>3.05 (.89)</td>
<td>3.24 (.94)</td>
<td>–.22*</td>
<td>–.21</td>
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<tr>
<td>English</td>
<td>3</td>
<td>.71</td>
<td>3.24 (.89)</td>
<td>3.23 (.97)</td>
<td>.15</td>
<td>.01</td>
</tr>
<tr>
<td>Science</td>
<td>3</td>
<td>.75</td>
<td>3.14 (.93)</td>
<td>3.24 (.95)</td>
<td>–.22</td>
<td>–.05</td>
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<td>Partial $\eta^2$</td>
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<td>.08</td>
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<td></td>
</tr>
<tr>
<td>Korean</td>
<td>–</td>
<td>–</td>
<td>75.63 (18.08)</td>
<td>71.00 (19.58)</td>
<td>2.75*</td>
<td>.25</td>
</tr>
<tr>
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<td>–</td>
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<td>68.07 (22.64)</td>
<td>66.85 (23.06)</td>
<td>.60</td>
<td>.05</td>
</tr>
<tr>
<td>English</td>
<td>–</td>
<td>–</td>
<td>71.05 (19.02)</td>
<td>69.07 (19.81)</td>
<td>1.14</td>
<td>.10</td>
</tr>
<tr>
<td>Science</td>
<td>–</td>
<td>–</td>
<td>76.24 (19.29)</td>
<td>72.14 (21.56)</td>
<td>2.24*</td>
<td>.20</td>
</tr>
</tbody>
</table>

Note: A 5-point Likert-type response scale was used for academic self-efficacy, interest, and academic self-regulation. Academic grade goal responses could range from 1 to 4. Academic achievement scores could range from 0 to 100. Academic achievement was not compared across academic subjects as unstandardized actual scores were used.

*p < .05.

**p < .01.
was conceptualized as a grade goal item ("What academic grade are you striving for in Korean this semester?") and the other as a self-evaluative standard item ("What is the lowest grade that you could get and still be satisfied with in Korean?"). However, our preliminary analysis on the measurement properties of the scale showed that the participants did not distinguish between these two items clearly. Therefore, we treated both items as indicators of academic grade goals in this study. The response scale ranged from 1 to 4, each corresponding to a letter grade from 'A' to 'D'. The responses were reverse-scored so that higher scores indicate higher academic grade goals. The academic grade goal scale produced acceptable reliability estimates in all four academic subjects (αs = .81, .84, .87, and .85 in Korean, mathematics, English, and science, respectively).

2.2.4. Academic self-regulation

We assessed academic self-regulation in each of the four academic subjects with three items adopted from the self-regulation measure of the MSLQ (Pintrich & De Groot, 1990; Pintrich et al., 1991). These items represented the three key self-regulatory processes: planning, monitoring, and reflecting (Pintrich, 1999). As an example of how they were adapted for this study, the items assessing self-regulation in mathematics were: "Before I begin studying mathematics, I think about the things I will need to learn," "I ask myself questions to make sure I understand the things I have been studying in mathematics," and "When I am studying mathematics, I stop once in a while and go over what I have learned." The response scale ranged from 1 (not at all true) to 5 (very true). Reliability estimates of the academic self-regulation scale for the four subject domains were slightly lower than those of the other scales but acceptable nonetheless (αs = .64, .74, .71, and .75 in Korean, mathematics, English, and science, respectively). We suspect that the relatively small number of items in this scale contributed to the lower reliability estimates.

2.2.5. Achievement scores

The school provided the actual scores obtained by the participating students in their second-semester final examinations for each academic subject. The scores from these examinations had a possible range of 0–100.

2.3. Data analysis

We computed descriptive and correlational statistics separately for girls and boys. We conducted independent-samples t-tests to examine mean-level differences in academic motivation, self-regulation, and achievement scores by gender. We also conducted repeated measures analysis of variance (ANOVA) with the Student–Newman–Keuls post hoc test to determine mean-level differences in academic motivation and self-regulation across subject domains. To detect significant differences in the correlation coefficients among the variables according to gender, we compared the correlation coefficients using Fisher’s Z-score method. There were only a small number of missing responses per item (i.e., less than 2% across all items), which were imputed using the expectation-maximization (EM) algorithm for subsequent analysis. We used SPSS 12.0 for the analysis.

To test our hypothesized model of academic self-regulation, we performed structural equation modeling (SEM), using AMOS 16.0 (Arbuckle, 2007). Models were fitted separately for each of the four academic subjects. A bootstrapping method with 1000 bootstrap samples was used to test the significance of mediation effects (Preacher & Hayes, 2004). We then conducted measurement invariance and structural invariance tests between girls and boys to see whether there was a significant gender difference in the relationship between student motivation, academic self-regulation, and achievement (Byrne, 2004). We consulted chi-square statistics, the root mean square error of approximation (RMSEA) with a 90% confidence interval, the comparative fit index (CFI), and the non-normed fit index (NNFI) to assess the model fit. We deemed the fit to be acceptable when the RMSEA value was less than .08 and the CFI and the NNFI values were greater than .90 (Kline, 2005, pp. 133–145). We used chi-square difference tests to compare the fit of the nested models.

3. Results

3.1. Descriptive statistics

Table 1 presents descriptive statistics, including Cronbach’s alpha reliability estimates for the individual measures. Table 1 also presents the results of the t-tests and repeated measures analysis of variance (ANOVA) we performed to test differences in mean-levels by gender and across academic subjects.

3.1.1. Mean-level differences by gender

Independent-samples t-tests between girls and boys demonstrated that girls showed significantly lower academic self-efficacy in mathematics, t(497) = −2.50, p < .05, Cohen’s d = −.22, and science, t(497) = −2.78, p < .01, Cohen’s d = −.25, than boys did. Girls also showed significantly lower interest in mathematics, t(497) = −4.36, p < .01, Cohen’s d = −.38, and science, t(497) = −4.11, p < .01, Cohen’s d = −.37. Contrary to our expectations, girls also reported significantly lower academic self-regulation in mathematics than boys did, t(497) = −2.27, p < .05, Cohen’s d = −.21. In contrast, girls attained significantly higher achievement scores in Korean, t(497) = 2.75, p < .01, Cohen’s d = .25, and science, t(497) = 2.24, p < .05, Cohen’s d = .20. No other gender difference was significant (see Table 1).

3.1.2. Mean-level differences across academic subjects within gender

Repeated measures ANOVA across academic subjects within gender yielded significant between-subject differences for most comparisons. Girls expressed significantly stronger academic self-efficacy, F(3,250) = 19.78, p < .01, partial η² = .19 (Korean > English > mathematics > science), higher academic grade goals, F(3,250) = 9.82, p < .01, partial η² = .11 (Korean > English > mathematics > science), and better academic self-regulation, F(3,250) = 7.48, p < .01, partial η² = .08 (Korean > English > science > mathematics), in the two verbal subjects than they did in mathematics and science. However, girls’ interest in science was not significantly different from their interest in the two verbal subjects and significantly higher than that in mathematics, F(3,250) = 2.68, p < .05, partial η² = .03 (science > English > Korean > mathematics). The pattern of between-subject differences for boys was less consistent than that for girls. Similar to girls, boys displayed significantly stronger academic self-efficacy in the verbal subjects than in science, F(3,243) = 5.70, p < .01, partial η² = .07 (Korean > English > mathematics > science). However, despite their relatively lower

1 Because the achievement scores were unstandardized, they could not be compared across academic subjects. Though we recognize this limitation, we decided to use the actual standardized achievement scores, because participants’ responses to the motivation and grade goal items were made in reference to their actual scores. We also feared that standardizing the scores would unduly restrict the variability in the responses and affect the results negatively.

2 “English = Korean > mathematics” denotes the results of the Student–Newman–Keuls post hoc tests. That is, the mean value of interest in mathematics was lower than that in English, and this difference was statistically significant. The mean value of interest in mathematics was also lower than that in Korean, but this difference was not statistically significant.
3.1. Differences in correlation coefficients by gender

Table 2 shows the correlation coefficients of the variables in each subject, estimated for girls and boys separately. Coefficients that are significantly different between girls and boys, as determined by Fisher’s Z scores, are boldfaced and underlined. There existed no significant difference between the genders for most of the correlations. Specifically, the correlation between individual interest and self-regulation was stronger for boys than girls in English, \( Z = -2.55, p < .05 \), and science, \( Z = -2.70, p < .01 \). The correlation between individual interest and self-efficacy in English, \( Z = 2.49, p < .05 \), and that between academic grade goals and academic self-regulation in Korean, \( Z = 2.29, p < .05 \), were stronger for girls than boys.

3.2. Tests of measurement models

Before testing our hypothesized structural model, we tested measurement models as a preliminary step. Individual items functioned as indicators of their respective latent variable. Table 3 presents the results of these analyses. We first fitted a measurement model with no error covariation. The fit of this model was less than acceptable, as the RMSEA values in all four subjects were greater than .08. Modification indexes suggested that allowing the errors of the first two and the last two self-efficacy items to covary would significantly improve the model fit. This made sense because the self-efficacy items used identical wording (e.g., “How confident are you about getting a grade of “B” or above in mathematics this semester?”) except for the target letter grade, and Korean students make a distinction between the grades of “A” and “B” and those of “C” and “D,” generally accepting the former as good grades and the latter as poor grades. As Table 3 shows, adding two correlated error paths between the self-efficacy items substantially reduced the RMSAE values and increased the CFI and NNFI values in all subjects.

It should be noted that having to incorporate these error term correlations does not necessarily mean that the self-efficacy measure was not unidimensional. Quite the contrary, exploratory factor analysis of the self-efficacy responses produced a single-factor solution for all four academic subjects, which accounted for up to 81.7% of the total variance (an average percentage accounted for = 79.8%).

3.3. Structural equation modeling

3.3.1. Hypothesized versus alternative models

We then tested whether our hypothesized model fit the data better compared with other alternative models in each of the four academic subjects. Because the hypothesized model and the Alternative Models 1, 2, and 3 are nested models (see Fig. 1), we performed chi-square difference tests to determine whether adding an additional Path ‘a,’ ‘b,’ or ‘c,’ respectively, reduced the chi-square value and hence improved the model fit significantly from that of the hypothesized model.

As presented in Table 4, the hypothesized model fit the data best in all academic subjects except Korean. Adding an extra path to the hypothesized model was not able to improve the model fit significantly in mathematics, English, or science. In Korean, Alternative Model 1 reduced the chi-square value significantly as judged by the chi-square difference test. Nonetheless, the reduction in the chi-square value was not accompanied by noticeable changes in other fit indexes. Overall, the improvement was deemed negligible. Moreover, adding a direct path from academic self-efficacy to self-regulation (i.e., Path ‘a’ in Fig. 1) as in Alternative Model 1 made this extra path as well as the path from academic grade goals to self-regulation statistically non-significant. These results are not consistent with theory or previous findings. Therefore, for both theoretical reasons and to maintain consistency with the results from the other subject areas, we decided that the hypothesized model best represented the empirical data in all four academic subjects and used it as the basis for subsequent invariance testing.

Fig. 2 presents the standardized path coefficients from the hypothesized model in each subject domain. All theoretically prescribed structural paths proved to be statistically significant at \( p < .05 \) for the whole sample, except for the one from academic
self-regulation to achievement in science. Specifically, the relationship between academic self-efficacy and academic achievement was partially mediated by academic grade goals in all academic subjects. The standardized coefficients for the direct paths from academic self-efficacy to achievement in Korean, mathematics, English, and science were .25, .35, .30, and .28, respectively. The magnitude of the indirect relationship from academic self-efficacy to achievement mediated by academic self-regulation was .05 (95% CI: .00, .07), .01 (p < .05 [95% CI: .00, .04]), and .02 (p < .05 [95% CI: .01, .05]) in Korean, mathematics, and English. The indirect relationship of academic grade goals to achievement via academic self-regulation was not significant in science.

In comparison to academic self-efficacy, which linked directed academic achievement and indirectly via academic grade goals and self-regulation in the subject, individual interest did not predict academic achievement directly in any of the four subjects. Instead, it indirectly predicted achievement via academic self-regulation. The relationship between individual interest and achievement was fully mediated by academic self-regulation in Korean, mathematics, and English. The magnitude of the indirect relationship between individual interest and academic achievement mediated by academic self-regulation was .05 (95% CI: .00, .10), .05 (95% CI: .00, .10), and .06 (95% CI: .01, .12), all ps < .05, in Korean, mathematics, and English, respectively.

### 3.3.2. Tests of gender invariance

Because the literature suggests significant gender differences in interest and self-efficacy across domains and also in the relationship between interest and academic achievement, we performed gender invariance testing using multi-group SEM. Table 5 reports the results from the invariance tests. We first specified the baseline model with no constraint of invariance, in which all parameters were separately estimated for the girl and boy groups. When this model demonstrated an acceptable fit, we proceeded with testing other models with equality constraints imposed on other paths of interest.

### Table 3

<table>
<thead>
<tr>
<th>Measurement model</th>
<th>Academic subject</th>
<th>Chi-square</th>
<th>df</th>
<th>RMSEA (90% CI)</th>
<th>CFI</th>
<th>NNFI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model without error term correlation</td>
<td>Korean</td>
<td>317.99</td>
<td>48</td>
<td>.106 (.095, .117)</td>
<td>.91</td>
<td>.87</td>
</tr>
<tr>
<td>Mathematics</td>
<td>302.04</td>
<td>48</td>
<td>.103 (.092, .114)</td>
<td>.94</td>
<td>.91</td>
<td></td>
</tr>
<tr>
<td>English</td>
<td>315.61</td>
<td>48</td>
<td>.106 (.095, .117)</td>
<td>.93</td>
<td>.91</td>
<td></td>
</tr>
<tr>
<td>Science</td>
<td>202.19</td>
<td>48</td>
<td>.080 (.069, .092)</td>
<td>.96</td>
<td>.94</td>
<td></td>
</tr>
</tbody>
</table>

### Table 4

<table>
<thead>
<tr>
<th>Academic subject</th>
<th>Model</th>
<th>Chi-square</th>
<th>df</th>
<th>RMSEA (90% CI)</th>
<th>CFI</th>
<th>NNFI</th>
<th>Δχ² (Δdf = 1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Korean</td>
<td>Hypothesized model</td>
<td>119.01</td>
<td>57</td>
<td>.047 (.035, .059)</td>
<td>.98</td>
<td>.97</td>
<td>9.73**</td>
</tr>
<tr>
<td>Alternative Model 1</td>
<td>109.28</td>
<td>56</td>
<td>.044 (.031, .056)</td>
<td>.98</td>
<td>.98</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alternative Model 2</td>
<td>118.15</td>
<td>56</td>
<td>.047 (.035, .059)</td>
<td>.98</td>
<td>.97</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alternative Model 3</td>
<td>119.01</td>
<td>56</td>
<td>.047 (.036, .059)</td>
<td>.98</td>
<td>.97</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mathematics</td>
<td>Hypothesized model</td>
<td>108.75</td>
<td>57</td>
<td>.043 (.030, .055)</td>
<td>.99</td>
<td>.98</td>
<td>–</td>
</tr>
<tr>
<td>Alternative Model 1</td>
<td>108.11</td>
<td>56</td>
<td>.043 (.031, .055)</td>
<td>.99</td>
<td>.98</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alternative Model 2</td>
<td>107.96</td>
<td>56</td>
<td>.043 (.031, .055)</td>
<td>.99</td>
<td>.98</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alternative Model 3</td>
<td>108.70</td>
<td>56</td>
<td>.043 (.031, .056)</td>
<td>.99</td>
<td>.98</td>
<td></td>
<td></td>
</tr>
<tr>
<td>English</td>
<td>Hypothesized model</td>
<td>166.78</td>
<td>57</td>
<td>.062 (.051, .073)</td>
<td>.97</td>
<td>.96</td>
<td>–</td>
</tr>
<tr>
<td>Alternative Model 1</td>
<td>164.87</td>
<td>56</td>
<td>.062 (.052, .074)</td>
<td>.97</td>
<td>.96</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alternative Model 2</td>
<td>165.92</td>
<td>56</td>
<td>.063 (.052, .074)</td>
<td>.97</td>
<td>.96</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alternative Model 3</td>
<td>166.64</td>
<td>56</td>
<td>.063 (.052, .074)</td>
<td>.97</td>
<td>.96</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Science</td>
<td>Hypothesized model</td>
<td>87.87</td>
<td>57</td>
<td>.033 (.018, .046)</td>
<td>.99</td>
<td>.99</td>
<td>–</td>
</tr>
<tr>
<td>Alternative Model 1</td>
<td>84.13</td>
<td>56</td>
<td>.032 (.016, .045)</td>
<td>.99</td>
<td>.99</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alternative Model 2</td>
<td>87.25</td>
<td>56</td>
<td>.033 (.019, .047)</td>
<td>.99</td>
<td>.99</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alternative Model 3</td>
<td>87.45</td>
<td>56</td>
<td>.034 (.019, .047)</td>
<td>.99</td>
<td>.99</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: N = 500. RMSEA = root mean square error of approximation; CI = confidence interval; CFI = comparative fit index; NNFI = non-normed fit index.

** p < .01.

** p < .05.
Model I is a measurement invariance model, constraining all factor loadings to be equal across the two samples. For this model, eight equality constraints imposed on factor loadings earned eight degrees of freedom from the baseline model. The chi-square value rose accordingly, but not to the degree that brought significant decrement in model fit from the baseline model. We thus concluded that the items functioned comparably for girls and boys and any subsequent difference in structural paths could not be attributed to the difference in how girls and boys interpreted the items. All subsequent models were created by adding one or more equality constraints to Model I. Therefore, the fit of the subsequent models was compared to that of Model I for evaluating the plausibility of the additional constraints.

Based on previous research suggesting that the strength of the relationship between individual interest and other constructs varies depending on gender (e.g., Schiefele et al., 1992), we first tested whether the path from individual interest to academic self-regulation was significantly different according to gender. This decision was aided by the significant gender difference in the correlation between individual interest and academic self-regulation observed in English and science in this study (see Table 2). Model II thus imposed an invariance constraint on this path, in addition to the invariance constraints on the factor loadings in Model I. Therefore, the fit of the subsequent models was compared to that of Model I for evaluating the plausibility of the additional constraints.

When the comparison of fit between Models I and II proved to be non-significant, indicating that the path from individual interest to self-regulation was similar for both genders, we tested the invariance of additional structural paths by sequentially constraining each remaining path in Model II. In contrast, if the comparison between Models I and II proved statistically significant, indicating that the path from individual interest to self-regulation was indeed significantly different between girls and boys, we let this path be estimated separately for each gender. We then proceeded with testing the invariance of other structural paths in the model by sequentially adding equality constraints to Model I. Only models with significant chi-square difference statistics (i.e., significant decrement in fit due to the invariance constraints) are included in Table 5 to conserve space. The final model for each subject represents the model with freely estimated parameters for both genders, except for those paths that proved to be equal for girls and boys according to the invariance tests. All final models provided an excellent fit with the data in each subject, one that was comparable to or better than the fit of the baseline or competing models, despite the substantial increase in the degrees of freedom.

As expected, individual interest functioned as a significantly stronger predictor of academic self-regulation for boys than for girls in all subjects but Korean. In mathematics, English, and science, individual interest directly predicted academic self-regulation with $b_s = .53, .70, .79$, all $p < .01$, for boys but with $b_s = .43, .41, .60$, all $p < .01$, for girls, respectively. Another path that differed significantly for girls and boys in three out of the four school subjects was the one linking academic grade goals to achievement. This path was significantly stronger for girls, $b_s = .57, .42, .57$, all $p < .01$, in Korean, English, and science, respectively, than it was for boys, $b_s = .09, p > .05$, in Korean, $b_s = .35, p < .01$, in English, and $b_s = .20, p < .05$, in science. Finally, the direct path from academic self-efficacy to achievement was significantly stronger for boys than it was for girls. The prediction coefficients for boys were $b_s = .48$ and .47, both with $p < .01$, in Korean and science, respectively. These values compare with the coefficients for the same paths for girls, $b_s = .00$ and .17, both with $p > .05$.

Fig. 2. Standardized path coefficients for the hypothesized model, separately estimated for four academic subjects. Path coefficients for girls are presented on the left of the slashes and those for boys are presented on the right when the gender difference was statistically significant. * $p < .05$. ** $p < .01$.

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3 Full results of the invariance tests are available from the first author upon request.
In the present study, we aimed to identify whether our hypothesized model of academic self-regulation accurately described the relationships between academic self-efficacy, interest, grade goals, self-regulation, and achievement in students. The following is a summary of the conclusions that can be drawn from our study: (a) individual interest in the subject predicts academic self-regulation in the subject above and beyond the prediction by academic self-efficacy and grade goals; (b) although individual interest directly predicts academic self-regulation, it does not predict grade goals or achievement in the subject directly; (c) academic self-regulation in the subject fully mediates the relationship of individual interest to academic achievement in the subject; (d) grade goals in the subject fully mediate the relationship of academic self-efficacy to self-regulation in the subject; however, (e) grade goals only partially mediate the relationship of academic self-efficacy to achievement in the subject.

Highly consistent results emerged across the four subject areas, increasing the likelihood that the present findings are generalizable for a variety of settings. In addition, several paths proved to be significantly different for girls and boys, offering theoretical and practical implications for future research on academic self-regulation.

4.1. Self-efficacy, grade goals, and a cognitive pathway to academic self-regulation

We once again confirmed the facilitative role of academic self-efficacy in academic self-regulation and achievement. Consistent with previous findings (Multon et al., 1991; Zimmerman, 2002), students’ beliefs of academic self-efficacy assessed in the middle of the semester in reference to a particular subject domain predicted students’ performance on their subject final examination at the end of the semester. The predictive link between academic self-efficacy and achievement was significant in all four subject domains.

We also observed that academic grade goals functioned as a crucial link in the relationship between academic self-efficacy, academic self-regulation, and academic achievement, consistent with goal-setting theory (Locke & Latham, 2002). Previous studies have repeatedly evidenced the partial mediational effects of academic grade goals in the link between academic self-efficacy and achievement (Zimmerman & Bandura, 1994; Zimmerman et al., 1992). However, they did not directly test the mediational effects of academic grade goals in the link between academic self-efficacy and academic self-regulation. What they demonstrated instead was the mediational role of academic grade goals in the link between academic self-efficacy and academic self-regulation. The non-significant path from academic self-regulation to achievement in science indicates that students’ engagement in higher-order self-regulatory processes such as planning, monitoring, and reflecting did not necessarily help them achieve higher scores on the science test. In other words, relying on surface strategies such as simple memorization did not penalize them in this subject.

### Table 5
Invariance test statistics.

<table>
<thead>
<tr>
<th>Academic subject</th>
<th>Model</th>
<th>Paths with invariance constraints</th>
<th>Chi-square</th>
<th>df</th>
<th>RMSEA (90% CI)</th>
<th>CFI</th>
<th>NNFI</th>
<th>Δχ²(Adj df)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Korean</td>
<td>Baseline model</td>
<td>–</td>
<td>173.73</td>
<td>114</td>
<td>.032 (.022, .042)</td>
<td>.98</td>
<td>.97</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>Model I</td>
<td>All factor loadings</td>
<td>177.26</td>
<td>122</td>
<td>.030 (.020, .040)</td>
<td>.98</td>
<td>.98</td>
<td>3.53(8)</td>
</tr>
<tr>
<td></td>
<td>Model II</td>
<td>Constraints in Model I + interest → self-regulation</td>
<td>179.36</td>
<td>123</td>
<td>.030 (.020, .040)</td>
<td>.98</td>
<td>.98</td>
<td>2.10(1)</td>
</tr>
<tr>
<td></td>
<td>Model III</td>
<td>Constraints in Model II + grade goal → achievement</td>
<td>188.84</td>
<td>124</td>
<td>.032 (.023, .041)</td>
<td>.98</td>
<td>.97</td>
<td>9.48(1)</td>
</tr>
<tr>
<td></td>
<td>Model IV</td>
<td>Constraints in Model II + self-efficacy → achievement</td>
<td>190.47</td>
<td>124</td>
<td>.033 (.023, .042)</td>
<td>.98</td>
<td>.97</td>
<td>11.11(1)</td>
</tr>
<tr>
<td></td>
<td>Final model</td>
<td>All factor loadings, all structural paths, except grade goal → achievement and self-efficacy → achievement</td>
<td>182.45</td>
<td>126</td>
<td>.030 (.020, .039)</td>
<td>.98</td>
<td>.98</td>
<td>5.19(4)</td>
</tr>
<tr>
<td>Mathematics</td>
<td>Baseline model</td>
<td>–</td>
<td>171.37</td>
<td>114</td>
<td>.032 (.021, .041)</td>
<td>.99</td>
<td>.98</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>Model I</td>
<td>All factor loadings</td>
<td>186.43</td>
<td>122</td>
<td>.033 (.023, .042)</td>
<td>.98</td>
<td>.98</td>
<td>15.06(8)</td>
</tr>
<tr>
<td></td>
<td>Model II</td>
<td>Constraints in Model I + interest → self-regulation</td>
<td>190.56</td>
<td>123</td>
<td>.033 (.024, .042)</td>
<td>.98</td>
<td>.98</td>
<td>4.13(1)</td>
</tr>
<tr>
<td></td>
<td>Final model</td>
<td>All factor loadings, all structural paths, except interest → self-regulation</td>
<td>190.78</td>
<td>127</td>
<td>.032 (.022, .041)</td>
<td>.98</td>
<td>.98</td>
<td>4.05(5)</td>
</tr>
<tr>
<td>English</td>
<td>Baseline model</td>
<td>–</td>
<td>221.92</td>
<td>114</td>
<td>.044 (.035, .052)</td>
<td>.98</td>
<td>.97</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>Model I</td>
<td>All factor loadings</td>
<td>229.05</td>
<td>122</td>
<td>.042 (.034, .050)</td>
<td>.98</td>
<td>.97</td>
<td>7.13(8)</td>
</tr>
<tr>
<td></td>
<td>Model II</td>
<td>Constraints in Model I + interest → self-regulation</td>
<td>241.63</td>
<td>123</td>
<td>.044 (.036, .052)</td>
<td>.97</td>
<td>.97</td>
<td>12.58(1)</td>
</tr>
<tr>
<td></td>
<td>Model V</td>
<td>Constraints in Model I + grade goal → achievement</td>
<td>232.90</td>
<td>123</td>
<td>.042 (.034, .051)</td>
<td>.97</td>
<td>.97</td>
<td>3.85(1)</td>
</tr>
<tr>
<td></td>
<td>Final model</td>
<td>All factor loadings, all structural paths, except interest → self-regulation and grade goal → achievement</td>
<td>232.02</td>
<td>126</td>
<td>.041 (.033, .049)</td>
<td>.98</td>
<td>.98</td>
<td>2.97(4)</td>
</tr>
<tr>
<td>Science</td>
<td>Baseline model</td>
<td>–</td>
<td>147.75</td>
<td>114</td>
<td>.024 (.011, .035)</td>
<td>.99</td>
<td>.99</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>Model I</td>
<td>All factor loadings</td>
<td>157.72</td>
<td>122</td>
<td>.024 (.011, .035)</td>
<td>.99</td>
<td>.99</td>
<td>9.97(8)</td>
</tr>
<tr>
<td></td>
<td>Model II</td>
<td>Constraints in Model I + interest → self-regulation</td>
<td>163.89</td>
<td>123</td>
<td>.026 (.014, .036)</td>
<td>.99</td>
<td>.99</td>
<td>6.17(1)</td>
</tr>
<tr>
<td></td>
<td>Model V</td>
<td>Constraints in Model I + grade goal → achievement</td>
<td>164.35</td>
<td>123</td>
<td>.026 (.014, .036)</td>
<td>.99</td>
<td>.99</td>
<td>6.63(1)</td>
</tr>
<tr>
<td></td>
<td>Model VI</td>
<td>Constraints in Model I + self-efficacy → achievement</td>
<td>162.51</td>
<td>123</td>
<td>.025 (.013, .035)</td>
<td>.99</td>
<td>.99</td>
<td>4.79(1)</td>
</tr>
<tr>
<td></td>
<td>Final model</td>
<td>All factor loadings, all structural paths, except interest → self-regulation, grade goal → achievement, and self-efficacy → achievement</td>
<td>165.10</td>
<td>125</td>
<td>.025 (.013, .035)</td>
<td>.99</td>
<td>.99</td>
<td>7.38(3)</td>
</tr>
</tbody>
</table>

Note. N = 500 (253 girls, 246 boys, 1 no response). RMSEA = root mean square error of approximation; CI = confidence interval; CFI = comparative fit index; NNFI = non-normed fit index. Only the models with significant results (i.e., significant decrement in fit due to the invariance constraints) are presented to conserve space.

* p < .05.
** p < .01.
This scenario is not uncommon in the context of Korean middle school science. Korean middle school science teachers, chemistry teachers in particular, emphasize applying correct formulas and obtaining accurate experimental results more than understanding basic science concepts and procedures (Han, Min, & Paik, 2012). A number of studies have also pointed out that Korean middle school science textbooks contain too many difficult science terms (Yun & Park, 2011) and, for this reason, students opt to memorize the content rather than trying to fully understand it (Park, Kim, Park, Hwang, & Park, 2011). The non-significant path from academic self-regulation to achievement in science suggests that the Korean middle school participants in this study were indeed able to get by without using self-regulatory strategies in this subject.

4.2. Individual interest and an affective pathway to academic self-regulation

The most interesting result of this study concerns the role of individual interest in the self-regulatory process. Individual interest emerged as a significant and independent facilitator of academic self-regulation, even in the presence of academic self-efficacy and grade goals. The direct path from individual interest to academic self-regulation was significant in all four subject areas. There have been a number of studies that have documented the role of task value as a significant positive predictor of academic self-regulation and subsequent achievement (Pintrich, 1999; Pintrich & De Groot, 1990). However, few studies have directly examined the function of individual interest in academic self-regulation, especially in conjunction with other cognitive and social cognitive motivational constructs. The present evidence strongly suggests that successful academic self-regulation depends upon not only strong academic self-efficacy beliefs but also strong individual interest in the subject. Academic self-efficacy and individual interest, respectively, appears to constitute a key element in the cognitive and the affective pathway to academic self-regulation.

The complementary nature of cognition and affect in human functioning has been fully recognized by the social cognitive perspective. Social cognitive theorists view humans as multifaceted organisms, whose cognition and affect work together in their reciprocal interaction with behavior and environment (Bandura, 1997). One example of this joint operation is the role of physiological and emotional responses in one’s self-efficacy belief. As students experience increased levels of anxiety, stress, and bodily arousal in learning situations, they lower their self-efficacy judgments for the given task (Usher & Pajares, 2009). Changes in self-efficacy beliefs could in turn induce further changes in affective states such as anxiety.

Furthermore, many researchers have already emphasized the unique and critical contribution of affective motivation to academic self-regulation. Boekaerts and Corno (2005) proposed two different routes to self-regulation, one serving cognitive growth in a top-down manner and the other serving emotional well-being in a bottom-up fashion. Personal interest, along with goals, values, and percepts of self-efficacy, initiate the top-down self-regulation. Negative emotional states caused by environmental stressors and task demand characteristics, such as boredom, insecurity, or anxiety, activate the bottom-up self-regulation. These authors hence described the role that a different type of interest could play in the self-regulatory process. Pekrun et al. (2002) showed that positive academic emotions such as enjoyment and hope correlated positively with academic self-regulation, while negative academic emotions such as anxiety and boredom correlated negatively with it. Given these accounts, it is not surprising that academic self-efficacy and individual interest predict academic self-regulation of the learners, independently and in concert.

Nevertheless, there are important differences in the two pathways, cognitive and affective, that deserve note. Academic self-efficacy of the students in the subject was able to predict their future achievement in the subject in all four subject domains, with or without the mediation by grade goals or self-regulation in the subject. Individual interest of the students in the subject, in contrast, was not able to predict their subsequent achievement directly. It was only when individual interest of the students led to better academic self-regulation in the subject that a significant indirect link was made between individual interest and academic achievement.

The same pattern was reported by Pintrich and De Groot (1990). The researchers did not measure individual interest separately but assessed “intrinsic interest” as a component in task value. Still, task value in their study exhibited a predictive pattern identical to that observed for individual interest in the present study. Specifically, when task value in the subject entered the regression equations predicting various indexes of academic performance in the subject, ranging from in-class seatwork and homework to letter grades, it worked to predict any of these performance indexes significantly in the presence of self-regulation or cognitive strategy use. For students who have developed strong individual interest in specific tasks or subject areas, then, good academic performance per se may not adequately represent their intended learning outcome. Rather, these students likely recruit high-order learning processes, such as self-regulatory activities and strategies, out of their enthusiasm and desire to learn more about what they are greatly interested in (Hidi, 2001). Good academic performance is simply a natural consequence of such processes. Of course, as we observed in the science domain in this study, it is possible that self-regulatory processes do not yield positive performance indexes, if the acquired knowledge is evaluated in such a way that does not require deep processing.

We also found that grade goals in the subject did not mediate the path from individual interest to academic self-regulation in the subject. This result contrasts with the path from self-efficacy to academic self-regulation, which was fully mediated by students’ grade goals in the subject. This difference between individual interest and self-efficacy in their relationships with grade goals is consistent with our conjecture that goals are directly influenced by an individual’s belief about their competence (Wood & Locke, 1987) but not necessarily by their interest. Although greater knowledge, stronger self-efficacy, and more ambitious goals in the domain are byproducts of increased interest (Hidi & Renninger, 2006), learners are assumed to enjoy these benefits only as a consequence of a more active engagement and deep involvement in the learning process to satisfy their individual interest. Future research can include a direct measure of cognitive engagement, effort investment, or persistence to test validity of this claim.

It is important to emphasize, once again, that the interest construct assessed in the present research corresponds to at least “emerging” or “well-developed” individual interest in the four-phase model of interest development (Hidi & Renninger, 2006). Emerging individual interest represents interest in its third developmental phase, wherein learners start maintaining their interest with little external support. With well-developed individual interest, learners carry out self-regulatory activities related to the target of interest with focused attention and increased effort. The role of individual interest in academic self-regulation and its relationships with cognitive motivational constructs such as self-efficacy and grade goals, therefore, would be quite different from those associated with “triggered” or even “maintained” situational interest (Hidi & Renninger, 2006; see also Sansone & Thoman, 2005).

Students come to possess emerging or well-developed individual interest in a given academic domain after having experienced relevant tasks and activities for an extended period (Hidi & Renninger, 2006). In the course of this long-term engagement, they
also develop broader knowledge and a stronger belief of self-efficacy in the subject domain. Students with only situational interest, unlike those with individual interest, are not yet armed with a sense of efficacy that is needed for the setting of challenging goals and managing the learning process effectively. It is only when affective orientations of the students toward a subject area is clearly established that their individual interest starts exerting reliable influence on their attention to the subject area, and this focused attention and persistence lead to deep and strategic processing of the learning material (Hidi, 2001; Schiefele, 1991). Accordingly, we would not expect the present results to hold with situational interest.

4.3. Greater benefit of interest for boys' self-regulation and of goals for girls' achievement

We replicated the existing finding that girls lack motivation in mathematics and science, despite their academic performance that is equal or superior to the performance of boys in these subjects (Eccles et al., 1993; Jacobs et al., 2002; Linn & Hyde, 1989; Schiefele et al., 1992). The Korean middle school girls participating in this research exhibited significantly lower academic self-efficacy and interest in mathematics and science compared to the Korean middle school boys. Academic self-efficacy and interest in mathematics of the girls were also relatively lower than their self-efficacy and interest in Korean or English. The Korean girls performed comparably or better than the Korean boys in mathematics and science.

Contrary to our hypothesis, girls also displayed poorer academic self-regulation compared to boys in mathematics. Further, girls' self-reported academic self-regulation in mathematics was poorer than that shown in Korean and English. These results may seem reasonable, given their significantly lower self-efficacy and interest in mathematics compared to boys, as well as their higher self-efficacy and interest in Korean and English. Still, the significantly lower levels of self-regulation in girls observed in this study does not correspond to the existing literature, which generally reports better self-regulation in girls regardless of subject areas or strengths of academic motivation (Ablard & Lipschultz, 1998; Pajares, 2002; Zimmerman & Martinez-Pons, 1990).

More interesting than the mean-level differences, however, are differences in how the constructs examined in this study related to one another for girls and boys. The first notable difference between the genders in construct relations involves the role of individual interest in academic self-regulation. In the present study, the four subject areas treated both academic self-efficacy and self-regulation in boys depended significantly more heavily on their individual interest in the subject than it did for girls. The second difference between the genders involves the role of academic grade goals in academic achievement. Grade goals in the subject were significantly more predictive of the achievement of girls than that of boys, again in three out of the four subject domains. Given that there was no difference between girls and boys in the paths linking their grade goals to academic self-regulation or their academic self-regulation to achievement, the difference in the goal-achievement connection indicates a mechanism other than self-regulation to be responsible for the observed gender difference.

Schiefele et al. (1992) offer a plausible explanation that could account for the gender difference observed in the current investigation. They argued that the weaker relationship between individual interest and achievement-related variables for girls could be attributed to their high conformity to achievement norms. Even when girls hold low interest in certain tasks or subject areas, their strong conformity to achievement expectations will minimize the detrimental effects of their low interest on their cognitive functioning, thereby weakening the link between the two. Also consistent with this interpretation is the fact that academic achievement for girls in the present study depended more heavily on the grade goals they set themselves to achieve in the subject than it did for boys. Girls' higher conformity to achievement norms could take the form of stronger volition (Boekaerts & Corno, 2005) or increased effort and persistence (Hidi & Renninger, 2006). Future research will prove fruitful when it can locate this missing link.

4.4. Limitations and suggestions for future research

There are several limitations in the present study. First, because we used only three items to assess self-regulation in each school subject, we might have excluded some important aspects of academic self-regulation. Though we were aware of the comprehensive number of other items available to assess academic self-regulation in the MSLQ (Pintrich et al., 1991), we were unable to use all of these items in this research because responding to such a long list of items for each of the four academic subjects would have overburdened the participants. As we were interested in confirming the universal nature of self-regulation across a disparate set of academic subjects, it was important to create a measure short enough to capture the essence of academic self-regulation. We thus carefully chose three items that reflected the three core aspects of academic self-regulation from the MSLQ: planning, monitoring, and reflecting (Pintrich, 1999; Zimmerman, 2000). However, results might have been different had we used a longer and more reliable measure of academic self-regulation.

Second, we only examined the independent contribution of academic self-efficacy, individual interest, and academic grade goals to academic self-regulation. Our selection of variables was guided by the social cognitive framework of self-regulation (e.g., Zimmerman et al., 1992). By doing so, however, we might have missed other motivational constructs that are equally or even more important than the selected constructs in the self-regulatory process. One variable that deserves attention in future research is effort investment. We strongly suspect that cognitive engagement, effort, or persistence is the intervening mechanism, or the missing link, between goals and performance. Though some researchers view effort investment as part of the self-regulation (e.g., Pintrich & De Groot, 1990), our definition of academic self-regulation in this research did not incorporate this element.

Another viable candidate to consider in future investigations is achievement goals. Students demonstrate different degrees of deep processing, surface processing, disorganization, persistence, and effort during learning, depending on whether they adopt mastery, performance-approach, or performance-avoidance goals (Elliot, McGregor, & Gable, 1999). Because interest is a known antecedent of mastery goal adoption (Harackiewicz, Durik, Barron, Linnenbrink-Garcia, & Tauer, 2008), it is possible that the relationship of individual interest with academic self-regulation and achievement is mediated by students' mastery goals. We were not able to examine this possibility in the present investigation but future research should.

Finally, the significant difference observed in this study in the relative effectiveness of using academic self-efficacy, interest, and grade goals to predict academic self-regulation and achievement for girls and boys is not completely in line with previous findings. In a study by Wolters and Pintrich (1998), for example, the relationships that motivational variables such as academic self-efficacy and task value display with academic self-regulation did not change according to gender or academic subject. To our knowledge, the present study was one of the first investigations that treated both academic self-efficacy and individual interest as independent motivational determinants of academic self-regulation. Future research should verify the stability and generalizability of the present findings.
5. Conclusion

We believe this research makes at least three important contributions to the existing literature on academic self-regulation. First, the model proposed in this study, although simple, includes both academic interest and self-efficacy as independent facilitators of academic self-regulation. Even though other researchers have already suggested that interest should be included in models of academic self-regulation, their conceptualizations often include interest as a target and not a facilitator of academic self-regulation (Hidi & Ainley, 2008; Sansone & Thoman, 2005). Despite differences in specific ways with which academic self-efficacy and individual interest relate to academic self-regulation and achievement, our research demonstrates that individual interest functions as a unique facilitator of academic self-regulation and subsequent academic achievement.

Second, the present results suggest the strong possibility that the pathways associated with interest-based self-regulation and efficacy-based self-regulation are distinct from each other. While academic self-efficacy was linked to self-regulation via goal setting, individual interest was directly linked to self-regulation in this study. The consistent nature of this observation across multiple academic domains makes it highly likely that there are two discrete psychological mechanisms at work.

Third, simultaneously studying the operation of interest and self-efficacy in a single model revealed significant gender differences in the relative importance of each construct in girls’ and boys’ academic self-regulation and achievement. Together with the different pathways associated with each construct, this finding opens up many interesting possibilities in future studies of academic self-regulation.

Acknowledgments

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References


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