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Investigating the Structure and the Pattern in Self-regulated Learning by High School Students

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The research to explain student's self-regulated learning has grown rapidly in recent years. However, the studies on self-regulated learning have shown fascinating but mixed results. Thus, there is a need to identify and describe the key dimensions of self-regulated learning according to an empirical framework in order to integrate these complex results. This study attempts to explore the structure and the pattern of self-regulated learning. In a sample of high-school students, it was found that self-regulated learning consists of three components; cognitive regulation, motivational regulation, behavioral regulation. The result also shows that students can be grouped into six clusters in terms of these components. This study appears to be useful for understanding self-regulated learning conceptually but has some methodological limitations.

Key Words: self-regulated learning, cognitive strategy, metacognitive strategy, mastery goal orientation, self-efficacy, achievement value, action control, help-seeking, an analysis of covariance structure , cluster analysis

Why do some students achieve better results than others? For a long time, it has been a question many educational psychologists have pursued. Some tried to find the answer from student cognition. Although extensive research has been conducted, the focus of such studies has been on non-academic tasks in a laboratory setting, so that they could not adequately describe student's learning in a context like the home or classroom.

Self-regulated learning (SRL) is a newly developed concept to explain the phenomena whereby the learners actively participate in their own learning and show goal directed behavior. Originally, the research in this area grew out of more general efforts to study self-control in Psychology (Zimmerman, 1989b). It has prompted educational researchers to consider student self-regulation during academic learning. They believed that effective learning can be achieved by self-regulation of the learners (Zimmerman, 1986) and tried to investigate the learning processes of the effective learners. After extensive discussions, some researchers published their results for the first time in 1986 in the journal of *'Contemporary Educational Research*'. Since they viewed learning as a process of self-regulation with much effort and endurance, they were interested in the learning methods used by effective learners.

In contemporary terms, students can be described as self-regulated to the degree that they are metacognitively, motivationally and behaviorally active participants in their own learning process (Zimmerman, 1989). However, more precise definitions tend to vary depending on the researcher's theoretical perspective. At the beginning of SRL research, a social-cognitive perspective based on the work of Bandura (1989) was embraced. Since then, many researchers have tried to define SRL based on their own interests and theories ranging from behavioralism to modern cognitive psychology (Zimmerman & Schunk, 1989).

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Even though there is considerable agreement that effective learners do self-regulate, theories differ in their descriptions of the various psychological dimensions. Despite differences in these descriptions, we can classify these psychological dimensions into 3 categories: a) cognition-centered studies b) motivation-centered studies c) behavior-centered studies. Cognition-centered studies attempt to explain self-regulated learning based on student use of cognitive and metacognitive strategy. They noted that high-achieving students have been found to employ cognitive and metacognitive strategies more voluntarily and spontaneously to understand learning material, compared to low achieving students (Zimmerman & Martinez-Pons, 1986, 1988, 1990; Corno & Mandinach, 1983; Peterson et al, 1982).

Cognitive strategies include rehearsal (repeating the information), elaboration (storing new information by linking with prior knowledge), and organization strategies (constructing connections among information) that help students encode, recall, and comprehend information. The use of these strategies reflects a deeper level of cognitive engagement and usually results in better academic performance (Weinstein & Mayer, 1986). Metacognive strategies include planning (setting goal), monitoring (assessing comprehension while reading) and regulating strategies (adjusting reading rate for test difficulty). Metacognitive strategies are also linked to better academic performance (Pintrich & DeGroot, 1990; Zimmerman & Martinez-Pons, 1986, 1988). Self-regulated learners do rehearse, elaborate and organize the learning materials and do plan, monitor and regulate their cognitive processes voluntarily and spontaneously. The use of cognitive and metacognitive strategies helps students process the learning materials in a deep and meaningful manner. In general, the use of various cognitive and metacognitive strategies is a manifestation of cognitive regulation.

There is another group of researchers who emphasize the importance of motivational aspects, contending that the use of a learning strategy alone is not sufficient for self-regulated learning. These researchers concentrated on the reason students select strategies voluntarily and control their cognition. According to them, the student must be motivated to use the strategies (Pintrich,1991). Goal-orientation (Ames & Archer, 1988; Nolen & Haladyna, 1990), self-efficacy (Schunk, 1983) and achievement value (Wigfield, 1994) are suggested as relevant to cognitive engagement and academic performance.

When students have mastery goals, their primary focus is on learning the material. Because they value the learning process itself, they seek out more challenging ones (Dweck & Leggett, 1988; Elliot & Dweck, 1988; Nicholls, 1884; Ames, 1992). In this process, self-efficacy is important because it plays a role in the amount of effort they invest. Students with high self-efficacy show active participation in their learning activities. They also show greater effort and persistence (Schunk,1990). Even though students believe they are efficacious, they may not engage in learning process if they have no compelling purpose for doing so. Achievement value is one major construct related to the question “Do I want to succeed?” It involves the student's perceptions of the importance, utility and interest about the learning. According to Wigfield (1994), it is critical to SRL.

Other researchers have stressed the behavioral aspects of SRL since motivation does not mean actual action or behavior. Students need to be responsible for guiding and controlling their own activities and for maintaining their learning over a long period of time. If students cannot control their learning behavior, SRL will be impaired. For example, in many learning situations, students have to overcome temptations such as watching TV or playing with friends. Action control helps students to maintain their motivational effort in the face of difficulties and other sources of distraction (Kuhl, 1985, 1987). In addition, self-regulated learners seek assistance from a more knowledgeable person when faced with difficult tasks. High achievers have been found to engage in help-seeking from their teachers and peers relatively frequently (Newman & Goldman, 1990; Zimmerman & Martinez-Pons, 1988). These studies give much attention to the behavioral aspects of learning.

Zimmerman takes a more integral, broad point of view. He defines SRL as students' learning process with metacognitively, motivationally, behaviorally active engagement. Metacognitively, self-regulated learners plan, organize, self-instruct and self-evaluate in their learning process. From a motivational vantage, they perceive themselves as self-efficacious, autonomous and intrinsically motivated. In terms of behavior, they select, structure and create social and physical environments that optimize their learning (Zimmerman, 1986).

Even though considerable efforts have been made in defining SRL, it is still difficult to identify variables that students use to regulate their learning. Researchers maintain that self-regulation is needed for effective learning, but results are sometimes mixed and complex. This problem stems partly from the researchers' use of different variables to describe and define self-regulated learning. In addition, most studies are

based on descriptive, correlational studies between variables. Therefore, there is a need to identify and describe the key dimension of academic self-regulation in order to integrate complex results.

This study attempts to explore the structure and the pattern of self-regulated learning. The conceptual model is developed to explore the structure of SRL. With the understanding that learning is multifaceted, this study incorporates three components of the cognitive, motivational and behavioral regulation. The second goal of this study is to explore the pattern of SRL which students display on theses 3 components.

Method

Subjects

The subjects were 757 students (339 boys, 418 girls) from the second year of 4 high schools in Seoul, Korea. They came from predominantly middle-class backgrounds. This sample included a range of achievement levels. Achievement score and IQ were derived from school records for the students.

Measures

The questionnaire was developed by the researcher. The conceptual model for this study draws upon many of the elements of recent studies on self-regulated learning. The Learning and Strategies Study Inventory (LASSI; Weinstein, Schulte, & Palmer, 1987), the Motivated Strategies for Learning Questionnaire (MSLQ; Pintrich, Smith, Garcia, & McKeachie, 1991) and Self-Regulated Learning Interviews Schedule (SRLIS; Zimmerman & Matines-Pons, 1986, 1988) are most widely used for assessing SRL. This study takes 8 variables that appear to overlap conceptually in these measures. These variables are divided into three components, the first focused on cognitive regulation, the second on motivational regulation, and the third on behavioral regulation. The conceptual model in this study is presented in <Table 1>.

Table 1. *the conceptual framework of SRL*

Component	Variable
Cognitive regulation	The use of cognitive strategy The use of metacognitive strategy
Motivational regulation	Mastery goal orientation Self-efficacy Achievement value
Behavioral regulation	Action control Time management Help-seeking

An initial pool of SRL items consisted of 140 items. Items were piloted on a group of high school students (N=239, 121 boys, 118 girls, 80 in the first year, 159 in the 2nd year) and revised or eliminated where appropriate. Items with extreme mean scores were dropped. Factor analysis was used to guide scale construction, resulting in exclusion of some items from the scales because of lack of correlation or unstable factor structure. Finally, 84 items were used.

Cognitive regulation

The items about cognitive regulation ask how much students regulate their own cognition voluntarily. Cognitive regulation consisted of a total of 27 items, using 2 variables; use of cognitive strategy, use of metacognitive strategy. For each item, student were asked to respond on 5-point scale anchored by 1) very rarely 5) very often.

Motivational regulation

Motivational regulation plays a role of sustaining one's learning motivation. The items on motivational regulation ask how much the students regulate their own learning motivation. Mastery goal orientation, self-efficacy and achievement value were used as the observed variables.

Behavioral regulation

Behavioral regulation refers to controlling and regulating one's own learning behavior. Items were developed to measure the student's control of their own behavior in various learning situations. Each item relates to learning behavior and measures a concrete behavior. Action control, time management and help-seeking were used as the observed variables.

Procedures

The data were collected over group administrations. Students were administrated self-reporting questionnaires, which they were instructed to complete in their classrooms. Measures of academic achievement were collected at the end of the spring term. Subjects' grades were standardized for each school before the data analysis.

Table 2. *description of Questionnaire (number of items)*

Component	Variable
Cognitive Regulation (27)	The use of cognitive strategy (17) e.g.; "I try to connect new ideas with what I have learned before." "I create my own examples to make information more meaningful." The use of metacognitive strategy (10) e.g.; "When I read the text, I pause sometimes to check my comprehension." "If I don't understand a sentence, I try to understand the sentences around it"
Motivation Regulation (27)	Mastery goal orientation (7) e.g.; "I choose the task that I can learn from even though it is difficult." "I try to learn from mistakes that I make." e.g.; Self-efficacy (11) "I can solve a problem if I keep working at it." "I am pretty good at my schoolwork." Achievement value (9) e.g.; "I believe that schoolwork is important to my future." "I believe schoolwork is useful to personal growth."
Behavioral Regulation (30)	Action control (14) e.g.; "I can keep studying even if it is noisy around me." "I can keep doing homework until I finish it." Time management (5) e.g.; "I try to study according to a schedule which I set before I begin to study." "I usually make a time schedule to study effectively in advance." Help-seeking (11) e.g.; "When I can not understand something by myself, I look for some references." "When I have trouble understanding, I ask the teacher."

Results

Final items were chosen on the basis of factor analysis. Cronbach's reliability coefficients are as follows;

Table 3. *the subscale reliabilities of SRL*

component	variable	Cronbach's α
cognitive (.88)	the use of cognitive strategy	.84
	the use of metacognitive strategy	.75
motivational (.93)	mastery goal orientation	.80.
	self-efficacy	.89
	achievement value	.91
behavioral (.88)	action control	.83
	time-management	.80
	help-seeking	.79
total		.95

The Structure of SRL

To explore the structure of SRL, an analysis of covariance structure was performed using the LISREL program (Joresk & Sorbom, 1993). An analysis of covariance structure provides the researcher with the ability to examine multiple interrelated relationships in the study. Many studies have indicated that SRL is related to achievement, so the appropriate causal relationship is for achievement to be predicted by SRL components. This study assumes a 3-factor model of SRL and attempts to determine the relationships of each factor to achievement. There in no substantive theory on existing paths between the three factors, so the causal relationships between the three latent factors were explored through the testing of alternative model specifications to get an idea. The alternatives are compared in fit measures. The proposed model achieves the best fit in these measures. Figure 1 shows the path diagram of the covariance

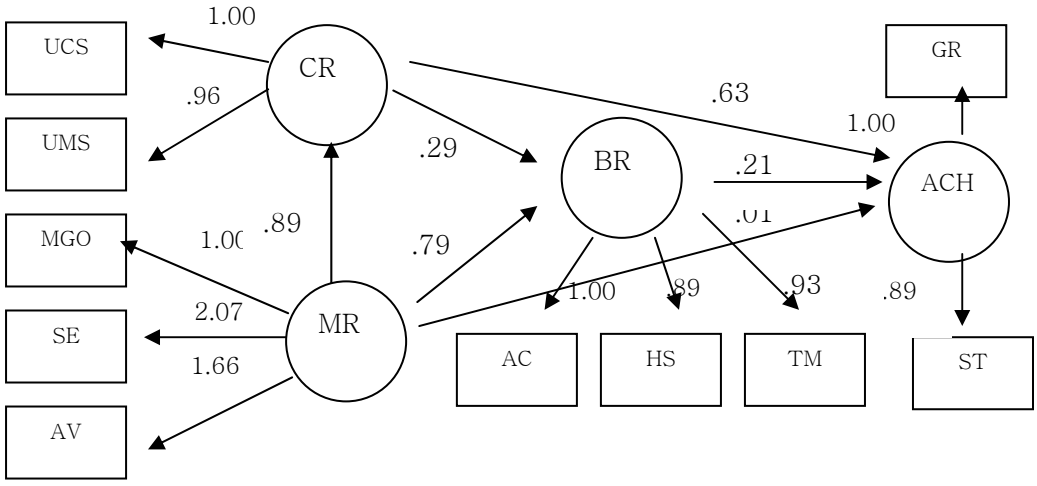

Figure 1. the structure of SRL : conceptual model

Notes: CR: cognitive regulation, MR: motivational regulation, BR: behavioral regulation, ACH: academic achievement, UMS: use of cognitive strategy, UMS: use of metacognitive strategy, MGO: mastery goal orientation, SE: self-efficacy, AV: acadecic value, AC: action control, HS: help-seeking, TM: time management, ST: study time, GR: grade

structure analysis for these four latent variables (expressed as ovals) and 10 observed variables (expressed as rectangles).

Each latent variable must be made scale invariant for the estimation procedure. This study fixed 1.00 in the first observed variable of each latent variable to define the unit for each latent variable in relation to one of the observed variables. As for the input matrix, a correlation matrix is used because the unit of measurement among variables in this study is very different. The covariance is affected by the scale of measurement. The correlation matrix in structural equation modeling is simply a standardized covariance matrix in which the scale of measurement of each variable is removed by dividing the covariances or covariances by the product of the standard deviations. The correlation matrix is particularly useful when comparisons are to be made across different variables (Loehlin, 1998).

Since there were no identification problems or offending estimates, the goodness of fit indices was assessed; the goodness of fit (GIF), the adjusted goodness of fit (AGIF), and root mean square residual (RMR). Table 4 shows these indices are quite good (Hair et al., 1995).

Analysis of the covariance structure allows the researcher to decompose the effect of one variable on another into direct, indirect and total effects. The indirect and total effects can help to answer important questions that are not addressed by examining the direct effects (Bollen, 1989). It is an interesting finding in this study that the direct effect of motivational regulation in achievement is not as strong as previously thought. Instead, indirect effect is striking. Table 5 indicates the total effects of three components in academic achievement. The total effect of motivational regulation is .79 whereas that of cognitive regulation shows .69. This means that the motivational regulation affects the achievement indirectly through the cognitive regulation and the behavioral regulation, whereas the cognitive regulation does so directly. In this sense, the motivational regulation can be thought of as the core of self-regulated learning.

Table 4. *goodness of fit indices : LISREL result*

GFI	AGFI	RMR
.97	.94	.04

Table 5. *total effects of 3 components on academic achievement*

Type of effect	cognitive regulation	Motivational regulation	behavioral regulation
direct effect	.63	.01	.21
indirect effect	.06	.78	
total effect	.69	.79	.21

The Pattern of SRL

Attention now turns to exploring the pattern of SRL which students display. In order to do this, we have to group students into clusters so that students in the same cluster are more similar to one another than they are to students in other clusters. The primary purpose is to group students based on 3 components of SRL. This attempt is to maximize the homogeneity of students within the groups while also maximizing the heterogeneity between groups. The result of cluster analysis showed that there are 6 different groups in the SRL. They have different levels and profiles of SRL. Table 6 shows the mean differences in three SRL components among six groups. They are statistically significant.

Figure 2 displays the profile of SRL in 6 groups. Let's examine Group 3 and Group 4 more closely. They are similar in the total score of SRL but quite different in their profiles on the three dimensions. Group 3 is high on cognitive regulation whereas Group 4 is high on motivational regulation.

We can examine these six groups in more detail. MANOVA was performed to identify any differences in academic achievement and IQ. Table 6 shows that these six groups are different on these cognitive characteristics. It is noteworthy to examine two groups; Group 2 and Group 6. The group high on SRL (Group 6) shows high scores in academic achievement. Students who do not self regulate in their learning despite high IQ (Group 2) are the lowest in achievement. The key point is that the group of students who were highest in all three forms of SRL displayed the highest achievement. These SRL students displayed virtually identical levels of IQ to the lowest group in the three forms of SRL.

Table 6. *mean differences in 3 SRL components*

SRL component	Group 1		Group 2		Group 3		Group 4		Group 5		Group 6		F	η^2
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD		
cognitive regulation	3.23	.30	2.14	.45	3.65	.24	3.43	.29	2.96	.29	3.89	.38	258.4***	.66
Motivational regulation	2.47	.35	1.95	.53	3.15	.28	3.60	.29	3.00	.25	3.94	.32	441.6***	.77
behavioral regulation	2.44	.34	2.09	.40	3.18	.26	2.73	.32	2.87	.27	3.53	.29	260.7***	.66

Table 7. *mean differences in cognitive characteristics*

Cognitive characteristics	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	F	η^2
grade	48.36	46.99	51.45	52.65	46.83	56.99	9.49***	.17
IQ	109.3	119.6	114.9	116.0	104.9	119.7	6.36***	.12

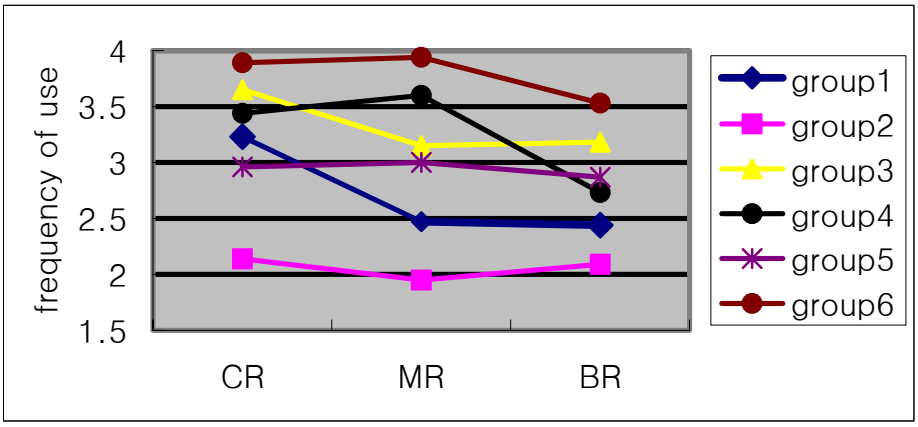

Figure 2. profile of SRL in 6 groups

Discussion

Self-regulated learning is a new approach to understanding student achievement. In contrast to traditional learning research, much research in SRL has been done in ecologically valid contexts and has been focused on actual tasks. Owing to its importance from an educational perspective, the research on this topic has grown rapidly. By exploring the structure of SRL, this study is intended to provide a way to reconcile the inconsistencies in the results of previous research and to provide a way to describe how SRL is linked to academic achievement.

The results of this study suggest three conclusions. First, this study provides empirical support for a three-factor model of SRL. To date, there have been few empirical studies that examined the structure of SRL. A three-factor model of this study provides a unified account of multiple aspects of SRL. In particular, its multidimensional nature makes it possible to explain why smart student sometimes fail. For example, they might fail because they have difficulty in regulating their motivation although they can regulate their cognition.

Second, there is evidence of interesting causal paths linking the three forms of SRL to academic achievement, with motivation being mediated through cognition. The findings so far have indicated that SRL is related to achievement. This study confirms that the students who regulate their cognition, motivation, and behavior show better levels of academic achievement. Figure 1 describes how these three components of SRL are linked to academic achievement. As has been shown in Table 5, motivational regulation plays an important role in this process. It is important not only because it leads to higher achievement, but also because it leads to more cognitive and behavioral endeavors in the learning process. In other words, motivational regulation moderates the deployment of cognitive and behavioral regulation. This result gives some support for Pintrich & De Grroot (1990). In their article, students' value and mastery goal orientation are important variables to understand how students come to use different cognitive strategies and become self-regulated learners.

Third, there is evidence that the students who use all three forms of SRL to the highest degree display the highest levels of academic achievement. As has been shown in Table 7, students who don’t regulate their cognition, motivation, and behavior despite having a high IQ are the lowest in achievement. In this regards, SRL is a better predictor of achievement than IQ. Students can achieve more when they use all three forms of SRL.

The results of this study have some implications to students and teachers. SRL is an important determinant of academic achievement. It is not a trait that the student has no control over, like IQ. Students can control their own cognition, motivation, and behavior in order to improve their achievement. In this sense, SRL plays a compensatory role in academic achievement by allowing students to participate actively in their learning. Therefore teachers should help students learn how to control their own learning and should teach in ways that help students become self-regulated learners.

This study can be taken as a skeleton to provide a better understanding of SRL. Still, it may not be directly applicable to middle school or college students because this study was conducted with high school students. Undoubtedly, much research remains to be done in this area.

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