DOCUMENT RESUME

ED 454 089 SE 065 067

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TITLE	Self-Regulated Strategies in Science Learning: The Role of Prefrontal Lobe Function.
PUB DATE	2001-04-00
NOTE	35p.; Paper presented at the Annual Meeting of the American Educational Research Association (Seattle, WA, April 10-14, 2001). Research was made possible by a grant from the Brain of Korea 21 Project and the Korea Science and Engineering Foundation.
PUB TYPE	Reports - Research (143) -- Speeches/Meeting Papers (150)
EDRS PRICE	MF01/PC02 Plus Postage.
DESCRIPTORS	Foreign Countries; *Learning Strategies; Metacognition; Middle Schools; *Motivation; Science Education
IDENTIFIERS	*Self Regulation; South Korea

ABSTRACT

The present study firstly examined the use of learning strategies for students classified as having either a high or a low level of motivation, based on level of academic volitional strategy (AVS) and academic delay of gratification (ADOG). Students were classified into four groups on the basis of a two (motivation: low, high) by two (AVS or ADOG: low, high) analysis. Secondly, planning ability as one of the prefrontal lobe functions was examined to see whether students who have high-level planning ability at a specified level of motivation (low or high) report the use of AVS and ADOG more than students with low-level planning ability. Eighth-grade students (N=164; 82 boys, 82 girls) participated in the study. Results showed that the students with high-level AVS and ADOG used more learning strategies than did students with low-level AVS and ADOG, regardless of the level of motivation. Although planning ability was related to intrinsic goal orientation, self-efficacy, elaboration, and critical thinking, there was no significant difference between low- and high-level planning ability students in AVS, and ADOG when level of motivation was controlled for. The implications of these results are discussed. Appended are Sample Items from the Motivation Scales, Learning Strategy Scales and from the Academic Volitienal Strategy Scales and Academic Delay of Gratification. (Contains 32 references and 5 tables.) (Author/YDS)

Running head: Self-Regulation

Self-Regulated Strategies in Science Learning:

The Role of Prefrontal Lobe Function

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A paper presented at the annual meeting of the American Psychological Association, April, 2001, Seattle, WA. Request for additional information should be directed to the first author (e-mail: kbs1013@hotmail.com).

Abstract

The present study firstly examined the use of learning strategies for students classified as having either a high or a low level of motivation, based on level of academic volitional strategy (AVS) and academic delay of gratification (ADOG). Students were classified into four groups on the basis of a two (motivation: low, high) by two (AVS or ADOG: low, high) analysis. Secondly, planning ability as one of the prefrontal lobe functions was examined to see whether students who have high-level planning ability at a specified level of motivation (low or high) report the use of AVS and ADOG more than students with low-level planning ability. Eighth-grade students (*N* = 164; 82 boys, 82 girls) participated in the study. Results showed that the students with high-level AVS and ADOG used more learning strategies than did students with low-level AVS and ADOG, regardless of the level of motivation. Although planning ability was related to intrinsic goal orientation, self-efficacy, elaboration, and critical thinking, there was no significant difference between low- and high-level planning ability students in AVS, and ADOG when level of motivation was controlled for.. The implications of these results are discussed.

Self-Regulated Strategies in Science Learning: The Role of Prefrontal Lobe Function

Zimmerman (1986) defines self-regulation as "the degree to which individuals are metacognitively, motivationally and behaviorally active participants in their own learning process" (p. 308). Previous studies have shown that self-regulated learners who use various learning strategies are more successful in academic performance than learners who report less cognitive engagement (Schunk & Zimmerman, 1997).

Research on self-regulation has focused primarily on the use of cognitive and metacognitive strategies (Pintrich et al., 1993; Weinstein & Mayer, 1986). Pintrich and his colleagues have considered motivational beliefs such as self-efficacy, intrinsic value to be important predictors of level of cognitive engagement and academic achievement (McKeachie, Pintrich, & Lin, 1985; Pintrich & De Groot, 1990). According to these researchers, learners who have a high-level of intrinsic goal orientation and self-efficacy report, not only more variable cognitive and metacognitive strategies, but also higher academic performance than the low-level learners.

Empirical evidence indicates that motivation that creates the intention to learn is a vital factor in the use of learning strategies or cognitive engagement, and that both motivation and use of cognitive activities facilitate academic performance. However, several studies have shown that motivation may be not sufficient to directly influence the use of learning strategies and the achievement of positive learning outcomes. Research conducted by Lee and Brophy (1996) revealed that even though a student was intrinsically motivated, he didn't show cognitive engagement constantly and was not willing to expand effort to understand science contents. Corno and Kanfer (1993) also pointed out that motivational belief for goal attainment can deteriorate, especially when learning tasks take days or weeks to accomplish. Therefore, self-regulatory control in order to protect one's motivation, and thus the intention to learn, is needed for positive learning outcomes. This self-regulatory control has been considered volition (Corno, 1993; Kuhl, 1985).

Volitional Control as Self-Regulated Strategy

According to action-control theory (Heckhausen & Kuhl, 1985; Kuhl, 1985), volitional control plays a key role in protecting the intention to learn and maintain attempts to learn in the face of difficulties, distractions and other competing goals. Therefore, volition mediates between the intention to learn and the use of learning strategies (Corno, 1993; Garcia et al., 1998; Kuhl, 1984; Snow, 1989). Garcia et al.(1998) clearly showed that the domain of volition differed from motivation factors and the type of learning strategy. Self-regulated strategies as overall volitional control have been explored mainly within the areas of metacognitive, attentional, and environmental control (e.g., Pintrich & Schrauben, 1992; Weinstein & Mayer, 1986; Zimmerman & Schunk, 1996). However, self-regulatory activities to maintain motivation and to regulate emotion in goal-striving have been relatively neglected. Based on this perceptive, McCann & Garcia (1999) developed the Academic Volitional Strategy Inventory (AVSI) to examine volitional control as self-regulatory behavior.

Academic Delay of Gratification as Self-Regulated Strategy

The ability to delay immediate satisfaction in order to attain delayed but more valued outcomes has been considered essential for self-regulation (Mischel, 1996; Mischel et al., 1989). Mischel and his colleagues found that delay of gratification behavior was most likely to reflect relevant cognitive and attentional competencies. Following this line of research, Bembenutty and Karabenick (1998) developed a course-specific Academic Delay of Gratification Scale (ADOGS) to investigate students' preference between an immediately available option and a delayed alternative. The studies conducted by Bembenutty and Karabenick have shown the relationships between ADOG and self-regulated strategies (Bembenutty, 1997; Bembenutty & Karabenick, 1998) and between ADOG and AVS (Bembenutty, 1999). Based on their findings, these authors suggested that ADOG is a volitional and self-regulatory strategy used by students to attain an academic goal.

Previous research on volitional control and ADOG suggests that the quality of these self-regulatory activities will affect the use of learning strategies even though the students have same-level motivation. When students face difficulties, distractions or immediately available satisfaction, if the students cannot regulate their motivational state or delay immediate gratification, they may fail to engage in those learning activities required to attain their academic goal even though their motivational state is high. Accordingly, the first purpose of the present research was to examine whether students who have high-level AVS or ADOG report using learning strategies more than students with low-level AVS or ADOG, when level of motivation is controlled for.

If our hypothesis is shown to hold, then one more question will be asked; to whit: why are some students more able to use cognitively and motivationally self-regulated strategies than others. Since research shows that learning strategies can be learned, how much students know various strategies may be one reason for the difference in the level of self-regulated strategy use. We intend to look for a possible reason for the difference using a neuropsychological approach. In particular, we intend to examine possible differences in prefrontal lobe function.

Prefrontal lobe, Cognitive Process and Volition

The prefrontal lobes are anatomically defined as the anterior frontal lobes of brain. Some early studies, based on functional localization of prefrontal lobes, have shown that the prefrontal lobes process human's higher-order thinking and regulation of complex activity (Luria, 1973). Stuss and Benson (1987) also indicated that the prefrontal cortex attends to, integrates, formulates, executes, monitors, modifies, and judges all nervous system activities. Previous research that focused on the effect of prefrontal lobe damage has reported that the prefrontal cortex affects attention, and memory. In addition, destruction of the prefrontal cortex has been linked to cognitive impairment. Frontal lobe damage has also been related to behavioral disturbances. These disturbances have been classified into five categories (Lezak, 1995): problems of starting; difficulties in making mental or behavioral shifts; problems in stopping; deficient self-awareness; and a concrete attitude or loss of the abstract attitude. Recently, a study with normal students conducted by Kwon and Lawson (2000) reported that prefrontal-lobe growth affects students' ability to reason scientifically and to learn theoretical scientific concepts.

In addition, several studies have emphasized the relationship between the prefrontal lobes and volition. Kornhuber (1984) classified volitional function into three stages. The first stage involves setting priorities (i.e. determining what needs to be done). The second stage involves planning and making decisions about how to do what needs to be done, and the third stage involves determining when the action is to be started. Prior work has demonstrated a positive relationship between these stages and the frontal cortex (Kornbuber, 1984; Lang et al., 1988; Rolls, 1983). Ingvar (1994) also suggested that prefrontal activation accompanying volitional acts most likely corresponds to a willful mobilization of inner representations of future events. These representations serve as action programs for the achievement of a goal. Although volitional control is required to initiate or maintain on-task effort and to protect initial motivation (Kuhl, 1984), patients with frontal lobe disorder have been shown to lack the ability to initiate action (Heilman & Watson, 1991).

Although most studies of the prefrontal lobe have been conducted with clinical populations, findings from previous studies have indicated that the prefrontal lobes most likely affect the cognitive process and volitional action. Accordingly, it may be important to see the relationship among prefrontal lobe functions and self-regulated strategies such as cognitively self-regulated strategies (learning strategies in this study) and motivationally self-regulated strategies (AVS and ADOG in the present study). The second purpose in the present study was to examine whether or not students who have a high-level of prefrontal lobe function use cognitively and motivationally self-regulated strategies more than students with a low-level prefrontal lobe function. Recently, some studies have focused on how students' ability for using various self-regulated strategies can be enhanced (e.g., Trawick & Corno, 1995). Results of the current research should also contribute to the development of a self-regulation enhancement program.

In summary, the research questions are as follows: 1) How are prefrontal lobe functions related to self-regulated strategies? 2) For students at equivalent levels of motivation (low or high), do students who have a high-level of academic volitional strategies and academic delay of gratification use learning strategies more than students with the low-level? 3) For students at equivalent levels of motivation, do students who have a high-level of prefrontal lobe function use cognitively and motivationally self-regulated strategies more than students with a low-level?

Method

Participants and Procedures

Motivation, learning strategy, academic volitional strategy (AVS), and academic delay of gratification(ADOG) surveys were translated by three science educators from English into Korean. The contents of all surveys were revised to fit the science classroom context. All surveys except the ADOGS used a 5-point Likert scale ranging from 1 (not at all true) to 5 (very true). The ADOGS used a 4-point scale: definitely choose A, probably choose A, probably choose B, and definitely choose B.

To examine the reliability of each survey, pilot test were conducted with one class of middle school students in Buchun City in the vicinity of Seoul, Korea. Cronbach alphas of the surveys ranged from .67 to .91.

Final versions of each survey were completed by one-hundred sixty-four students (82 boys and 82 girls, all 8^{th}-grade) from a middle school in Chungju City, Korea. Firstly, students completed four surveys; motivation, learning strategy, academic volitional strategy, and academic delay of gratification during regular classroom time. Sequentially, the prefrontal lobe functions were examined.

Measures

Motivation. Motivation and learning strategy items were adapted from the Motivational Strategy for Learning Questionnaire (MSLQ; Pintrich et al., 1993). The motivation measures used in this study included three sub-scales: intrinsic goal orientation, task value, self-efficacy (respectively 4-items: Sample items are in Appendix A). Intrinsic goal orientation concerns the degree to which the student perceives herself to be participating in a task for reasons such as challenge, curiosity, and mastery. Task value refers to the student's evaluation of the how interesting, how important, and how useful the tasks are. Self-efficacy concerns performance expectations, and judgments about one's confidence to accomplish a task. A Cronbach Alpha reliability coefficient of .91 was obtained in a pilot study.

Learning Strategy. The learning strategy survey in this study consisted of a cognitive strategy scale including four sub-scales (respectively 3 items) and a metacognitive strategy scale (6 items) (Example items: see Appendix A). Sub-scales of cognitive strategies are rehearsal, elaboration, organization, and critical thinking. Rehearsal strategies are best used for simple tasks and activation of information in long-term memory. Elaboration strategies refer to constructing internal connections among the information to be learned. Organization strategies concern building internal connections among the pieces of information to be. Critical strategies refer to applying previous knowledge to new situation in order to solve problems. Metacognitive strategies in MSLQ refer to three general processes; awareness, knowledge, and control of cognition. A Cronbach Alpha reliability coefficient was .91 in a pilot study.

Academic Volitional Strategy. Academic volitional strategy was taken from the Academic Volitional Strategy Inventory (AVSI; McCann & Garcia, 1999). Academic volitional strategies used in this study refer to strategies used to regulate students' emotion and motivation if faced with distractions that threaten ongoing goal-attainment activity. Academic volitional strategies include three sub-scales: self-efficacy enhancement; stress reduction; and negative-based incentives (respectively 4 items: sample items are in Appendix B). Self-efficacy enhancement refers to reassuring thoughts that enhance self-efficacy. Stress reduction concerns getting rid of stress or quieting an aroused emotional state, which may inhibit task action. Negatively-based incentives refer to the attempt to evoke an emotional response through recalling the possible negative consequences of a poor performance in order to promote task action. In a pilot study, a Cronbach Alpha reliability coefficient of .82 was obtained.

Academic Delay of Gratification. Academic delay of gratification items (total 6 items) were adopted from the Academic Delay of Gratification Scales (ADOGS; Bembenutty & Karabenick, 1998). Bembenutty defined academic delay of gratification as students' preference for an immediate gratification or a delayed alternative (An example item: see Appendix B). For each situation, the students appraised their preference for an immediately available option (e.g., "Going to a favorite concert, play, or sporting event, even though it may mean getting a lower grade on an exam in this class to be taken the next day") or a delayed gratification option (e.g., "Staying home and studying to increase your chances of getting a higher grade"). A Cronbach Alpha reliability coefficient was .83 in a pilot study.

Prefrontal Lobe Functions. The prefrontal lobe functions were defined as inhibiting ability and planning ability in this study. The functions were tested via the computer-based test. The computer-based test (CBT) was developed by Kwon. The manual of the CBT was based on a hand-based test reported in previous studies.

Planning Ability. The essence of planning is the attainment of a goal through a series of intermediate steps using the representation of action for the future. Planning ability was examined by the Tower of London Test (TOLT; Krikorian et al., 1994). The TOLT requires planning in terms of a means-ends analysis to successively solve more difficult tasks. The participants must generate and execute a sequence of moves controlled by planning. The TOLT consists of a board with three vertical sticks planted on it and three moveable balls. The color of each ball is different (red, green, and blue) and the balls can be shifted from one stick to another stick. From the initial form, students were asked to move balls to attain a certain predetermined goal (e.g., order the balls, green over blue over red on the long stick). There are a total of ten tasks in the TOLT. Each task has a prescribed number of moves. If a student reaches the goal position within the prescribed number, she will earn three points. She will receive two points for a successful performance within twice the prescribed number of moves, and one point for a successful performance within three times the prescribed number of moves. If the number of moves taken is more than three times the prescribed number, zero points will be awarded.

Inhibiting Ability. An inhibiting process is an active process that suppresses task-irrelevant information by removing it from the currently-activated information group.

Inhibiting ability was assessed by the Wisconsin Card Sorting Test (WCST); (Heaton et al., 1993). The test consists of 4 stimulus cards and 128 response cards that have different shapes (crosses, circles, triangles, or stars), colors (red, yellow, blue, or green) and numbers (one, two, three or four) on them. The student has to correctly match a response card to one of the four stimulus cards. After each match, the student is seen whether the match is correct or incorrect. Inhibiting ability is defined as a total number of perseveration errors on the WCST. A perseveration error refers to card sorting behavior in which an inappropriate response to a particular category (e.g., color) persists in the face of negative feedback (e.g., "the match is incorrect"). Accordingly, students who make fewer perseveration errors are considered to have a greater inhibiting ability. Unfortunately, we found a problem with the WCST program based on CBT. The frequent program error allowed students to adapt easily to WCST operation, so a practice effect appeared. Compared with previous data that were collected by a hand-based test, the CBT data were not reliable. Thus, the use of the WCST program based on CBT needs validation in future research.

Analyses

To determine correlations between motivation constructs, learning strategies, AVS, ADOG, and TOLT, we conducted simple correlations between the variables. In order to examine the difference between the low- and high-level AVS and ADOG groups on learning strategies at the low- and high-levels of motivation, we used an ANOVA with four different groups based on the levels of motivation and AVS or ADOG. Firstly, students were classified into high or low groups based on a median split of motivation, AVS, and

ADOG scores and then, each group was reclassified into four groups using a two (motivation: low, high) by two (AVS or ADOG: low, high) analysis.

To test for any difference between the low- and high-level planning ability groups, as determined by results on the TOLT, in terms of AVS, ADOG, and learning strategy use at both the low- and high-level of motivation, the above method was repeated. After classifying the students into four groups, a two (motivation: low, high) by two (planning ability: low, high) ANOVA was conducted.

Results

Correlation among Variables

As shown in Table 1, there were significant relationships between motivation (i.e., intrinsic goal orientation, task value, and self-efficacy), learning strategies (i.e., rehearsal, elaboration, organization, critical thinking, and metacognition), AVS (self-efficacy enhancement, stress-reducing action, and negative-based incentives), and ADOG. However, planning ability tested by the TOLT was not related to all sub-scales of AVS and ADOG, though it was related to several motivational factors (intrinsic goal orientation, self-efficacy) and learning strategies (elaboration, critical thinking).

The Mean Scores *of AVS and ADOG on Use of Learning Strategies*

Table 2 shows the means of the four groups for the use of learning strategies. As shown in Table 2, at the same levels (high or low) of motivation, students who used more AVS and ADOG reported using more learning strategies. With respect to AVS, the means of group 1 (low-level AVS) and group 2 (high-level AVS) for students with a low level of motivation are 32.2 (SD = 8.7), and 50.1 (SD = 9.5) respectively. For students with a high level of motivation, group 3 (low-level AVS) had a mean of 49.8 (SD = 6.1) and group 4 (high-level AVS) had a mean of 58.9 (SD = 8.9). In terms of ADOG, the means of each group are 40.8 (SD = 10.4), 46.5 (SD = 9.2), 52.6 (SD = 6.8), and 57.8 (SD = 10.0) respectively.

To examine whether or not each group's mean for learning strategy differed statistically, an ANOVA was conducted between the four groups. Firstly, there was a significant difference between the means of the four groups for AVS, ($F = 49.2$, $p < .001$). Secondly, a significant difference was also shown between the means of the four for ADOG, ($F = 31.5$, $p < .001$).

To determine which groups differed in their use of learning strategies, a post hoc Scheffé test was run (Table 3). The test for AVS showed that differences between group 1 (low-level motivation and AVS) and group 2 (low-level motivation and high-level AVS), and between group 3 (high-level motivation and low-level AVS) and group 4 (high-level motivation and AVS) were statistically significant, ($p < .05$). However, there was no significant difference between group 2 and group 3, as shown in Table 3.

A Scheffé test for ADOG showed that there was no significant difference between group 1 (low-level motivation and ADOG) and group 2 (low-level motivation and high-level ADOG), and between group 3 (high-level motivation and low-level ADOG) and group 4 (high-level motivation and ADOG).

The mean scores of the Planning ability on Self-regulated Strategies

As shown in Table 4, compared with low-level planning ability groups, the means of high-level groups are nearly similar in terms of each of the self-regulated strategies (learning strategy, AVS, ADOG). Overall, the groups' means are significantly different for learning strategy, ($F = 22.6$, $p < .001$); for AVS, ($F = 9.7$, $p < .001$); for ADOG, ($F = 10.0$, $p < .001$). A Scheffé test (Table 5) revealed that there were no significant differences between group 1 and groups 2, 3 or 4. There are no main differences for low- and high-level planning ability groups on any of the self-regulated strategies. On the contrary, group 2 (low-level motivation and high-level planning ability) differs from group 3 (high-level motivation and low-level planning ability) significantly in using learning strategy, AVS, and delaying immediate gratification.

Discussion

The first purpose of the present research was to examine the differences in the use of learning strategies between the low- and high-level AVS or ADOG groups when motivation level was controlled for. Results showed that AVS and ADOG are critical and positive factors in using learning strategies. Primarily, there were significant relationships among motivational constructs and self-regulated strategies (learning strategies, AVS, and ADOG). The results support the relationships among motivation and cognitively and motivationally self-regulated strategies reported by prior studies (Bembenutty, 1999; Bembenutty & Karabenick, 1998; Garcia et al., 1998; Pintrich & De Groot, 1990).

There were significant differences for AVS between group 1 (low-level motivation and AVS) and groups 2 (low-level motivation and high-level AVS), 3 (high-level motivation and low-level AVS) and 4 (high-level motivation and AVS). These results show that students at both the low- and high-levels of motivation who employ more AVS use more learning strategies. That is to say that although students might be intrinsically motivated to learn in science class, we can't expect to see a higher use of learning strategies from the students if they don't use academic volitional strategies appropriately. In terms of ADOG, the differences between group 1 (low-level motivation and ADOG) and group 2 (low-level motivation and high-level ADOG), group 3 (high-level motivation and low-level ADOG) and group 4 (high-level motivation and ADOG) were not significant. At the same time, the differences between group 1 and 3, or 4, 2 and 4 were statistically significant. This result reveals that motivational constructs are more likely than ADOG to be the important factor involved in students' use of learning strategies. However, we should pay attention to there was no significant difference between group 2 (low-level motivation and high-level ADOG) and group 3 (high-level motivation and low-level ADOG). It appears, therefore, that if students fail to delay immediate satisfaction, it is difficult for the students to attain a higher use of learning strategies even though they are motivated intrinsically.

These results clearly show that the levels of AVS and ADOG are strongly and positively related to the use of learning strategy regardless of the level of motivation (low- or high-level). Based on the results, we may positively answer the question whether students who have high-level AVS or ADOG at low- and high-level motivation report the use of learning strategies more than students with low-level AVS or ADOG.

The findings on prefrontal lobe function consistently show that the levels of planning ability are not related to the use of cognitively self-regulated strategies (learning strategies) and motivationally self-regulated strategies (AVS and ADOG). The differences between group 1 (low-level motivation and the planning ability) and 2 (high-level motivation and low-level the planning ability), group 3 (high-level motivation and low-level the planning ability) and group 4 (high-level motivation and the planning ability) for the use of learning strategies, AVS, and ADOG were not significant, though planning ability was significantly related to some motivational constructs (intrinsic goal orientation and self-efficacy) and some learning strategies (elaboration and critical thinking). Therefore, results of this study provide little support for the hypothesis that prefrontal lobe function is more likely to be related to the use of self-regulated strategies.

Planning ability has been shown to be one cognitive ability that results in part from the maturation the brain (Stuss & Benson, 1984) and is strongly related to science achievement (Kwon, 2000a). Despite this, in the current study, planning ability did not correlate the self-regulated strategies. In particular, it did not correlate with learning strategies that were directly related to learning outcomes. Our interpretation of the pattern in which planning ability unrelated to the use of self-regulated strategies is that AVS and ADOG are the more likely to be related to motivational constructs directly than planning ability as represented by prefrontal lobe function. In addition, this result may expand our knowledge of whether self-regulated strategies that are needed to attain high achievement can be learned. The finding that there was no correlation between prefrontal lobe function and self-regulated strategies may indirectly support the fact that self-regulated strategies can be learned. The finding of no correlation may also have come about because our measure of prefrontal lobe function was limited. Further research with more extensive range of measures of the various cognitive functions of the prefrontal lobe is needed in order to examine the relations between prefrontal lobe functions and self-regulated strategies more exactly.

Acknowledgments

We would like to thank Héfer Bembenutty for his invaluable comments and suggestions. The authors extend our sincere thanks to Dr. Erin McCann for engaging in insightful discussions about the results of this paper. We also thank Dr. Teresa Garcia for her helpful advice and Roser Peach for editorial work. Finally, we would like to thank Dr. Youngshin Kim for incisive suggestions related to data analysis, and Yunbok Park and Chongmi Kim for helping to collect data.

This research was made possible by a grant from the Brain of Korea 21 Project and Korea Science and Engineering Foundation. Any opinions, or conclusions are those of the authors and do not necessarily reflect the views of the supporting agency.

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Table 1.
Pearson Correlations among Variables

	1	2	3	4	5	6	7	8	9	10	11	12
1. Intrinsic goal orientation												
2. Task value	.77*											
3. Self-efficacy	.62*	.74*										
4. Self-efficacy enhancement	.54*	.51*	.49*									
5. Stress-reducing action	.40*	.40*	.33*	.49*								
6. Negative-based incentives	.32*	.32*	.43*	.58*	.40*							
7. Rehearsal	.51*	.52*	.50*	.50*	.36*	.46*						
8. Elaboration	.60*	.58*	.58*	.49*	.47*	.39*	.55*					
9. Organization	.51*	.56*	.48*	.53*	.45*	.43*	.64*	.58*				
10. Critical Thinking	.52*	.45*	.44*	.37*	.42*	.26*	.30*	.64*	.42*			
11. Metacognition	.58*	.63*	.56*	.58*	.50*	.43*	.60*	.70*	.70*	.57*		
12. ADOG	.47*	.50*	.48*	.49*	.32*	.38*	.53*	.42*	.48*	.27*	.44*	
13. TOL	.20*	.16	.19*	.12	-.15	.02	.12	.17*	.05	.22*	.12	.08

* p < .05

Table 2.
Descriptive Statistic for Four Groups by Motivation x AVSI and Motivation x ADOG on Use of Learning Strategies

	Motivation x AVS					Motivation x ADOG				
Group	G 1	G 2	G 3	G 4	Total	G 1	G 2	G 3	G 4	Total
N	57	28	23	56	164	55	30	23	56	164
M[a]	39.2	50.1	49.8	58.9	49.3	40.8	46.5	52.6	57.8	49.3
SD	8.7	9.5	6.1	8.9	11.8	10.4	9.2	6.8	9.5	11.8

Note: [a] sum = 90

Table 3.
Scheffe Test for Four Groups by Motivation x AVSI and Motivation x ADOG on Use of Learning Strategies

	Motivation x AVSI				Motivation x ADOG			
Group	G 1	G 2	G 3	G 4	G 1	G 2	G 3	G 4
G 1								
G 2	*							
G 3	*				*			
G 4	*	*	*		*	*		

* p < .05

Table 4.
Descriptive Statistics of the Four Groups by Motivation x Planning Ability

		Learning Strategy		Academic Volitional Strategy		Academic Delay of Gratification	
Group	N	M[a]	SD	M[b]	SD	M[c]	SD
G 1	48	43.5	9.5	39.9	7.3	14.7	3.1
G 2	31	43.1	11.6	36.3	8.2	13.8	3.6
G 3	29	56.2	8.8	44.0	7.0	17.3	3.7
G 4	39	57.1	9.3	44.9	6.4	17.5	3.7
Total	147	49.5	11.6	41.2	7.9	15.8	3.8

Note: [a] sum = 90, [b] sum = 60, [c] sum = 24.

Table 5.
Scheffe Test for Four Groups by Motivation x Planning Ability on Each Variable

	On Learning Strategy				On Academic Volitional Strategy				On Academic Delay of Gratification			
Group	G 1	G 2	G 3	G 4	G 1	G 2	G 3	G 4	G 1	G 2	G 3	G 4
G 1												
G 2												
G 3	*	*			*	*				*		
G 4	*	*			*	*			*	*		

* $p < .05$

Appendix A

Sample Items from the Motivation Scales, Learning Strategy Scales

MOTIVATION CONSTRUCTS*

Motivated Strategies for Learning Questionnaire (MSLQ; Pintrich et al., 1993)

Intrinsic Goal Orientation

- In science classes, I prefer course material that arouses my curiosity, even if it is difficult to learn
- The most satisfying thing for me in this science course is trying to understand the content as thoroughly as possible

Task Value

- I think I will be able to use what I learn in this science course in other courses
- I think the course material in this science class is useful for me to learn

Self-Efficacy

- I believe I will receive an excellent grade in this science class
- I'm certain I can understand the most difficult material presented in the readings for this science course

LEARNING STRATEGIES*

Motivated Strategies for Learning Questionnaire (MSLQ; Pintrich et al., 1993)

Rehearsal

- When studying for this science class, I read my class notes and the course readings over and over again
- When studying for this science course I try to determine which concepts I don't understand well

Elaboration

- I try to relate ideas in this science class to those in other courses whenever possible
- When reading for this class, I try to relate the material to what I already know

Organization

- When I study the readings for this science course, I outline the material to help me organize my thoughts
- I make simple charts, diagrams, or tables to help me organize this science course material

Critical thinking

- I often find myself questioning things I hear or read in this course to decide if I find them convincing
- I try to play around with ideas of my own related to what I am learning in this science course

Metacognition

- When reading for this science class, I make up questions to help focus my reading
- If course readings are difficult to understand, I change the way I read the material

* The response format consisted of a 5-point Likert scale (1 = "Not at all true" to 5 = "Very true").

Appendix B
Sample Items from the Academic Volitional Strategy Scales and Academic Delay of Gratification

ACADEMIC VOLITIONAL STRATEGIES*

Academic Volitional Strategy Inventory (AVSI; McCann & Garcia, 1999)

Self-Efficacy Enhancement

- I remind myself that I usually do fine on exams and/or other course assignments when I stay on track with my studying
- I tell myself, "you can do this!"

Stress-Reducing Actions

- I promise myself something I want when I complete a specific amount of studying (e.g., going to a movie, getting together with friends, favorite CD, etc.)
- I call a friend from class and discuss the assignment or material with them

Negative-Based Incentives

- I think about how disappointed others (family/friends) will be if I do poorly
- I think about the amount of time my classmates probably study for this science class, and that they will get a better grade than me

ACADEMIC DELAY OF GRATIFICATION**

Academic Delay of Gratification Scales (ADOGS; Bembenutty & Karabenick, 1998)

Situation 1

Which of the following would you choose to do?

A. Delay studying for an exam in this class the next day even though it may mean getting a lower grade, in order to attend a concert, play, or sporting event, OR

B. Stay home to study to increase your chances of getting a high grade on the exam.

Choose One

_Definitely choose A _Probably choose A _Probably choose B _Definitely choose B

* The response format consisted of a 5-point Likert scale (1 = "Not at all true" to 5 = "Very true").

** Values are based on a 1 ("Definitely choose A") to 4 ("Definitely choose B") coding responses, with higher values indicating greater preference for academic delay of gratification.

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October 22, 2001

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Dear Mrs. Ammerman:

My name is Byoung-Sug Kim. On April, 2001, I presented a paper in Seattle during the American Educational Research Association. The paper is entitled Self-Regulated Strategies in Science Learning: The Role of the Prefrontal Lobe Function. The coauthors are Wan-Ho Chung, Kil-Jae Lee, and Yong-Ju Kwon. At the time of the presentation, we all were associated to the Korean National University of Education, Chungbuk, Korea.

I am glad to inform you that we authorized our colleague, Mr. Héfer Bembenutty to submit, in our behalf, our papers to ERIC database. Thus, Mr. Bembenutty acted responsible and in accordance with our authorization. We authorized him because since we are living in Korea oversea communication is often difficult and because Mr. Bembenutty has previous experience submitting papers to ERIC database.

In behalf of all of the authors of our paper, I would like to thank you for inquiring about Mr. Bembenuttys authorization to submit our paper to you. If you have any question, you may contact me by e-mail : kbs1013@hotmail.com

Sincerely yours.
Byoung Sug Kim