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The Development of Self-Regulated Learning

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The purpose of this study is to examine the tendency for the development of self-regulated learning according to grade level. As a means to this end, competing causal models for each grade were set up, and through validity tests for the causal models the most fitting self-regulated learning model for South Korea students could be arrived at. Based on the conceptual model of self-regulated learning proposed by Pintrich (1989), Pintrich and De Groot (1990), and Zimmerman (1989, 1990), which focus on the relationship between motivation and cognition, three causal models were set up. According to the results of a structural analysis for 1,865 elementary, middle and high school students, model Ⅱ which structures intrinsic value as an exogenous variable, was determined the best-fitting model. In addition, the 30% variance in the 5th grade elementary school students and 32% and 18% variance in middle school and high school students respectively are explained by the test model.

Nowadays, the attention on the role of the learner not as a passive responder, which is a point of view out of the past, but as active participant is highly emphasized. Through regulated learning, which is a multi-faceted and dynamic construct, recent studies have been conducted with the intention of better understanding student's cognition and motivation which influence academic achievement and have been carried out hinged on self-regulated learning.

According to recent studies on self-regulated learning, learning is controlled not by external effects only but also by self-regulated elements (Weinert, 1983). Additionally, the academic achievement and learning of students in the classroom is controlled by this self-regulation of cognition and learning activity (Corno and Mandinach, 1983). Much progress has been made in defining self-regulated learners' structures of knowledge and the processes that underlie their abilities. These studies have also gone far in recognizing the importance of metacognitive, cognitive, and affective components and in postulating the existence of a high correlation between self-regulated learning and achievement (Bandura, 1986; Brophy, 1983; Corno and Mandinach, 1983; McCombs, 1984; Schunk, 1989; Zimmerman and Martinez-Pons, 1986; and Zimmerman, 1989, 1990).

Recent studies on self-regulated learning in South Korea have treated the relationship between motivation, cognition, or academic achievement and self-regulated learning, but they have neglected to define and explore the concept of self-regulated learning itself. These studies have also analyzed the relationship between the latent variables of self-regulated learning and academic achievement as special developmental levels and have accounted for the learning subjects' characteristics (gifted and learning-disabled students) descriptively and correlatively rather than concretely and in an explanatory manner. Thus, they have not been able to explain the theoretical variables sufficiently.

Therefore, this study clarifies tendencies in the development of self-regulated learning and determines the relationship between the measurement variables of self-regulated learning which influence academic achievement. It also suggests important prerequisites in the development of self-regulated learning programs which influence academic achievement. To clarify the tendency of developmental self-regulated learning competing causal models according to grade were set up. The most fitting model was determined by assessing the suitability of these causal models. This was then used to establish the self-regulated learning model which is most suitable for the Korean educational environment. Lastly, the validity of the model was tested.

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Conceptualization of Self-Regulated Learning

Points of view related with concepts of self-regulated learning vary according to the use of theory, but the synthesis of cognition and motivation in human learning is supported by many researchers. In light of this agreement Bandura (1977) explained learner's intrinsic processing, the learner's environment, and three decisive variables of learning activity employed by learners to manage effective learning. On the basis of Bandura's contribution "self-regulated learning" is defined here as the situation when learners, as masters of their own learning, monitor their academic goals and motivations for themselves, manage human and material resources, and become the subjects of decisions and performances in all learning processes. However, in order to establish an adequate theoretical basis for conceptualizing self-regulated learning further investigation into the factors influencing self-regulated learning is needed. To date many researchers have suggested various constituent factors and measurement variables. Generally, motivation, metacognition, and learning strategies have been classified as key factors in self-regulated learning.

The motivation factors involved in self-regulated learning have been identified by researchers as including the following components: self-enhancement (Bandura, 1982); academic goals and self-schema (Garcia and Pintrich, 1993); internal orientation, importance of task, and expectations for success (Pintrich, 1989); general self-efficacy, special self-efficacy, intrinsic motivation, self-esteem, and tendency of completeness (Sink, 1991); self-efficacy, and anxiety (Zimmerman, 1989) and metamotivation (Park, 1995).

Metacognition factors include plan, self-evaluation, and self-control (Bandura, 1982), executive treatment processes (Linder, Harris and Gordon, 1996), metacognitive control for learning and performance (Sink, 1991), and self-teaching, self-monitoring, and self-evaluation (Zimmerman and Martinez-Pons, 1986).

Learning strategy factors include techniques for solving problems and settling an idea (Bandura, 1982), circumstance-control, and environment-control (Corno, 1986), memory, elaboration, organization, time management, effort management, environmental condition management, and seeking outside assistance (Pintrich, 1989), cognition strategy, and self-control (Pintrich and De Groot, 1990), and social assistance and structuring of the learning environment (Zimmerman and Martinez-Pons, 1986, 1988).

In the light or the substantial research literature in the field this study considers motivation, metacognition, and learning strategies as the three key factors involved in self-regulated learning.

The Development of Self-Regulated Learning

The study of the development of self-regulated learning is classified into developmental and environmental aspects. As for the developmental aspects, Zimmerman and Martinez-Pons (1990) showed the developmental differences of self-regulated learning among 5th, 8th, and 11th grade students. The results of their study clearly show that there is considerable difference between student's perception of academic efficacy and the use of self-regulated learning strategies.

The studies of Purdie (1995) and Purdie and Hattie (1996) focussed on the environmental aspect of the development of self-regulated learning. They reported that the cross cultural-comparison of students from Australia and Japan showed that the frequency of reliance on teacher's or adult's assistance is much lower in Japanese students (N = 248) than Australian students (N = 215), and that the frequency of memorizing or reviewing the text is much higher in Japanese students than Australian ones. These findings suggested empirically that the learning environment at school has a strong effect on the nature of the practices of self-regulated learning employed by students. This means that the learning environment is very important in explaining self-regulated learning in South Korea, which has a learning environment similar to that of Japan.

Based on the above argument, then, it can be hypothesized that the influence of factors affecting self-regulated learning differs depending on the learning environment at school.

The Self-Regulated Learning Model

The self-regulated learning model is built on the basis of motivational and cognitive studies carried out to determine how students choose their academic goals and problem-solving strategies and how they apply their plans and efforts for their success (Corno and Mandinach, 1983; Paris and Newman, 1990; and Pintrich, 1989). In developing a model of self-regulated learning it is accepted, then, that there are causal relationships among the factors of motivation, metacognition, learning strategies, and academic achievement.

This conceptual model is based on the dynamic interplay between motivation and cognition which Pintrich (1989), Pintrich and De Groot (1990), and Zimmerman (1989, 1990) have explained in their studies. That is, motivation, which triggers effort in activity for academic achievement and provides energy to proceed in a constant direction, is an exogenous variable. It consists of 3 sub-factors; namely, self-efficacy, intrinsic values and test anxiety. Metacognition and learning strategies as endogenous variables are

dependence variables of motivation and independence variables of academic achievement. Metacognition consists of planning, monitoring, and regulation and learning strategies consist of cognitive strategies and resource management strategies. In order to select and utilize the suitable strategy, metacognition which is the knowledge of the strategy's value and usefulness, and its effect, is required. Thus, metacognition can be said to predict the continuance and generalization of learning strategies.

Before displaying the conceptual model as a concrete structural model, which includes a measurement model and structural model and assessing its suitability to fit the structure model with a correlation matrix, three causal models were built based on the literature.

Model Ⅰ was based on Biggs's (1978) learning process model and McCombs's(1986) unified model for the intrinsic motivation of learning. Model Ⅰ assumes that the motivational variable is an exogenous variable which affects academic achievement not only directly but also indirectly through mediating variables such as metacognition and learning strategies.

Model Ⅱ was based on Pintrich and De Groot's (1990) study and the structural model proposed by Garcia and Pintrich (1991) using a covariance structure analysis. Based on their proposed model, Model Ⅱ claims that motivational variables, such as self-efficacy, intrinsic value, and test anxiety do not predict academic achievement directly but indirectly affect academic achievement through metacognition and learning strategies.

Model Ⅲ was based on the studies of Ames and Archer (1988), Meece, Wigfield and Eccles (1990), and Miller, Behrens, and Greene (1993). Here self-efficacy is assumed to be an exogenous variable which affects academic achievement, metacognition, learning strategies, intrinsic values, and test anxiety. Intrinsic values and test anxiety are assumed to be mediating variables of metacognition and learning strategies.

Method

Subjects

To maximize the generalization of Korean characteristics, 14 classes of 5th-grade elementary school students, 12 classes of 2nd-year middle school students, and 13 classes 2nd-year high school students from Seoul, Kyung-gi, Choong-chung, Kyung-nam, and Kyung-buk participated in this study. These samples were chosen in consideration of previous studies on the self-regulated learning synthetically and also taking in to account that the ideal interval of comparative age group studies in the cross-sectional research is considered to be 3-5 years (Bloom, 1964). Consequently, the comparative age group was divided, on the basis of 5th-grade students of elementary school, at intervals of 3 years and 2nd-year students of middle school and high school were sampled.

The sample data collected from 1,865 boys and girls of 5th-grade elementary school students (312 boys, 281 girls), 2nd-year middle school (334 boys, 328 girls) and high school students (319 boys, 291 girls) are divided into two samples according to grade by random assignment method. The structural model is verified by the first sample, and the second sample is used to analyze the model's cross validation in order to verify the possibility of generalization.

Instruments

The Self-regulated learning test. On the basis of exploring literature on the concepts of self-regulated learning and its factors a self-regulated learning test to measure motivation, metacognition and learning strategies was made. This test uses a Likert-type scale, which consists of five steps from 5 (usually yes), to 1 (never). The test consists of 88 items and the previous studies used as a basis for this self-regulated learning test are as follows :

As for motivation, Pintrich and De Groot's (1990) Motivated Strategies for Learning Questionnaire (MSLQ) was used. This scale consists of 3 sub-factors such as self-efficacy (9 items; coefficient alpha = .88), intrinsic value (9 items; coefficient alpha = .80), test anxiety (4 items; coefficient alpha = .74). Among the total 22 items, 9 items were used.

To measure metacognition of reading and writing, Paris, Cross and Lipson's (1984) Index of Reading Awareness was used. This scale consists of 3 sub-factors, such as planning (12 items; coefficient alpha = .84), monitoring (10 items; coefficient alpha = .76), and regulation (11 items; coefficient alpha = .53). Among the total 33 items, 9 items were used.

As for learning strategies, a cognitive scale and resource management scale selected from McKeachie, Pintrich, Lin and Dmiyh's (1986) Motivated Strategies for Learning Questionnaire (MSLQ) was used. This scale consists of cognitive strategies, such as rehearsal (5 items; coefficient alpha = .70), organization (5 items; coefficient alpha = .54), and elaboration (7 items; coefficient alpha = .67) and resource management strategies, such as time and study management (5 items; coefficient alpha = .60), environment of study management (3 items; coefficient alpha = .68), effort management (4 items; coefficient alpha = .44) and activity of seeking assistance (4 items;

coefficient alpha = .28). The activity of seeking assistance was excluded in analysis for lower coefficient alpha. Among the total 33 items, 17 items were used.

Academic achievement. As for the reference of academic achievement, scores (T-scores) for Korean and mathematics, which are common subjects in elementary school, middle school, and high school were used among the academic scores checked by teachers according to school and grades.

Procedures

I divided factors of self-regulated learning into exogenous and endogenous variables, and made the factors go through the confirmatory process and exploratory one and tested the validity of the factors.

Reliability. For the estimates of reliability, I tried item-analysis via the exploratory process and confirmatory process in order to choose items included in the final scale (Song, 1982). As the result of estimating reliability, exploratory alpha coefficients were ranged from .8613 to .8882 and confirming alpha coefficients were from .8618 to .9085, which have shown acceptable level of reliability.

Validity. To confirm the construct validity of self-regulated learning's factors I performed the main factor analysis with the method of orthogonal rotation and factor analysis according to the following procedures.

First, in the factor analysis, the references deciding statistically significant number of factor were generally divided on the basis of the number of factor which was more than 1 eigenvalue proposed by Kaiser (as cited in Choi & Son , 1993), but in order to raise reliability I considered both the number of factors drawn from the Scree test suggested by Cattell and Harman (as cited in Choi & Son, 1993) and the number of factor drawn from searching literatures.

Second, Bentler (1980) insisted that, in LISREL analysis, the reliable of parameter estimate should be drawn on condition that the number of subject per parameter must be at least more than 5 times. Thus, in minimizing the number of items, it is desirable to select 3-6 measurement variables per each theoretical variables (Bentler and Chou, 1987), so I chose 3 measurement variables which have high factor loading.

Results

The best-fitting model of self-regulated learning according to grade

Testing the causal model for 5th grade elementary school students. The correlation matrix and descriptive statistics among 19 measurement variables analyzing the 5th-grade elementary school students are shown in Table 1.

Analysis of the appropriateness of fit. The appropriateness of fit for the hypothetical models are all ideal, and in order to find the best-fitting model by applying a difference test among models an x^2 difference test was performed. An x^2 difference test is a method of verifying whether the increase of appropriateness of fit is as large as it justifies victimizing parsimony.

The results of the x^2 difference test on model Ⅰ and model Ⅱ are as follows: $\Delta x^2(2, n = 294) = .96, P < .05$, model Ⅱ Ⅲ $\Delta x^2(2, n = 294)=.96, P <.05$, model I and model Ⅲ in both theoretical model sampling and cross-validation sampling did not show an extensive increase in appropriateness of fit in contrast with the victim of parsimony, and thus the null hypothesis was confirmed at the .05 level.

Therefore, in explaining the relation between factors of self-regulated learning and academic achievement with 5th-grade elementary school students, model Ⅱ $x^2[136, n = 294] = 88.60, P < .001$ [GFI = .93, AGFI = .91, RMSR = .04, NNFI = 1.07]), which structures intrinsic value as an exogenous variable agreed with the empirical data well. This means that knowledge of only metacognition and learning strategies doesn't accelerate
academic achievement and in order to make metacognition or learning strategies affect academic achievement learners must be motivated most of all.

The empirical results of this study are in the same vein as Garcia and Pintrich's (1991) theory in which they consider intrinsic value as triggering the process and the exogenous variables as affecting the use of learning strategies, evaluation of ability, and expectations for success. This also agrees with the theories of Meece, Wingfield, and Eccles (1990) and Pintrich and De Groot (1990), in which learners who thought class study interesting and important would participate in learning more actively and be more self-regulated. They also continued to study longer in order to learn and understand the material in class study.

Table 1. The Correlation Matrix and Descriptive Statistics of Elementary School Students

	EFF1	EFF2	EFF3	VAL1	VAL2	VAL3	ANX1	ANX2	ANX3	MET1	MET2	MET3	COG1	COG2	COG3	RES1	RES2	RES3	ACH
EFF1	1.000																		
EFF2	.456	1.000																	
EFF3	.429	.436	1.000																
VAL1	.189	.320	.274	1.000															
VAL2	.216	.279	.248	.346	1.000														
VAL3	.232	.300	.279	.474	.362	1.000													
ANX1	.145	.114	.086	.112	-.019	.142	1.000												
ANX2	.138	.185	.075	.128	.065	.117	.460	1.000											
ANX3	.088	.118	.031	.089	.043	.039	.364	.594	1.000										
MET1	.406	.355	,303	.136	.257	.170	.039	.100	.042	1.000									
MET2	.333	.354	.308	.232	.345	.314	.108	.148	.088	.464	1.000								
MET3	.395	.419	.338	.226	.316	.344	.038	.108	.094	.490	.543	1.000							
COG1	.334	.318	.274	.179	.237	.249	.013	-.022	-.015	.469	.551	.475	1.000						
COG2	.279	.207	.167	.146	.237	.311	.035	.067	-.010	.359	.442	.415	.403	1.000					
COG3	.253	.286	.275	.190	.239	.236	.071	.086	.051	.364	.553	.417	.551	.417	1.000				
RES1	.341	.346	.375	.291	.298	.357	.173	.167	.066	.335	.429	.460	.457	.388	.473	1.000			
RES2	.244	.270	.235	.154	.178	.214	.037	.026	-.012	.219	.331	.317	.326	.297	.393	.359	1.000		
RES3	.298	.373	.291	.160	.342	.283	-.012	.002	-.096	.412	.466	.410	.473	.353	.446	.463	.411	1.000	
ACH	.429	.283	.382	.189	.340	.254	.128	.243	.255	.369	.252	.291	.138	.133	.127	.161	.177	.324	1.000
M	3.047	3.375	3.186	3.682	3.939	3.696	3.172	2.576	2.451	3.729	3.307	3.551	3.136	3.258	2.950	3.168	3.150	3.408	50.882
SD	.971	.897	.955	1.042	1.036	1.093	1.249	1.299	1.358	.860	.825	.885	.913	.817	.850	.811	1.113	.773	9.655
Kurtosis	-.11	-.02	.02	-.22	-.24	-.20	-.97	-.97	-.87	-.18	-.09	-.33	-.24	-.09	-.13	.02	-.81	.02	-.17
Skewness	-.18	-.29	-.02	-.54	-.65	-.55	-.07	.42	.50	-.48	-.22	-.34	-.20	-.23	-.11	-.03	-.07	-.27	-.80

Note. N = 294. EFF1 = self-efficacy 1; EFF2 = self-efficacy 2; EFF3 = self-efficacy 3; VAL1 = intrinsic value 1; VAL2 = intrinsic value 2; VAL3 = intrinsic value 3; ANX1 = test anxiety 1; ANX2 = test anxiety 2; ANX3 = test anxiety 3; MET1 = metacognition 1; MET2 = metacognition 2; MET3 = metacognition 3; COG1 = cognitive strategy 1; COG2 = cognitive strategy 2; COG3 = cognitive strategy 3; RES1 = resource management strategy 1; RES2 = resource management strategy 2; RES3 = resource management strategy 3; ACH = academic achievement; M = mean; SD = standard deviation.

Detailed fit measure. The fit of the null model in 5th-grade elementary school students was acceptable, χ^2 (136, n = 294) = 88.60, P<.001 (χ^2/df = .65, GFI = .93, AGFI = .91, RMSR = .04, NNFI = 1.07). However, the search for the best-fitting model was continued using a fixed parameter (T-value), which is a method of providing information to search for a better model than the present one.

The best-fitting self-regulated learning model in the 5th-grade elementary school students is model Π 3, χ^2 (147, n = 294) = 107.44, P < .001 (χ^2/df = .73, GFI = .92, AGFI = .90), with significant improvement from the null model, $\Delta\chi^2$(11, n = 294) = 18.84, P < .05. The final SRL model is an explanatory and parsimonious one without damaging the appropriateness of fit. The path coefficients of the final SRL model are diagramed in Figure 1.

The effects of each variable on the basis of the test model of self-regulated learning in 5th-grade elementary school students are summarized as follows.

First, the causal path affecting academic achievement of 5th-grade elementary school students is intrinsic value → self-efficacy → academic achievement, and it is statistically significant. That is, it suggests that for effective learning the learner necessarily understands the importance of the text and its value must be preceded.

Second, there exists the path intrinsic value → self-efficacy → metacognition → resource management strategies → cognitive strategies, but this path does not affect academic achievement significantly. This means that for the proper use of learning strategies the teacher's guide is indispensable at first because elementary school students lack the ability to regulate and control learning strategies.

Third, the test model accounts for 30% (Ψ_6 = .70) variance of academic achievement. Also, what appears to have a great effect on academic achievement is self-efficacy (.55). In regard to this, an individual's self-efficacy rather than his or her own ability or learning strategies accurately

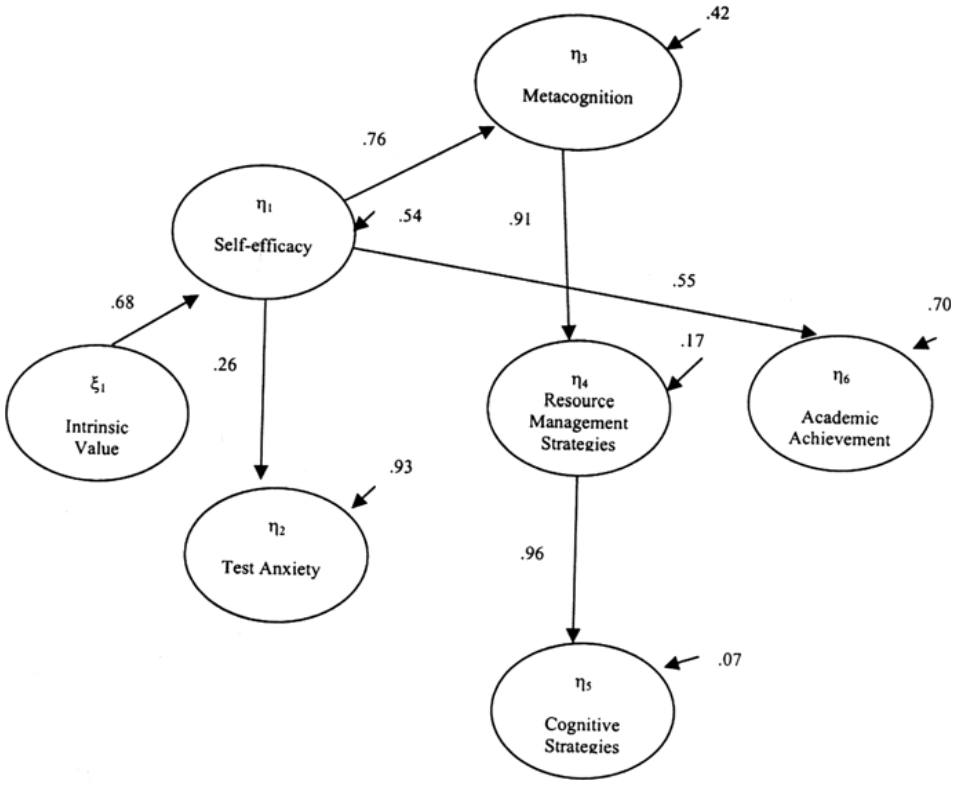

Figure 1. Testing Model of Self-Regulated Learning in 5th Grade of Elementary School Students.

predict academic achievement and provides a more powerful learning motivation than any other variable. The results of this study agree with empirical evidence proposed by Pajares (1996), Schunk (1984), Zimmerman and Martinez-Pons (1988).

Testing the causal model in 2nd-year middle school students. The correlation matrix and descriptive statistics for 19 measurement variables used to analyze the 2nd-year middle school students are shown in Table 2.

Analysis of the appropriateness of fit. Models were estimated using the overall fit measure, which means that the conceptual model was fitted to the empirical data. Putting various appropriateness of fit statistics together, the hypothetical models set up in this study are proper to the data in the case of analyzing 2nd-year middle school students. These results were also supported by the analysis of cross-validation. Thus, in order to look for the most fit model through a difference test among models, an x^2difference test was conducted.

The results of the x^2difference test are as follows; model I II $\Delta x^2(2, n = 305) = 2.86, P < .05$, model II III $\Delta x^2(2, n = 305) = 2.86, P < .05$. Models I III n both theoretical model sampling and cross-validation sampling, didn't show such an extensive increase in appropriateness of fit in contrast with the victim of parsimony and thus the null hypothesis was confirmed at the .05 level.

Therefore, the analysis of 2nd-year middle school students, which was the same with the results of testing 5th-grade children in the elementary school, explained well the relationship between factors of self-regulated learning and academic achievement, and have shown that model II $x^2(136, n = 305) = 290.56, P < .001$ (GFI = .90, AGFI = .87, RMSR = .05, NNFI = .90), structuring intrinsic value into an exogenous variable, was the proper model based on the empirical data. These results are empirical ones, which make similar claims as Garcia and Pintrich (1991), Meece, Wigfield and Eccles (1990), and Pintrich and De Groot's (1990) theories in which they reported that learners who thought class study interesting and important and whose intrinsic value was high participated more actively in understanding and learning the data and were more self-regulated and continued to study much longer.

Detailed fit measure. Model II used in analyzing the 2nd-year middle school students, had sufficient

Table 2. The Correlation Matrix and Descriptive Statistics of Middle School Students

	EFF1	EFF2	EFF3	VAL1	VAL2	VAL3	ANX1	ANX2	ANX3	MET1	MET2	MET3	COG1	COG2	COG3	RES1	RES2	RES3	ACH
EFF1	1.000																		
EFF2	.614	1.000																	
EFF3	.419	.444	1.000																
VAL1	.297	.275	.427	1.000															
VAL2	.249	.253	.295	.379	1.000														
VAL3	.265	.293	.383	.603	.384	1.000													
ANX1	.170	.138	.122	.037	.128	.126	1.000												
ANX2	.116	.082	.106	.013	-.087	.057	.508	1.000											
ANX3	.039	.033	.110	.015	-.073	.038	.393	.627	1.000										
MET1	.275	.301	.247	.136	.295	.150	.124	-.002	-.051	1.000									
MET2	.257	.301	.259	.183	.159	.175	-.039	-.011	-.061	.401	1.000								
MET3	.358	.364	.264	.224	.296	.159	.151	.069	.014	.485	.490	1.000							
COG1	.272	.272	.283	.243	.222	.216	-.040	-.043	-.133	.244	.401	.403	1.000						
COG2	.336	.360	.346	.225	.344	.258	.030	-.042	-.104	.466	.386	.412	.387	1.000					
COG3	.247	.233	.328	.286	.164	.312	.070	-.072	-.040	.314	.522	.396	.308	.324	1.000				
RES1	.322	.337	.364	.414	.306	.401	.048	-.042	-.066	.301	.388	.368	.369	.379	.505	1.000			
RES2	.251	.291	.261	.240	.225	.204	.111	.011	-.033	.252	.314	.286	.332	.379	.325	.447	1.000		
RES3	.356	.387	.256	.265	.348	.178	.090	-.073	-.103	.379	.415	.471	.373	.502	.304	.397	.387	1.000	
ACH	.376	.488	.292	.130	.215	.146	.258	.106	.034	.296	.218	.351	.292	.301	.164	.241	.290	.364	1.000
M	2.938	3.088	2.618	3.019	3.606	3.059	3.150	2.953	2.516	3.622	2.961	3.565	3.134	3.241	2.628	2.626	2.998	3.467	49.708
SD	1.098	1.009	.905	1.023	1.045	1.035	1.201	1.279	1.240	.876	.788	.806	.884	.766	.728	.778	1.072	.768	10.005
Kurtosis	-.63	-.39	.18	-.22	-.19	-.13	-.97	-1.04	-.86	.05	-.08	.13	-.18	.34	.03	.25	-.81	.42	-1.09
Skewness	.05	-.13	-.12	-.07	-.48	-.06	-.09	.10	.44	.44	-.01	-.47	-.06	-.39	.16	-.12	-.01	-.43	-.28

Note. N = 305.

appropriateness of fit, but its parsimony was low and T-value was small. Thus, the search was continued for the best-fitting model by using a T-value which could minimize models into parsimonious ones without damaging the appropriateness of fit.

The most fitting self-regulated learning model for 2nd-grade students in middle school is model Π , χ^2 (145, n = 305) = 300.70, P < .001 (χ^2/df = 2.07, GFI = .90, AGFI = .87), with significant improvement from the null model, $\Delta\chi^2$(9, n = 305) = 10.14, P < .05. This model was also determined without damaging the appropriateness of fit. The path diagram of the final SRL model is found in Figure 2 below.

The effects of each variable are summarized as follows.

First, the causal path which links the affecting academic achievement of 2nd-year students in middle school is intrinsic value → self-efficacy → academic achievement and intrinsic value → self-efficacy → metacognition → academic achievement. This causal path shows significant results. This means that 2nd-year students in middle school enjoy a high level of self-confidence and the more effectively they use metacognition regulating, monitoring, and planning the cognition, the higher their level of academic achievement. Also, when they have interest in class study and its value, the fact of strong self-confidence in their own ability affects academic achievement strongly as well as the self-confidence itself.

Second, the causal path of intrinsic value → self-efficacy → test anxiety → resource management strategy → cognitive strategy, and intrinsic value → self-efficacy → metacognition → resource management strategies → cognitive strategies was confirmed. This path, however, did not affect academic achievement significantly. These are the meaningful results, which show empirically that in the case of middle school students as well, the teacher's guide in the use of proper strategies is essential.

Third, 32% (Ψ_6 = .68) variance of academic achievement is accounted for in the final SRL model. The factor of self-regulated learning which has the strongest effect on academic achievement is self-efficacy (.43). Once more, academic achievement is determined depending on how

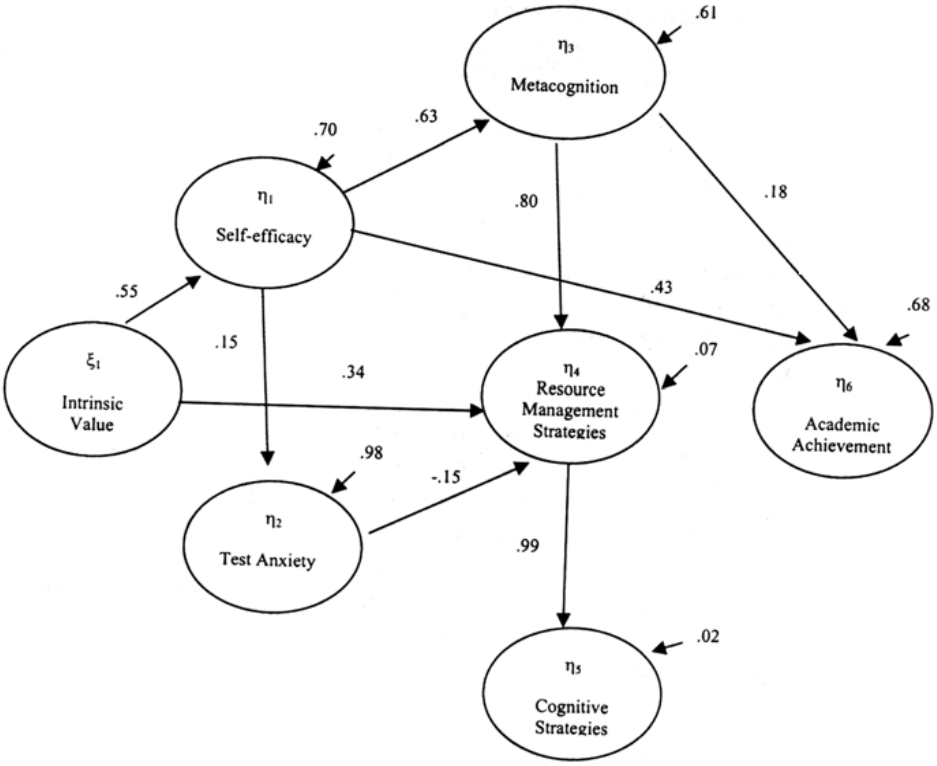

Figure 2. Testing Model of Self-Regulated Learning in 2nd Grade of Middle School Students.

confidence in his/her own ability is formed.

Testing the causal model for 2nd-year high school students. The correlation matrix and descriptive statistics for the 19 measurement variables used in analyzing the 2nd-year high school students are shown in Table 3 below.

Analysis of the appropriateness of fit. The hypothetical models built in this study agreed with the data well, particularly in the case of analyzing 2nd-year high school students. These results were also supported by an analysis of cross-validation. Thus, an x^2difference test was conducted in order to find the best-fitting model through difference test among models.

The results of x^2difference test are as follows: model Ⅰ and model Ⅱ $\Delta x^2(3, n = 285) = 2.68$, $P < .05$, model Ⅱ and model Ⅲ $\Delta x^2(3, n = 285) = 2.68$, $P < .05$. Models Ⅰ Ⅲ didn't show an extensive increase on the appropriateness of fit in spite of the victim of parsimony, so the null-hypothesis was confirmed at the .05 level.

Therefore, for 2nd-year high school students, like the test results of 5th-grade elementary school children and 2nd-year middle school students, it has been concluded that in explaining the relationship between constituent factors of self-regulated learning and academic achievement, structuring intrinsic value into exogenous variable is proper to the empirical data, I find the following:$x^2(137, n = 285) = 236.43$, $P < .001$ ($x^2/df = 1.72$, GFI = .92, AGFI = .89, RMSR = .05, NNFI = .90). These results are in the same vein with Garcia and Pintrich (1991), Meece, Wigfield and Eccles (1990) and Pintrich and De Groots (1990) studies, in which they reported that learners who thought class study interesting and important and whose intrinsic value was high, participated more actively in understanding and learning the data and were more self-regulated and continued to study much longer.

Detailed fit measure. Because model Ⅱ in verifying 2nd-year high school students has enough appropriateness of fit but low parsimony, and the T-value is small, a more fitting model continued to be sought after using a reasonable fixed parameter. The best fitting self-regulated learning model for 2nd-year high school students is Ⅱ -11, $x^2(146, n = 285) = 252.25$, $P < .001$ ($x^2/df = 1.72$, GFI = .91, AGFI = .89), with significant improvement from the null model, $\Delta x^2(9, n = 285) = 15.82$, $P < .05$. Additionally it is parsimonious without damaging goodness of fit and provides a powerful explanatory

Table 3. The Correlation Matrix and Descriptive Statistics of High School Students

	EFF1	EFF2	EFF3	VAL1	VAL2	VAL3	ANX1	ANX2	ANX3	MET1	MET2	MET3	COG1	COG2	COG3	RES1	RES2	RES3	ACH
EFF1	1.000																		
EFF2	.647	1.000																	
EFF3	.345	.335	1.000																
VAL1	.179	.177	.116	1.000															
VAL2	.149	.186	.148	.366	1.000														
VAL3	.194	.228	.297	.667	.445	1.000													
ANX1	.004	.054	-.037	-.150	-.015	-.112	1.000												
ANX2	.018	.005	-.081	-.101	-.146	-.080	.564	1.000											
ANX3	-.090	-.069	-.053	-.233	-.131	-.193	.432	.642	1.000										
MET1	.185	.193	.023	.082	.128	.110	.019	.072	-.048	1.000									
MET2	.264	.210	.202	.283	.251	.310	-.191	-.066	-.132	.392	1.000								
MET3	.172	.205	.110	.047	.112	.187	-.037	-.082	-.117	.253	.218	1.000							
COG1	.103	.143	.181	.238	.217	.261	-.115	-.103	-.160	.220	.296	.267	1.000						
COG2	.251	.240	.239	.126	.165	.162	.015	.032	.001	.287	.355	.271	.341	1.000					
COG3	.270	.250	.244	.192	.173	.325	.022	-.027	-.084	.323	.417	.296	.284	.373	1.000				
RES1	.130	.151	.234	.238	.158	.302	.032	-.066	-.118	.205	.226	.143	.160	.216	.392	1.000			
RES2	.160	.208	.191	.155	.186	.118	-.077	-.203	-.256	.195	.252	.203	.304	.156	.207	.233	1.000		
RES3	.258	.326	.182	.184	.170	.170	.016	-.028	-.176	.280	.284	.325	.328	.316	.333	.260	.322	1.000	
ACH	.318	.351	.176	.077	.093	.168	.037	.010	.000	.032	.078	.108	.074	.221	.206	.144	.099	.289	1.000
M	3.240	3.239	2.615	2.551	3.541	2.642	3.384	3.010	2.601	3.795	2.953	3.809	3.336	3.408	2.807	2.431	3.140	3.842	50.176
SD	1.057	.874	.810	.914	.933	.871	1.025	1.091	1.073	.675	.717	.569	.798	.678	.731	.637	1.137	.598	10.084
Kurtosis	-.46	-.12	.01	-.46	.12	-.20	-.64	-.78	-.67	.61	.07	.69	-.24	.35	-.12	.46	-.88	.07	-.55
Skewness	.20	-.24	-.11	.01	-.40	.04	-.31	.10	.31	-.47	-.04	-.46	-.19	-.35	.12	.28	-.23	-.36	-.17

Note. N = 285.

model. The path diagram of the final SRL model is located in the Figure 3 below.

The effects between each variable on the basis of the test model of self-regulated learning for 2nd-year high school students in Figure 3 are summarized as follows.

First, the causal path links affecting the academic achievement of 2nd-year high school students is intrinsic value → self-efficacy → metacognition → resource management strategies → cognitive strategies → academic achievement, which is significant statistically. These results show that evidence data confirmed a synergy effect of self-regulated learning appearing as synthesis of motivation and cognitive variable.

Second, direct effects appear, such as intrinsic value → metacognition (.35), intrinsic value →test anxiety (-.18), self-efficacy → ıcademic achievement (.37), cognitive strategy → ıcademic achievement (.08). This is interpreted to mean that the stronger the confidence in one's own ability is, the more effectively one uses metacognition regulating, monitoring, and planning cognition and the level of academic achievement is additionally high. Also, when one has interest in class study and recognizes the value of class study, one uses metacognition and learning strategies effectively along with confidence in his ability, and it means that the use of self-regulated learning can attribute to improving academic achievement.

Third, 18% (Ψ_6=.82) variance of academic achievement is explained by the test model. Self-efficacy appears to have the strongest effect on academic achievement. The test models for elementary school, middle school, and high school all agree with one another. That is, self-efficacy, which emphasizes confidence in one's own ability to control the important aspects of life, is the most powerful learning motivation of all the self-regulated learning variables. Also, this agrees with the results that self-efficacy has the most powerful direct effect of all the predictor variables of academic achievement proposed by Pajares (1996), Schunk (1984) and Zimmerman and Martinez-Pons (1988).

Discussion

This study supports the viewpoints of previous studies including those of Corno and Mandinach (1983),

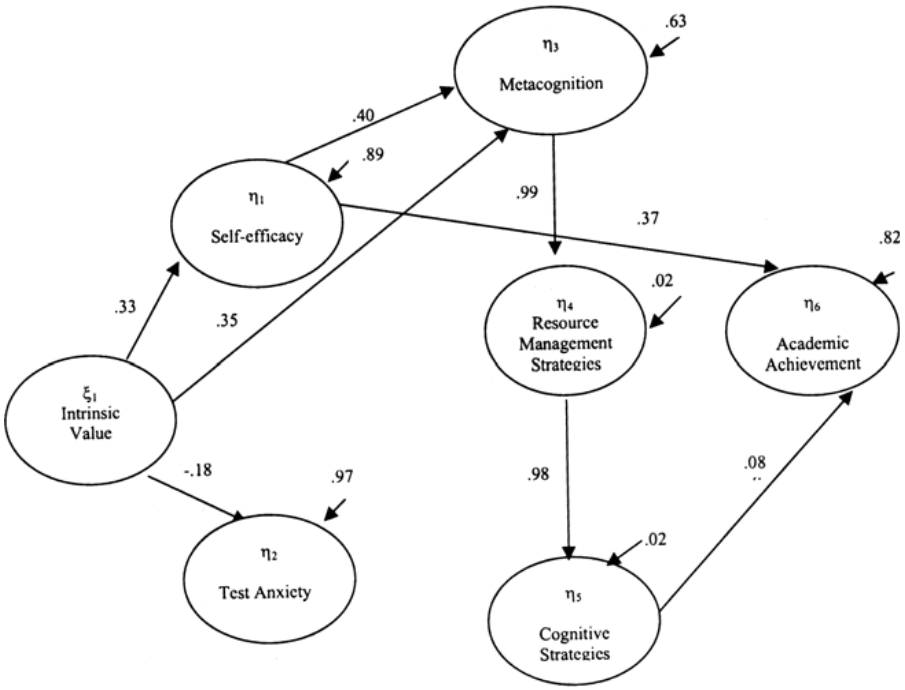

Figure 3. Testing Model of Self-Regulated Learning in 2nd Grade of High School Students.

Paris and Newman (1990), Pintrich (1989), and Schunk (1984), in which unifying cognitive factors as well as motivational ones are said to be important in order to understand learning processes thoroughly because the interactional effect between motivation and cognition is greater than their individual effects. The construct of self-regulated learning explaining academic achievement phenomenon was confirmed empirically.

According to the results, Model Ⅱ proved to be the best-fitting model. This was verified using the self-regulated model according to grade and analyzing cross-validation with sampling 2 in each grade in order to increase generalizability, model Ⅱ in which intrinsic value is an exogenous variable is proved to be the best-fitting model. This is the empirical result, which is in the same vein with the theories proposed by Garcia and Pintrich (1991), Meece, Wigfield and Eccles (1990), and Pintrich and De Groot (1990). They have reported that learners who had high intrinsic value thought class study interesting and important and they would participate in learning more actively and be more regulated and continue to study much longer.

As scientific parsimony is an important element for advancing a theory, the best-fitting model was searched for using a T-value, which was like the detailed fit measure. As a result the final SRL model according to grade not only suggests a close correlation between self-regulated learning and academic achievement but also shows the development of a self-regulated learning model and degree of differentiation.

First, the factor of self-regulated learning, which has the strongest effect on academic achievement according to grade, appears to be self-efficacy. The direct effect of self-efficacy on academic achievement is .55 in the 5th-grade children in elementary school, .43 in 2nd-year middle school students, and .67 in 2nd-year high school students. Therefore, it is clear that the effect of self-efficacy on academic achievement is very strong but, as these children grow up, the direct effect decreases. This is because the self-confidence in one's own ability for elementary school students is greater than that of middle school or high school students. As self-evaluation has a strong effect on academic achievement in guiding elementary school students, the improving of the motivational factor is required. Paris and Newman (1990) interpreted the above result noting that

elementary school students are not able to evaluate their own ability objectively.

Second, the path of intrinsic value → self-efficacy → metacognition → esource-management strategies → ognitive strategies appears over all the grades. With 5th-grade elementary school student, this path wasn't linked with academic achievement. Empirical results show that metacognition has a .18 direct effect on academic achievement in the middle school students, and cognitive strategy has a .08 direct effect on the academic achievement in the high school students. As Pressley and Ghatala (1990) suggested, though learning strategies were formulated, as for learners who did not have useful information about learning strategies, such as when, where or how to use them, the possibility of using strategies widely is limited. Accordingly, as the elementary school students lack ability to control and regulate learning strategies, the teacher's guide is indispensable at first in order to improve academic achievement.

Third, 30% of the variance in the 5th-grade elementary school students, 32% and 18% of the variance in middle school and high school students respectively are explained by the test model. In this case, the self-regulated learning model of 2nd-year middle school students can explain academic achievement better than any other grade's model and the degree of differentiation is high. However, the differentiation doesn't develop constantly with the increase of age. This means that self-regulated learning does not increase in proportion to an increase of age and it is influenced by the study patterns of school, task, and learning environment, which is in the same vein as Bandura's (1977) social-cognitive view. This study, furthermore, supports the results the previous studies (Armstrong, 1989; Paris and Newman, 1990; Zimmerman & Martinez-Pons, 1990) in claiming that the critical period in the development of self-regulated learning is that of middle school.

In view of the subject of this study, the effect of causal relation between latent variables seems to be grasped more concretely by means of a longitudinal method correcting the measurement errors of variables using collected data. As for the method of measurement employed, the results from questionnaire have shown only the learner's perceptions of using learning strategies, not the accuracy and fitness of metacognition or uses of strategies. To approach these aspects of self-regulated learning the development of pertinent theories and relevant empirical study must be continued.

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