

Scale Design of Self-regulated Learning for College Students

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Abstract: Inspired by the novel self-regulated learning theories both at home and abroad, this study developed a self-regulated learning scale for college students in China. The scale included learning motivation subscale and strategy subscale. First, six factors formed the motivation subscale, including learning self-efficacy, learning control belief, and learning anxiety, etc. Moreover, the learning strategy subscale contained learning methods, learning planning and learning managing, etc. The inspection and analysis showed that the proposed scale was suitable for the judgment of college students' self-regulated learning ability.

Keywords: Self-regulated Learning Ability; Learning Self-Efficacy; Learning Control Belief; Learning Managing

1. Problem Statement

Self-Regulated Learning refers to the process in which learners actively and autonomously participate in their own learning activities to a certain extent [1], from the aspects of meta cognition, motivation, and behavior. Its core lies in students' proactive control and regulation of their own learning. Some scholars in China translate it as "Self-regulated Learning", while others translate it as "Self-Monitoring Learning," [2] etc. Since the translation of "Self-Regulated Learning" directly reflects the core position of students' autonomy in self-regulated learning, this article adopts this translation. In the late 1980s and early 1990s, a series of studies by Zimmerman and others sparked a wave of interest in self-regulated learning internationally. In China, due to the advocacy of teaching students how to learn and emphasizing the cultivation of students' learning abilities, self-regulated learning has also become an important topic in education and psychological research. It has become a hot issue of joint concern for researchers and

educational practitioners [3].

Research on self-regulated learning involves concepts, structures, influencing factors, and assessments of self-regulated learning. Currently, international research on self-regulated learning mainly includes seven theoretical categories: Operant Behavioral, Phenomenological, Information Processing, Social Cognitive, Volitional, Speech-Guided, and Constructivist Schools. Among these, Zimmerman's social cognitive theory, developed upon incorporating Bandura's ideas of personal, behavioral, and environmental triadic reciprocity and self-regulation, is one of the most influential theories in the field of self-regulated learning. He proposes that self-regulated learning can be divided into three stages: planning, behavioral or volitional control, and self-reflection, and is influenced by personal, behavioral, and environmental dimensions. Learners need to proactively control and regulate their learning process while also actively monitoring and adjusting based on external feedback regarding their performance and learning environment. Personal factors include students' knowledge, meta cognitive processes, goals, and emotions; behavioral factors are manifested in self-observation, self-judgment, and self-response; and environmental factors include modeling, verbal guidance, social support, and environmental structuring. He also emphasizes the crucial role of self-efficacy in self-regulated learning [4].

In practical research, a primary issue often turns out to be the assessment of self-regulated learning. The assessment of self-regulated learning is a concretization of concepts, theories, and components of self-regulated learning. Although many measurement methods have been developed, self-report scales are often preferred in practical research and teaching due to their simplicity and ease of operation. Internationally, there are already assessment scales for self-regulated learning among elementary, secondary, and even

college students. For instance, the "Learning and Study Strategies Inventory" developed by Weinstein et al., the "Self-Regulated Learning Interview Schedule" and the "Student Self-Regulated Learning Outcome: Teacher Rating Scale" by Zimmerman and Martinez-Pons, and the "Motivated Strategies for Learning Questionnaire" by Pintrich et al. In China, the assessment of self-regulated learning primarily includes the "Self-Regulated Learning Scale for Elementary and Secondary School Students" by Pang Weiguo and the "Learning Self-Monitoring Scale" by Dong Qi et al., suitable for secondary school students. [5] However, there are no appropriate tools yet for the assessment of self-regulated learning among college students.

Although current research on self-regulated learning in China mainly focuses on elementary and secondary schools, studies involving college students are relatively rare. However, college students experience a more liberal and relaxed management style, making their initiative and self-discipline in learning especially crucial. Students' learning abilities and their proactive approach to learning can significantly impact their academic achievements. Therefore, the assessment and research of self-regulated learning among college students are also of great theoretical and practical importance. Consequently, this study aims to develop an assessment scale for self-regulated learning suitable for Chinese college students, drawing on the latest theories of self-regulated learning from both domestic and international sources. This scale is intended to meet the urgent needs of evaluating learning abilities and conditions in the current teaching and management of college students.

2. Development and Implementation of the Self-regulated Learning Questionnaire for College Students.

2.1 Definition of Self-regulated Learning and Its Dimensions

Currently, there are varying definitions of self-regulated learning. Some researchers suggest that self-regulated learning is learning dominated by the student, a mode of learning that is opposite to other-directed learning. Others point out that when students can actively make choices, control, or regulate aspects such as their learning

motivation, content, methods, timing, process, outcomes, and environment, their learning is considered self-regulated. [6] Some scholars, from the perspective of the learning process, believe that self-regulated learning should include three aspects: planning, arrangement, and preparation before learning; monitoring, evaluation, and feedback during the learning process; and adjustment and remediation of the learning. Synthesizing these definitions, we believe that learners are engaging in self-regulated learning when they can autonomously initiate the desire to learn, positively influence their learning outcomes, and, behaviorally, plan, control, and regulate their learning process.

According to Zimmerman's social cognitive theory and our definition of self-regulated learning, we believe that the self-regulated learning questionnaire for college students should consist of two parts: a motivation subscale and a strategy subscale. Through small group discussions with college students and graduate students in psychology, we further determined the secondary dimensions of these two subscales. The motivation subscale includes four dimensions: learning goals and values, learning expectations, learning attribution, and learning anxiety. Within this, learning goals and values further encompass three secondary dimensions: intrinsic, extrinsic goal orientations, and task value beliefs. Learning expectations include two secondary dimensions: sense of control over learning and self-efficacy. The strategy subscale is composed of five dimensions: planning, methods, feedback, learning regulation, and learning summarize and remediation. The planning dimension includes two sub-dimensions: plan formulation and time management. Learning regulation is composed of three sub-dimensions: persistence in learning, management of learning emotions, and regulation of learning activities.

2.2 Item Compilation

In reference to some mature learning motivation and strategy scales in China, as well as P.R. Pintrich's research [7] on self-regulated learning in middle and high school students and the research by Pang Weiguo and

others on the "Development of a Self-Regulated Learning Scale for Elementary and Middle School Students," we followed the proposed dimensions and structure. Graduate students majoring in psychology and undergraduate students from other majors (including both arts and science students), a total of 9 people, individually wrote items. Then, through joint discussions, the questionnaire items were determined. Finally, a self-regulated learning questionnaire for college students with a total of 119 items was formed, including 55 items in the learning motivation section and 64 in the learning strategy section. Each item required a response on a six-point scale, ranging from "Strongly Disagree," "Disagree," "Somewhat Disagree," "Somewhat Agree," "Agree," to "Strongly Agree," scored from 1 to 6 points, respectively.

2.3 Administration of the Questionnaire

The formal administration of the questionnaire was conducted in May 2004 at Foshan University. First to third-year students were sampled as subjects, and group testing was carried out in each class. A total of 507 valid subject data were obtained, including 241 females and 266 males, with a balanced representation of both genders. The number of students from the first, second, and third years was 187, 173, and 147, respectively, with a roughly equal distribution of students from arts and sciences.

3. Structural Analysis of the Scale

3.1 Project Analysis

All data were processed using the SPSS 10.0 software package.

Based on the responses of the subjects, item-total correlations were conducted separately for the motivation and strategy subscales. To improve the power of the items in the test, a total of 21 items were removed based on the principle that items with correlation coefficients less than 0.3 were to be deleted. Among these, 11 items were removed from the motivation subscale and 10 items from the strategy subscale.

3.2 Factor Analysis

In the factor analysis of the motivation and strategy subscales, it was found that the Bartlett's test was significant at the 0.00 level,

and the KMO coefficients were 0.90 and 0.92 respectively, indicating suitability for factor analysis.

Using the principal component method with Varimax rotation, factor analyses were conducted separately for both subscales. Based on the screen plots, eigenvalues, and theoretical hypotheses, items with factor loading less than 0.4 were removed. Ultimately, it was determined that both the motivation and strategy subscales consist of six factors. The eigenvalues and variance contribution rates of each factor are shown in Table 1. A total of 69 items were included, with 30 items in the motivation subscale and 39 items in the strategy subscale. The factor assignments and loading are presented in Tables 2 and 3.

From Tables 1, 2, and 3, it can be observed that the six factors of the motivation subscale explained 47.17% of the total variance, with the highest loading being 0.88 and the lowest loading being 0.43. The six factors of the strategy subscale explained 42.84% of the total variance, with the highest loading at 0.81 and the lowest loading at 0.40.

3.3 Factor Naming

Based on the items of each factor in the motivation subscale, they are named accordingly. The first factor, comprising 6 items, involves the sense of achievement and competency in learning activities and is named 'Learning Self-Efficacy.' The second factor, with 8 items, pertains to the students' willingness to learn during the learning process, reflecting their focus on acquiring knowledge and skills, and is named 'Intrinsic Learning Goals.' The third factor includes 7 items and reflects the students' belief in achieving good results through effort, named 'Learning Control Belief.' The fourth factor consists of 3 items, relating to external rewards and competition with others, and is named 'Extrinsic Learning Goals.' The fifth factor, encompassing 2 items, reflects the students' cognition of the usefulness of learning, and is named 'Sense of Meaning in Learning.' The sixth factor, with 4 items, indicates the students' anxiety about learning and exams, and is named 'Learning Anxiety.'

Based on the items of each factor in the strategy subscale, they are named accordingly. The first factor, including 12 items, involves the learning methods commonly used by

students during the learning process and is named 'General Methods.' The second factor, consisting of 9 items, reflects students seeking help from teachers or peers and making efforts to overcome difficulties, and is named 'Learning Assistance.' The third factor includes 7 items, reflecting students' planning and design of learning activities before they commence, and is named 'Learning Planning and Arrangement.' The fourth factor, with 5

items, relates to students' review of their learning, and is named 'Learning Summarization.' The fifth factor, comprising 3 items, involves the evaluation of learning plans and time management, and is named 'Learning Evaluation.' The sixth factor, with 4 items, reflects the control students have over their learning activities and time, and is named 'Learning Management.'

Table 1. Eigenvalues and Variance Contribution Rates of Factors in the Motivation Subscale and Strategy Subscale

motivation subscale			strategy subscale		
Eigenvalue	Variance Contribution Rate	Cumulative Variance Contribution	Eigenvalue	Variance Contribution Rate	Cumulative Variance Contribution
9.01	23.11	23.11	13.19	24.43	24.43
3.01	7.71	30.81	2.91	5.39	29.82
2.08	5.33	36.14	1.99	3.68	33.5
1.67	4.27	40.41	1.86	3.44	36.94
1.37	3.51	43.92	1.67	3.09	40.04
1.27	3.25	47.17	1.51	2.8	42.84

Table 2. Results of the Factor Analysis of the Motivation Subscale

Factor1		Factor2		Factor3		Factor4		Factor5		Factor6	
Item	Loading	Item	Loading	Item	Loading	Item	Loading	Item	Loading	Item	Loading
78	0.88	90	0.73	65	0.73	47	0.64	3	0.86	52	0.68
92	0.77	31	0.72	34	0.67	102	0.6	4	0.72	81	0.66
91	0.69	77	0.6	64	0.65	62	0.57			7	0.56
18	0.65	89	0.57	93	0.63					94	0.44
20	0.56	33	0.5	112	0.55						
79	0.52	63	0.48	5	0.53						
		1	0.46	49	0.49						
		6	0.43								

Table 3. Results of the Factor Analysis of the Strategy Subscale

Factor1		Factor2		Factor3		Factor4		Factor5		Factor6	
Item	Loading	Item	Loading	Item	Loading	Item	Loading	Item	Loading	Item	Loading
58	0.73	120	0.65	39	0.67	97	0.81	82	0.64	86	0.7
73	0.71	119	0.62	11	0.67	74	0.52	30	0.52	27	0.67
54	0.64	10	0.56	8	0.48	70	0.5	24	0.44	69	0.57
42	0.63	53	0.54	25	0.46	15	0.48			9	0.48
117	0.61	114	0.51	13	0.46	95	0.4				
45	0.56	85	0.51	14	0.42						
44	0.55	84	0.5								
88	0.53	75	0.48								
55	0.52	118	0.46								
87	0.44										
29	0.44										
59	0.43										

4 Confirmatory Factor Analysis of the Scale

To better explore the structural validity of the scale, confirmatory factor analysis was conducted using AMOS 4.0. In June 2004, 520

students from the first to third years were randomly sampled from three key universities in Guangdong Province (Sun Yat-sen University, South China Normal University, South China Agricultural University) and one

general university (Foshan University). A total of 501 valid data were obtained. Among them, 171 were first-year students, 174 second year, and 156 third-year students; 248 were male, 253 females; 286 from science disciplines, 215 from arts; 311 from general colleges, and 190 from key universities.

Based on the results of the exploratory factor analysis, the Maximum Likelihood method was used to conduct confirmatory factor analysis on the structures of the two parts (motivation subscale and strategy subscale). In terms of fit indices, we selected χ^2 , df, NFI, NNFI, CFI, and RMSEA as criteria to evaluate

the model fit. Among these, the values of NFI, NNFI, and CFI should be close to 1, but generally, values of these three indicators not less than 0.90 are considered as a standard for a good model fit. RMSEA is a measure of the difference per degree of freedom, and a value of 0.05 or less is considered as a good model fit. If it is greater than 0.05 but less than or equal to 0.08, the model is considered acceptable. Additionally, a χ^2/df value of 2 or less is also an important indicator of a good model fit, though a larger sample size may result in a higher value. The fit indices of the model are shown in Table 4.

Table 4. Summary of Model Fit Indices

Model	χ^2	df	NFI	NNFI	CFI	RMSEA
Learning Motivation Subscale	1240.72	389	0.97	0.98	0.98	0.07
Learning Strategy Subscale	2228.54	687	0.96	0.97	0.97	0.07

As seen from Table 4, although the large sample size led to relatively high χ^2/df values (3.19 and 3.24 respectively), the NFI, NNFI, and CFI values in the model reached 0.96 and above, and the RMSEA was below 0.07, meeting the acceptable standards. [8] This indicates a good fit between the model and the data, validating the hypothesis that the learning motivation and learning strategy scales are each composed of six related factors.

5 Analysis of the Reliability and Validity of the Scale

5.1 Analysis of the Reliability of the Scale

To assess the internal consistency of each dimension of the questionnaire, Cronbach's alpha coefficient was used as the indicator of internal consistency for this scale. The results indicate that the internal consistency coefficients of various dimensions, except for the learning management factor in the strategy component table (0.57), are between 0.6 and 0.8. The overall internal consistency coefficients of the two components tables also reached 0.8 and 0.9. We also analyzed the correlations between each dimension and the total score of the component tables. The results show that the correlation coefficients range from 0.41 to 0.84 ($P < 0.01$).

Considering both Cronbach's alpha coefficients and the correlation coefficients between each dimension and the total score of the component tables, it is evident that the internal consistency within each dimension of the motivation component table and the strategy component

table is relatively high, as well as the consistency between these dimensions and their respective component tables.

5.2 Analysis of the Validity of the Scale

5.2.1 Content validity of the questionnaire

The content validity refers to the appropriateness of the items sampled to measure the content or behavior under investigation. During the questionnaire development process, we strictly defined the scope of the questionnaire, which is autonomous learning among college students, and operationally defined autonomy in terms of motivation and strategies. [9] While developing the questionnaire, we referred to previously validated scales in various dimensions and conducted a systematic analysis of autonomous learning among college students. After questionnaire development, it was reviewed and revised by professionals in the field of psychology, and consensus was reached that the questionnaire was well-constructed.

5.2.2 The structural validity of the scales

To assess the structural validity of the scale, we calculated the correlation coefficients between dimensions, as well as the correlations between the two component tables and the total score table. The results are shown in Table 5 and Table 6.

In general, if a test consists of a composite of multiple traits, it is expected that items measuring the same trait have a high correlation, while the correlation between items measuring different traits should be

lower. Based on the data results, the correlation coefficients within each dimension of the sub-scales vary, but the correlation coefficients between the motivation sub-scale and the total scale score are 0.96, and for the

strategy sub-scale, it is 0.92, both exceeding 0.9. This indicates that the scale has good internal consistency, and the dimensions are relatively independent, demonstrating a clear and consistent structure.

Table 5. Correlations between Dimensions of the Motivation Subscale

	Self-efficacy	Intrinsic Goal	Learning Control Sense	External Goal	Sense of Learning Meaning
Intrinsic Goal	0.51***				
Learning Control Sense	0.44***	0.58***			
External Goal	0.20***	0.23***	0.12***		
Sense of Learning Meaning	0.37***	0.37***	0.27***	0.15***	
Learning Anxiety	0.1*	0.22***	0.09*	0.43***	0.1*

Note: * indicates $p < 0.05$, ** indicates $p < 0.01$, *** indicates $p < 0.001$, the same applies below.

Table 6. Correlations between Dimensions of the Strategy Subscale

	General Method	Seeking Help in Learning	Learning Planning and Arrangement	Learning Summary	Learning Evaluation
Seeking Help in Learning	0.47***				
Learning Planning and Arrangement	0.48***	0.55***			
Learning Summary	0.54***	0.44***	0.56***		
Learning Evaluation	0.44***	0.45***	0.53***	0.42***	
Learning Management	0.26***	0.16***	0.19***	0.16***	0.16***

5.2.3 Criterion-Related Validity of the Scale
Criterion-related validity is an important method for assessing the validity of a scale's construction. Based on the analysis of the essence of autonomous learning, whether learning is autonomous is an important factor affecting learning outcomes. Students with higher autonomous learning abilities should have better academic performance. Therefore, in this study, we also used students' exam scores as a criterion to test the validity of autonomous learning. The exam scores refer to the final exam scores of compulsory courses in the previous semester. They are transformed into average scores weighted by credits, and then the top and bottom 27% of students are compared, as shown in Table 7.

Table 7. The Differences in Scores between High and Low-achieving Students

	Motivation Subscale	Strategy Subscale
low achieving (n=131)	123.9±15.4	157.5±20.5
high achieving (n=136)	129.3±15.2	166±18.6
t	2.89***	3.55***

Through the analysis of the reliability, content validity, structural validity, and criterion-

related validity of the scale, it can be observed that the scale meets the requirements of psychometrics for scales quite well. This indicates that the scores on the scale can effectively predict the quality of students' academic performance. The analysis of differences between excellent and poor students in scale scores demonstrates significant distinctions. Higher scale scores are associated with better academic performance.

6. Discussion

From the perspective of the content of the scale, this research strictly adhered to relevant theories, referenced mature scales, and combined them with the actual situation of college students to design the questionnaire. Therefore, the designed questionnaire possesses a high level of scientific rigor. The analysis of reliability also demonstrates the effectiveness of the scale in terms of content. Both exploratory factor analysis and confirmatory factor analysis of the scale indicate that the scale has a reasonable structure, ensuring its determinacy, stability, and reliability. The correlation analysis of the dimensions within the scale further supports this. The analysis of criterion-related validity

once again confirms the effectiveness of the scale.

From the results of factor analysis, it is evident that there are certain differences compared to our initial conception. Some dimensions have been merged with others, and some items with low factor loadings were removed, while new dimensions have emerged. This situation may be attributed to the following reasons: The framework for the development of the self-directed learning questionnaire was established based on two main foundations: foreign scales and domestic scales related to self-directed learning among primary and secondary school students, as well as scales related to learning motivation and learning strategies.

Regarding the questionnaire for college students, there is currently no such scale available in China. Therefore, the development of this framework was primarily based on theoretical induction, and it still includes a substantial hypothetical component. Whether it aligns with the actual situation of current college students needs further verification. Exploratory factor analysis was conducted based on the data's condition to explore the structure. Different factor selection criteria can lead to different data structures. During the process of factor selection, we strictly adhered to standards such as scree plots, factor variance contribution rates, and item loadings. We proposed models for both the motivation component and the strategy component, each consisting of six factors. [10] When evaluating the questionnaire using indicators such as internal consistency reliability, content validity, structural validity, and criterion-related validity, it's evident that although there are differences between the questionnaire after factor analysis and the initial theoretical conception, the developed questionnaire is more concise while still comprehensively reflecting the self-directed learning of college students. Therefore, we believe that the development of the questionnaire was successful and effective.

If we further categorize the factors obtained from the factor analysis, we can observe that learning motivation, including intrinsic goals, extrinsic goals, and a sense of

learning significance, can be grouped into the category of goals and values. Additionally, self-efficacy in learning and a sense of learning control can be categorized as components related to expectations. Learning anxiety is part of the emotional component. The six dimensions of learning strategies also reflect students' cognitive, metacognitive, and resource management strategies. This categorization aligns with Pintrich's conception of dividing the motivation aspect of self-directed learning into three parts: values, expectations, and emotions, as well as dividing the strategy aspect into cognitive, metacognitive, and resource management strategies. [11] Furthermore, this questionnaire shares similarities with the "Self-Directed Learning Scale for Primary and Middle School Students" developed by Pang Wei. Both scales draw on social cognitive theory and comprehensively consider various aspects of students' autonomy in the learning process. The main difference lies in the target audience, with Pang Wei's scale designed for primary and middle school students, while your scale is tailored for college students. Additionally, Pang Wei's scale emphasizes learning motivation composed of proactive awareness, value consciousness, self-responsibility, self-efficacy, and learning interest. In contrast, your scale recognizes that self-directed learning can be both self-initiated and motivated by external pressures, reflecting the multifaceted nature of college students' learning motivation in real-life situations. Overall, this scale has a concise and clear factor structure that effectively reflects the essence of self-directed learning. It aligns well with Zimmerman's theory of self-directed learning and our definition of self-directed learning. It not only reflects the learner's autonomy in motivation but also provides a comprehensive reflection of the learner's learning process. It effectively captures aspects of self-regulation and autonomy in learning, including learning methods, learning management, and seeking help.

7. Conclusions

This study established a self-regulated learning scale for college students through factor

analysis, consisting of two parts: a motivation scale and a strategy scale. It includes 12 factors: learning self-efficacy, intrinsic goals, learning control, extrinsic goals, sense of learning significance, learning anxiety, as well as general methods, seeking help in learning, learning plan and arrangement, learning summarization, learning evaluation, and learning management. Through validation and analysis, this scale shows good reliability and validity indicators, making it suitable for assessing the self-regulated learning status of college students in China.

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