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ABSTRACT

Using items gathered directly from learners and checked against a theoretical model of learning, an instrument to assess learning strategies was developed. The approach involved collection of descriptions of learning strategies from undergraduate and graduate students, implementation of a principal components analysis to determine the factor structure of the items, and analysis of the relationship between the resulting factors and academic achievement. Development of the Student Strategic Learning Inventory (SSLI) began with an analysis of extended narratives on learning strategies written by undergraduates. Seventy-nine items were extracted and rated by 65 graduate students, 200 college sophomores, and 56 college juniors and seniors on a four-point scale. To establish construct validity of the SSLI, upperclassmen raters also completed the Inventory of Learning Processes--a 62-item, true-false instrument recognized in the literature as a measure of learning strategies. Results from both instruments were correlated with grade point average. Only a factor analysis of the items and correlation of the factor scores were used in data analysis. The procedure, beginning with narrative analysis, was repeated with a variety of students, items were added, and a 94-item instrument was the final result. The methodology of soliciting items from learners was successful, and the derived factors supported the theoretical model of learning previously proposed. Four tables are included. (TJH)

DEVELOPMENT OF AN INSTRUMENT TO ASSESS LEARNING STRATEGIES

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Much of the effort to measure learning strategies seems to have been of a more traditional nature. That is, items were collected from various sources, evaluated by the developers of the measures and/or experts in the area of learning strategies or psychological measurement, the resulting instrument analyzed, and the revisions made. The final version of the instrument may have gone through this cyclical process several times before a satisfactory instrument emerged. The strategy employed in developing the instrument described in this paper used a different approach. We gathered items directly from learners and checked our results against a theoretical model of learning.

A combination of qualitative and quantitative methods was used in the instrument development, but the effort was not an attempt at instrument building using psychometric properties of the items. What we did may indeed seem a departure from sound methodlolgical procedures, but we were interested in investigating a process yielding results which could be related to theory. The purpose of our research was to: (1) collect a set of items from learners describing their learning strategies; (2) conduct a principal components analysis to determine the factor structure of the items; and (3) relate the resulting factors to academic achievement.

The starting point for the development of what we have chosen to call the Student Strategic Learning Inventory (SSLI) was to ask undergraduate students to provide an extended written narrative about their learning strategies and study habits. The idea being, that we would be able to collect information directly from individuals who are active participants in the learning process. Strategies actually employed by the students could be quite different from the kinds of strategies that are described in the literature or devised by experts on learning. We hypothesized that what students actually do when they are learning should translate into what they achieve.

Instrument Development Study I

The first step in the process of developing the SSLI was to obtain responses to our request for an extended narrative from a group of undergraduate students enrolled in introductory educational psychology and statistics classes. Approximately 50 narratives made up the first sample of responses.

The narratives were analyzed carefully for statements relating to study and learning strategies employed by the students and compared to each other to detect overlap among the statements. Many statements reflected the same basic strategy, only with a different wording. For example, the statement "I underline all the important ideas in the textbook" was considered the same as "I use a color highlighter to mark the main thoughts in my textbook."

Through this qualitative approach to instrument development we identified a

group of items we considered to be unique and not redundant. We repeated this process twice more with more advanced groups of learners, graduate students and students from disciplines other than education. By carefully comparing all items extracted from the narratives for overlap and uniqueness, we identified a final group of 79 items to comprise the initial form of the instrument.

Step two in the process involved shifting to a quantitative approach in analyzing the factor structure of the instrument and subsequently its relationship to achievement. Altogether, 321 students rated each of the items on the SSLI-79 on a four point scale. There were 65 graduate students, 200 sophomores, and 56 juniors and seniors in the sample. In addition to the SSLI, the junior-senior group also received the Inventory of Learning Processes (ILP) (Schmeck et al., 1977), an instrument recognized in the literature as a measure of learning strategies. The ILP consists of 62 items that require a true or false response.

Only factor analysis of the items and correlation of the factor scores were used in the analysis of the data. Item analysis procedures and internal consistency reliability estimates were not used, because the emphasis in the methodology was not on instrument building. Rather, the emphasis was on discovering whatever strategies students use and their relationship with the model on the one hand, and achievement on the other. The purpose of the ILP was to establish a degree of construct validity for the SSLI, and to compare the correlations of the two instruments with GPA.

Principal components analysis, followed by a varimax rotation, yielded four interpretable factors. Examples of items included in each factor are shown in Table 1 along with the factor loadings.

Insert Table 1 About Here

The factors that emerged were compared to the learning model, earlier versions of which were proposed by Iran-Nejad (1989). The most recent version of the model was presented in a paper at The American Educational Research Association annual meeting (Iran-Nejad & Chissom, 1989) and is reproduced in Figure 1.

Insert Figure 1 About Here

When interpreting the factor analysis we used a combination of information from the Scree Test, factor loadings, item content, and fit to the theoretical model. The four factors that constituted the final structure were named Postdictive, Predictive, Procrastinative and Piecemeal Metacognition. According to the model, Postdictive Metacognition strategies involved a high degree of simultaneous, dynamic control; Predictive Metacognition is more purely under active internal control, is sequential, and includes most of the study strategies

frequently used by students; and Piecemeal, which is externally controlled, is best represented by rote strategies such as memorizing facts or lists. The Procrastinative factor is not represented in this version of the model and represents strategies and activities that are actually detrimental to learning and achievement.

Factor scores were computed for each factor by multiplying the subjects' raw scores by the item factor loadings greater than .3 and summing over the items. (.3 was considered a significant loading for this study.) The four factor scores were then correlated with the subject's overall grade point average (GPA) and the four subscales of the Inventory of Learning Processes (ILP). Subjects included in this correlation analysis were only those who received both the SSLI and the ILP. They were all classified as juniors or seniors. This group (N = 56) had completed the most classes and as a result, should have had the most stable GPAs. Freshmen, sophomores, and graduate students were eliminated because they did not respond to both instruments. These correlation results are included in Table 2.

Insert Table 2 About Here

The Postdictive Factor had the highest correlation with GPA (.44) as predicted by the model, and the Piecemeal and Procrastinative factors were also

significantly correlated with GPA. In the model, Postdictive Metacognition is considered a higher order process than other types of metacognition, because it involves extensive simultaneous processing as opposed to sequential processing. The Procrastinative items correlated negatively (-.25) with GPA while the Piecemeal Factor demonstrated a positive relationship (.35). The ILP subscales of Deep Processing (DP), Elaborate Processing (EP), Fact Retention (FR), and Methodical Study (MS) (Schmeck, 1988) all correlated significantly with GPA. The Postdictive Factor correlated higher with GPA than any of the other three factors in the SSLI, and higher than any of the four factors of the ILP. This evidence provided support for the theoretical model. Further, the results provided data indicating that the SSLI is valid when compared with a conventional inventory like the ILP. The two inventories were comparable in their ability to predict achievement as measured by GPA.

The intercorrelations among the factors of the two inventories provided some interesting relationships. The significant correlations of DP, EP, and MS with the Postdictive Factor, indicate that the Postdictive Factor is seemingly composed of elements of Deep and Elaborative Processing and Methodical Study. This is exactly what Postdictive Metacognition means in the model of learning presented in Figure 1. The negative to zero correlation of FR with Postdictive, and Predictive, and the positive correlations with Piecemeal Learning, indicates the similarity of the two factors which both represent memorization and

rote learning. The negative relationship of the Procrastinative Factor with all other factors and GPA provides empirical verification for this factor as a part student learning strategies. Although the items of the Procrastinative Factor are not recommended for improving achievement, they exist among the strategies reported by students.

To sum up the results of Study I, the initial attempt at developing an inventory for assessing learning strategies resulted in an instrument with a four factor structure that was comparable to a proposed theoretical model. Moreover, the Postdictive Factor was significantly related to achievement as measured by GPA, and as predicted by the theory. Finally, the newly developed SSLI was generally comparable to the ILP as indicated by the correlations among the factors from both instruments, and by the correlations of the factors from each instrument with GPA.

Instrument Development Study II

After the initial attempt at developing an instrument through a mixed qualitative/quantitative methodology, we continued to collect learning strategy items from students to determine whether or not we had reached a saturation point indicated by continued overlap of new items with items we had already used. Additional narratives were obtained from graduate and undergraduate students representing the academic areas of Social Work, Engineering, and Business Administration. All narratives were examined for items that were

unique and that had not occurred before. These new items were compared to the previous set to eliminate any overlap and redundancy among items. In all, 13 new items were added to the instrument making a total of 94 items to be analyzed using the same quantitative procedures as before.

The 94 item SSLI was administered to 162 students (100 sophomores and 62 juniors and seniors) enrolled in undergraduate and graduate classes in the College of Education during the spring semester, 1989. The ILP, as before, was administered at the same time to a group of juniors and seniors (N = 62). The ILP was not administered to the other students due to a lack of time and other considerations.

This time the principal components analysis of the SSLI yielded five factors after varimax rotation. The decision process used a combination of the Scree Test results and meaningfulness of the factors, in terms of the model, to settle on five interpretable factors. The major departure from Study I was that the Predictive factor, identified in the first analysis, seemed to be represented by two sets of items. One set of items for the Predictive factor consisted of strategies and activities that were beneficial to learning, and a second set of items which were not of apparent benefit. Table 3 shows the five factors with three items that had the highest factor loadings on each factor.

Insert Table 3 About Here

The factor structure in this second analysis was more complex than the theoretical model from Figure 1 which proposed only three factors. The additional Procrastinative factor and two Predictive factors indicated a greater complexity than was indicated with the previous 79-item instrument. The two new factors that were identified as being related to the original theoretical Predictive factor and the Predictive factor from the first analysis, were distinguished by the fact that one factor contained items representing learning strategies that would help to improve achievement. The second Predictive factor was defined by items representing learning strategies that were not helpful in increasing achievement.

Factor scores were derived for the five factors using the procedure described previously. The five factor scores were correlated with the students' overall GPA and the four subscales of the ILP. These correlations are presented in Table 4. For the correlation analysis, a subset of the original sample was used (N = 62) composed of those students classified as Juniors and Seniors. This subset was used because they were the only students who responded to both instruments.

Insert Table 4 About Here

The Postdictive Factor was again the highest significant correlator with GPA (.40) followed by the Predictive Factor with items that "helped" achievement (.36). In the analysis with 79 items the Predictive Factor was not related to GPA, but with the division of the factor into two factors with items that described "helpful" and "not helpful" strategies the new Predictive "help" factor was significantly related. However, in the second set of results the Deep Processing and Elaborate Processing factors of the ILP were not significantly related to GPA, while Fact Retention and Methodical Study were significantly correlated. The Procrastination Factor again had significant negative relationships with all four ILP factors and low or low negative relationships to the other four SSLI factors. Overall, the correlational results were similar to the ones for the 79 item instrument. The major discrepancy was the failure of the DP and EP Factors of the ILP to significantly correlate with GPA.

Summary

In summary, we feel that the methodology of soliciting items about learning strategies from learners was successful in helping to develop an instrument, and the factors derived from those items were supportive of the theoretical model of learning previously proposed. The positive relationship between the Postdictive

factor and GPA, predicted to be most importantly related to achievement from theory, was supported by the data. Finally, the comparison of the SSLI to the ILP indicated that the SSLI is a valid predictor of learning progress by traditional standards. The similarity of the factors in both instruments provided support for the qualitative methods used in the development of the SSLI.

A major problem encountered by these two research efforts was the lack of a suitable criterion measure of achievement. Grade point average, while widely used as an indicator of student achievement, is fraught with difficulties. The major difficulty is the lack of variability in the GPA's of upper-division and graduate level students, students who are most likely to participate in research studies such as the two described in this paper. Our solution to this problem is to develop a more suitable measure of achievement that will provide the necessary depth and variability as a criterion.

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Table 1
Factors Derived from the Student Learning Inventory (SSLI), 79 Items

Factor 1: Posdictive Metacognition

1. (.71) I try to think things out so that I fully understand them.
2. (.68) I try to take an interest in what I'm reading, which helps me want to figure things out.
3. (.64) When I don't understand things, I persist until I get some insight into what's being said.

Factor 2: Predictive Metacognition

1. (.64) I rewrite my notes because I understand things better when I do that.
2. (.60) Before every test, I make an outline for that particular test.
3. (.57) I take written notes as I do the assigned readings.

Factor 3: Procrastinative Metacognition

1. (.[illegible]) When it comes to studying, I think I am a procrastinator.
2. (.52) I take frequent breaks as part of my study routine.
3. (.42) The learning method I use is mentally exhausting.

Factor 4: Piecemeal Metacognition (Rote Memory)

1. (.46) I read my notes slowly going over each definition and each term.
2. (.44) In order to memorize what I am studying, I go over my notes or the book chapters without looking at them.
3. (.37) Memorizing the materials in their original wording works best for me.

Figure 1
Active and Dynamic Self-Regulation of Learning Processes

Learning Processes	Learning Subprocesses	Sources of Control		
		External	Active	Dynamic
Attention	1. Attention-Catching	High	Low	Low
	2. Attention-Paying	Low	High	Low
	3. Attention-Holding	Low	Low	High
Inquiry	1. Surprise	High	Low	Low
	2. Self-Questioning	Low	High	Low
	3. Curiosity	Low	Low	High
Closure	1. Orientation	High	Low	Low
	2. Prediction	Low	High	Low
	3. Postdiction	Low	Low	High
Combination	1. Independent	High	Low	Low
	2. Sequential	Low	High	Low
	3. Simultaneous	Low	Low	High
Knowledge Creation	1. Categorical	High	Low	Low
	2. Propositional	Low	High	Low
	3. Thematic	Low	Low	High
Metacognition	1. Piecemeal	High	Low	Low
	2. Predictive	Low	High	Low
	3. Postdictive	Low	Low	High

Note: Adopted from Associative and nonassociative schema theories of learning by A. Iran-Nejad, 1989, Bulletin of the Psychonomic Society, 27, p. 3. Copyright 1988 by Psychonomic Society, Inc. Reprinted by permission.

Table 2
Correlation Matrix--All Factor and GPA (79 Items)

Variables	SSLI				ILP			
SSLI	**FAC1**	**FAC2**	**FAC3**	**FAC4**	**DP**	**EP**	**FR**	**MS**
Postdictive (FAC1)	----	----	----	----	--	--	--	--
Predictive (FAC2)	.40**	----	----	----	--	--	--	--
Procrastinative (FAC3)	-.15	-.11	----	----	--	--	--	--
Piecemeal (FAC4)	.38**	.42**	-.06	----	--	--	--	--
ILP								
DP	.41**	-.05	-.23*	.07	--	--	--	--
EP	.63**	.36**	-.08	.37**	.33**	--	--	--
FR	-.02	-.10	-.20	.27*	.13	-.08	--	--
MS	.48**	.53**	-.42**	.28*	.26*	.51**	.04	--
GPA	.44**	.07	-.25*	.36**	.30**	.36**	.23*	.26*

* $p < .05$; df = 54
** $p < .01$; df = 54

Table 3
Factors Derived From The Student Learning Inventory (SSLI), 94 Items

Factor 1: Postdictive Metacognition

1. (.74) I go over concepts in my mind trying to link different concepts.
2. (.73) I try to picture in my mind how everything fits together.
3. (.69) I try to get a whole picture in my mind of everything I have learned about the topic.

Factor 2: Predictive Metacognition (Helpful)

1. (.70) I do all the assigned readings.
2. (.62) I read the required chapters in the textbook.
3. (.57) I try to study a little each day.

Factor 3: Predictive Metacognition (Not Helpful)

1. (.59) I hold study sessions with my classmates.
2. (.59) I make an outline based on assigned readings prior to going to class and use it as a guide to take lecture notes during class.
3. (.56) I prefer to study with a partner.

Factor 4: Procrastinative Metacognition

1. (.57) I stay up all night studying.
2. (.56) I must study right before the test because I know I cannot remember things if I study too far in advance.
3. (.56) I cram for exams.

Factor 5: Piecemeal Metacognition

1. (.63) To be able to concentrate, I must be in a quiet environment.
2. (.52) The method I use for studying takes a long time.
3. (.35) I quiz myself before a test.

Table 4
Correlation Matrix--All Factors and GPA (94 Items)

Variables	SSLI					ILP			
SSLI	FAC1	FAC2	FAC3	FAC4	FAC5	DP	EP	FR	MS
Postdictive (FAC1)	----	----	----	----	----	--	--	--	--
Predictive Help (FAC2)	.56**	----	----	----	----	--	--	--	--
Predictive No Help (FAC3)	.34**	.40**	----	----	----	--	--	--	--
Procrastinative (FAC4)	-.03	-.25*	.16	----	----	--	--	--	--
Piecemeal (FAC5)	.22*	.30**	.37**	.06	----	--	--	--	--
ILP									
DP	.49**	.35**	-.07	-.38**	-.06	--	--	--	--
EP	.41**	.32**	.13	-.32**	.05	.35**	--	--	--
FR	.37**	.31**	.15	-.35**	.20	.41**	.17	--	--
MS	.41**	.66**	.23*	-.47**	.11	.44**	.55**	.40**	--
GPA	.40**	.36**	.16	.05	.11	.15	.07	.29**	.27**

* p <.05; df = 60
**p <.01; df = 60