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ABSTRACT

A self-concept test was developed for use in a mathematics course for prospective elementary teachers in which a master learning approach was being tried. The 27-item test contains two scales that measure (1) satisfaction and (2) change in the way the subject feels with respect to each item. Coefficient alpha reliabilities were .86 for Scale I and .88 for Scale II when the test was given to 250 subjects. Factor analysis produced subtests of self-concept related to Class Participation, Doing Assignments, Confidence in Class, Independent Study, and Attitude. The use of these factors to measure specific effects of instructional programs is proposed. (Author)

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A Mathematics Self-Concept Test

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A self-concept test was developed for use in a mathematics course for prospective elementary teachers in which a mastery learning approach was being tried. The 27-item test contains two scales that measure (1) satisfaction and (2) change in the way the subject feels with respect to each item. Coefficient alpha reliabilities were .86 for Scale I and .88 for Scale II when the test was given to 250 subjects. Factor analysis produced subtests of self-concept related to, Class Participation, Doing Assignments, Confidence in Class, Independent Study, and Attitude. The use of these factors to measure specific effects of instructional programs is proposed.

A MATHEMATICS SELF-CONCEPT TEST

Gerald Kulm
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Studies have indicated that there is a significant correlation between academic self-concept and achievement (Brookover 1962, Sears 1963, Kern 1971). More specifically, both Brookover (1962) and Bachman (1970) reported significant correlations between mathematics self-concept of ability and achievement in mathematics for seventh grade Ss. Sex differences were found, however, for correlations between general academic and specific subject matter self-concept. Mathematics self-concept was a better predictor of mathematics achievement than general self-concept for boys than girls according to Brookover (1962).

Although the Brookover scale contains specific subject area items, the questions are general. An example is "How do you feel if you don't do as well as you know you can in Arithmetic?" In a subsequent study, Brookover (1965) attempted to raise self-concept scores and found that school-centered treatments were unsuccessful. A similar result was found by Boyko (1970) in a study of the effect of discovery and expository teaching methods on self-concept.

In order to assess the effects of instructional programs, materials, or methodologies on self-concept, it may be necessary to obtain very specific data regarding self-concept toward the subject matter and toward the classroom environment. The instrument developed in this study was designed to assess specific aspects of self-concept in mathematics classes for the college freshmen.

Procedure

The test was given five weeks before the end of the semester to 161 Ss in the fall and to 89 Ss in the spring. The Ss were elementary

education majors enrolled in a number systems course, the first in a three course sequence. About 90 percent of the Ss were females and most were freshmen. One class period was used to have Ss complete the self-concept test, an attitude toward mathematics test, and a course and instructor evaluation.

A pool of items and the test format were pilot tested with a separate group of subjects enrolled in the second course of the elementary mathematics sequence. The final form contained 27 items; the Ss responded to two different questions for each item, producing two self-concept scores.

Insert Table 1 about here

Scale I (Satisfaction)

Directions to Ss: Am I pretty well satisfied with myself now? "Yes" means you feel pretty satisfied, "No" means you are not very satisfied.

Scale II (Change)

Directions to Ss: How have I changed so far this semester? "Better" means you feel you have done better; that is, made some improvement compared to the way you have felt in previous math classes. "Same" means that your feelings haven't changed much, and "worse" means that you feel worse about this class than you have about math classes in the past.

For each scale, the responses to each of the items were totaled (Scale I: yes = 2, no = 1; Scale II: better = 3, same = 2, worse = 1) to obtain a total score over the 27 items on each scale.

RESULTS

Coefficient alpha reliabilities were computed for each semester. In the fall, the reliabilities were .86 for Scale I (Satisfied) and .88 for Scale II (Change). In the spring, the reliabilities were .85 and .91 for Scales I and II, respectively.

The scores on the two self-concept scales were correlated with attitude and achievement variables.

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Insert Table 2 about here
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The responses to each item were factor analyzed and principal components having eigenvalues greater than 1 were varimax rotated. For Scale I, six rotated factors were obtained accounting for 56.75 percent of the variance.

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Insert Table 3 about here
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Only items having loadings greater than $|.40|$ were considered in interpreting the factors. The following factors were identified for Scale I.

Factor I: Ability to Learn Math.
The items with heavy loadings were concerned with being a good math student, doing well compared to others, and not worrying about tests.

Factor II: Doing Assignments.
In addition to items having to do with assignments, paying attention in class had a significant loading on this factor.

Factor III: Class Participation.
The items are primarily those related to voluntary participation, although being called on in class also had a substantial loading.

Factor IV: Confidence in class.
Heavily loaded items concern feeling comfortable, enjoying class, and learning math. This factor identifies a general feeling about being in class rather than about participating.

Factor V: Attitude.
High loadings were obtained for interest in math and caring about learning math. Interestingly, two items related to concentrating on

math and sticking to problems also had high loadings on this attitude factor.

Factor VI: Independent Study.
Along with going ahead with problems and having good ideas, this factor included applying and remembering what is learned.

Six factors were also obtained for Scale II, accounting for 59.28 percent of the variance.

Insert Table 4 about here

Factor I: Attitude.
This was similar to Factor V on Scale I except that loadings were obtained for being a good student and learning math, in addition to attitude items.

Factor II: Test Anxiety.
In addition to items about tests, this factor also had a fairly high loading for the being a good student item.

Factor III: Class Participation.
This factor is almost identical to Factor III of Scale I.

Factor IV: Doing Assignments.
This factor is very similar to Factor II of Scale I except that paying attention does not have a high loading.

Factor V: Not interpreted.

Factor VI: Attention in Class.
This factor is similar to Factor IV of Scale I except for higher loadings on asking questions and having good ideas in class.

DISCUSSION

On the basis of the present data, both scales of the test appear to be reliable measures of self-concept in mathematics classes for college freshmen. The validity of Scale I is evidenced by its correlations with attitude and achievement. Although Scale II was significantly

correlated with Scale I, it is not clear why similar correlations were not obtained between Scale II and other measures. Apparently changes in self-concept occur independent of attitude and achievement. A subject may have an improved self-image, for example, of how often he volunteers in class but not improve in achievement or attitude.

On the other hand, the result may be explained by the fact that most of the Ss were females. It has been found that non-intellective variables, used along with intellective variables, add significantly to the prediction of achievement for males, but not for females (Binder, Jones, & Strowig 1970). For female college Ss, a change in mathematics self-concept may not be an important change in relation to social acceptance and self-adjustment which Florence (1956) found to be among important goals for college students. Further investigation is needed to determine exactly what other measures are correlated with Scale II scores.

The items identified by factor analysis suggest that mathematics self-concept is made up of a number of specific factors. Some of the factors such as Classroom Interaction, Attention in Class, and Independent Study may be useful in measuring specific effects of instructional programs. Although it is not clear that Scale II is a valid measure of change in self-concept, the similarity between the factors for the two scales indicates that Scale II may be tapping variables related to these factors and independent of actual self-concept. If these variables are indeed related to change in specific aspects of self-concept, the scale may be useful in investigating teaching methods aimed at producing changes in distinct areas of classroom behavior.

Further use of the test will be necessary to determine whether these results are generalizable beyond female freshmen who are prospective elementary school teachers. This population may have self-concepts in mathematics different from other student populations. Investigation of self-concept in mathematics should be pursued since it is central to the mastery learning approach present in many recent instructional innovations.

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Table 1

Mathematics Self-Concept Test

1. How good a student I am in Math
2. How much I am learning in Math
3. How comfortable I feel in Math class
4. How often I take part in class discussions
5. How well I stick to Math problems, not giving up
6. How well I remember what I learn in math
7. How often I volunteer in Math class
8. How well I do on Math quizzes
9. How often I ask questions when I don't understand
10. How often I do assignments on time
11. How many good ideas I have in Math class
12. How well I'm doing compared to others in class
13. How well I'm able to concentrate on Math
14. How much I enjoy myself in Math class
15. How much I like math
16. How much I pay attention in Math class
17. How easily I learn Math
18. How often I go ahead with problems on my own
19. How well I understand things in class
20. How well I'm able to apply what I learn
21. How often I get homework problems done correctly.
22. How calm I feel when called on in class
23. How confident I am that I can learn math
24. How interested I am in Math
25. How well I keep up with assignments
26. How little I worry about math tests
27. How much I care about learning math

Table 2

Correlations of Self-Concept

Scores with Attitude and Achievement

	Scale I	Math Sat	Exam I	Exam II	Final Exam	Attitude
Scale I		.314	.417	.239	.416	.625
Scale II	.247	-.156	-.034	-.013	-.007	.055

$p(|r| > .17) < .01$

Table 3

Rotated Factor Loadings

for Scale I Items

	Factor					
Item	I	II	III	IV	V	VI
1	.676	-.024	-.146	.112	-.338	-.055
2	.010	-.072	.141	-.660	-.190	-.001
3	.393	-.079	-.317	-.450	-.053	-.060
4	.107	.035	-.860	.026	-.085	-.078
5	.129	-.216	-.236	.049	-.424	-.413
6	.422	-.016	.064	-.327	-.090	-.461
7	.109	-.011	-.806	-.009	-.112	-.038
8	.539	-.260	-.222	-.182	.027	.045
9	.151	-.085	-.565	-.198	-.049	-.181
10	.022	-.873	-.027	-.075	-.050	.044
11	.223	.106	-.214	-.159	.029	-.650
12	.711	-.029	-.215	-.080	-.108	-.027
13	.372	-.199	-.054	-.391	-.429	-.043
14	.079	.037	-.196	-.625	-.332	-.113
15	.338	.082	-.049	-.348	-.649	-.156
16	-.265	-.477	-.113	-.516	-.127	-.090
17	.675	.050	-.140	-.053	-.261	-.291
18	-.100	-.317	-.182	.126	-.142	-.624
19	.475	-.045	-.226	-.406	.123	-.229
20	.264	.111	-.022	-.206	-.282	-.511
21	.459	-.433	.048	-.194	-.022	-.211
22	.301	.010	-.539	.018	-.177	-.163
23	.463	.102	-.235	-.103	-.341	-.392
24	.291	.016	-.181	-.123	-.765	-.057
25	.105	-.864	.022	.004	-.038	-.005
26	.476	.082	-.076	.174	-.157	-.295
27	-.037	-.170	-.095	-.215	-.747	-.130
% Variance	13.43	8.45	9.66	8.03	9.67	7.50

Table 4

Rotated Factor Loadings

for Scale II Items

Item	Factor					
	I	II	III	IV	V	VI
1	.465	-.415	.274	.283	.312	.081
2	.651	-.072	.138	.077	.071	-.338
3	.069	-.184	.540	.199	.416	-.166
4	.128	.006	.857	.019	.093	-.115
5	.076	-.008	.084	.382	.437	-.254
6	.322	-.282	.059	.110	.448	-.338
7	.153	-.174	.801	.034	.051	-.173
8	-.038	-.598	.203	.250	.236	-.235
9	-.085	-.175	.452	.156	.206	-.466
10	.190	-.046	.020	.822	.018	-.176
11	.168	-.277	.264	.212	.191	-.407
12	.054	-.611	.221	.169	.301	.060
13	.334	-.148	.013	.249	.423	-.354
14	.251	.126	.227	.057	.483	-.515
15	.637	.001	.137	.102	.453	-.193
16	.305	.015	.106	.220	-.029	-.656
17	.198	-.391	.069	.085	.657	-.077
18	.386	.068	.154	.304	.350	.101
19	.136	-.217	.159	.059	.622	-.264
20	.370	-.245	.019	-.006	.466	-.322
21	.163	-.266	.110	.516	.463	-.174
22	.041	-.121	.505	-.018	.519	.195
23	.197	-.114	.172	.023	.732	.051
24	.708	-.146	.187	.203	.242	.021
25	.206	-.044	.064	.848	.040	-.095
26	.165	-.747	-.008	-.141	.040	-.023
27	.722	-.100	-.069	.173	.093	-.168
% Variance	11.28	7.98	9.68	8.97	13.98	7.38