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AUTHOR   Gourgey, Annette F.
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ABSTRACT
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(Author)

Development of a Scale for the Measurement of

Self-Concept in Mathematics

Annette F. Gourgey

New York University

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Abstract

Evidence suggests that victims of mathematics anxiety suffer from a poor self-concept regarding their mathematical ability. A 27-item attitude scale was developed reflecting attitude toward one's ability to learn mathematics. This scale was administered to 92 students taking a required statistics course, along with the Mathematics Anxiety Rating Scale, an arithmetic test, a list of erroneous statements about mathematics, and a midterm examination. Mathematical self-concept was moderately related to mathematics anxiety and was more highly correlated with arithmetic skills, acceptance of erroneous beliefs about mathematics, performance on the midterm examination, and number of years since last mathematics course than was mathematics anxiety. It was suggested that mathematical self-concept is an important dimension of attitude in mathematics learning to consider in both research and remediation.

Development of a Scale for the Measurement of

Self-Concept in Mathematics

Knowledge of mathematics is now recognized as vital
for entry into many careers. Along with the increased
recognition of the need for mathematical competence has
come an increased recognition of mathematics anxiety as a
widespread impediment to mathematical performance in both
academic settings and everyday life. Research on the nature
and correlates of affect toward mathematics has shown that
people frequently experience strong feelings of fear and
anxiety toward mathematics, and that these feelings are
associated with avoidance and poor performance in
mathematics (Aiken, 1970, 1976; Betz, 1978; Kogelman &
Warren, 1979; Poffenberger & Norton, 1959; Richardson &
Suinn, 1972; Tobias, 1978).

Studies of attitude toward mathematics have demonstrated
that feelings of liking and fear of mathematics are related
to achievement for both children and adults (Aiken, 1963,
1972, 1974; Aiken & Dreger, 1961; Dreger & Aiken, 1957;
Dutton, 1956; Feinberg & Halperin, 1978). Moreover, it has
frequently been observed that mathematically anxious people
make disparaging remarks not only about the subject of
mathematics but about their own ability to perform in
mathematics (Donady & Tobias, 1977; Kogelman, Nigro, &
Warren, 1978; Kogelman & Warren, 1979; Tobias, 1978).

Though researchers have demonstrated that self-concept
of ability affects children's academic performance in a
variety of areas, including arithmetic (Brookover, Paterson,
& Thomas, 1962), and specialists in the treatment of
mathematics anxiety have pointed out the frequency of low
self-esteem and feelings of incompetence among victims of
mathematics anxiety (Kogelman et al., 1978), little
research has been done on the nature and measurement of
mathematical self-concept and its relationship to perfor-
mance.

The purpose of this study was to develop a valid and
reliable measure of mathematical self-concept and to
clarify its relationship to mathematics anxiety and to
performance in mathematics. The construct of mathematical
self-concept was developed during three years of tutoring
undergraduate and graduate students taking a required
basic statistics course, at which time I noted that
students having difficulties with the course frequently
made disparaging remarks regarding their ability to learn
mathematics, despite academic accomplishment in other areas
of study. Thus, mathematical self-concept is defined as
beliefs, feelings or attitudes regarding one's ability to
understand or perform in situations involving mathematics.
The self as capable or incapable of learning or performing
in mathematics, rather than the subject of mathematics,
is the object of attitude.

Method

Subjects

Two groups of subjects, a total of 120 people,
participated in this study. The pilot sample consisted
of 28 undergraduate and graduate students enrolled in a
required basic statistics course given in the School of
Education, Health, Nursing and Arts Professions at New
York University. The main sample consisted of 92
undergraduate and graduate students, 16 male and 76 female,
enrolled in the same basic statistics course the following
semester. Students in the main sample ranged in age from
18 to 57 years, with a mean age of 27, and were enrolled
in a variety of undergraduate and graduate programs, mostly
in the health professions.

Development of the Scale

Based on written statements from undergraduate
students taking a basic mathematics course at New York
University, 32 scale items were derived which reflected
attitude toward one's mathematical ability. Items were
worded both positively and negatively. Respondents were
asked to indicate degree of agreement or disagreement with
each item on the following scale: Agree Strongly (5),
Agree Somewhat (4), Undecided (3), Disagree Somewhat (2),
Disagree Strongly (1). Scoring on negatively worded items
was reversed so that a high score would indicate a favorable
mathematical self-concept.

The Mathematical Self-Concept Scale was submitted to three mathematicians experienced in the remediation of mathematics anxiety and basic mathematical skills, in order to establish content validity. Modifications of a few items were recommended. The scale was then given to the sample of 28 students. Two items which elicited confusion among respondents were reworded, and a few redundant items (having a correlation above .9 with other items) were eliminated, for a final total of 27 items (see Table 1). Items 2, 4, 7, 10, 12, 13, 18, 20, 24, 26 and 27 are worded in a positive direction; the remaining items are worded in a negative direction. Possible scores range from a low of 27 to a high of 135.

Insert Table 1 about here

Procedure

The main sample of 92 students was given the final version of the Mathematical Self-Concept Scale at the end of the first class session of the semester. In addition to the Mathematical Self-Concept Scale, students were given the Mathematics Anxiety Rating Scale, or MARS (Richardson & Suinn, 1972), and a test of arithmetic skills (Durost, Bixler, Wrightstone, Prescott, & Balow, 1970), and were asked to indicate agreement or disagreement with a list of

erroneous statements about mathematics (Gourgey, 1982).

Examples of erroneous statements included: The most

important thing in doing math is to use the right formulas;

Some people have a mathematical mind and some don't; Math

requires only logic, not intuition. After eight weeks,

students took a midterm examination covering topics in

descriptive statistics.

Results

The mean mathematical self-concept on the final form

of the scale for the sample of 92 students was 94.53, the

standard deviation was 21.88, and the actual range of

scores was from 34 to 133. Due to the small number of

males in the sample, sex differences could not be evaluated.

The internal consistency reliability (by coefficient

alpha) of the preliminary version of the scale, using the

sample of 28 students, was .98. After revisions, the

reliability of the final version of the scale was .96

(N = 92). All item-total correlations but one in the

final version were above .5. In addition, a principal

components factor analysis was performed on the scale items

which showed most of the variance among items to be

accounted for by one factor.

The correlation of the preliminary version of the

Mathematical Self-Concept Scale with self-report of

anxiety about mathematics was -.71; this result was

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statistically significant, $\underline{t}$ (26) = -5.14, $\underline{p}$ < .001.
The correlation matrix for the five tests given to the
main sample is presented in Table 2. It can be seen that
mathematical self-concept correlates moderately highly with
mathematics anxiety as measured by the MARS; this result
was statistically significant, $\underline{r}$ = -.62, $\underline{t}$ (90) = -7.50,
$\underline{p}$ < .001. However, mathematical self-concept correlates
more highly with acceptance of erroneous beliefs about
mathematics, arithmetic skills, and performance on the
midterm examination than does mathematics anxiety. (Due
to the relative simplicity of the material covered by the
midterm examination, the distribution of midterm exam
scores was highly negatively skewed and had a relatively
small variance. This may have accounted for its low
correlations with the other variables.)

Insert Table 2 about here

Additional analyses were performed regaring age of
student and number of years since last mathematics course,
both previously found to correlate with mathematics anxiety
(Betz, 1978), and their relationship to mathematical self-
concept and mathematics anxiety. These results are
presented in Table 3. (A few students did not supply
demographic information and had to be omitted from these
analyses.) Not surprisingly, the correlation of age with

number of years since last mathematics course was
moderately high; yet these two variables were not equally
related to the affective variables. Age was only slightly
more related to mathematical self-concept than to mathe-
matics anxiety. However, number of years since last
mathematics course was more strongly related to mathematical
self-concept than to mathematics anxiety.

Insert Table 3 about here

Discussion

Research on affect toward mathematics has suggested
that both children and adults may experience not only
mathematics anxiety which interferes with their performance
in mathematics courses, but an impaired self-concept in
mathematics as well. In order to measure self-concept in
mathematics, a 27-item Likert-type attitude scale was
developed and validated on a sample of undergraduate and
graduate students taking a required basic statistics course.

The results of the analyses of the Mathematical Self-
Concept Scale provide support for its validity and relia-
bility as a measure of mathematical self-concept. Both the
item-total correlations and the internal consistency
reliability were high; additionally, a principal components
factor analysis showed most of the variance of the scale
items to be accounted for by one factor. These results

suggest that the Mathematical Self-Concept Scale measures
one construct.

The moderately high correlation of the Mathematical
Self-Concept Scale with measures of mathematics anxiety
also lends support to the validity of the scale as a measure
of mathematical self-concept. It is interesting to note
that the correlation of the Mathematical Self-Concept
Scale with the MARS was identical to the correlation
between mathematics anxiety and mathematics confidence
obtained by Sudweeks, Stoler, and Croker (1980) using
completely different measures for both variables. This
lends further support to the construct of mathematical
self-concept and its relationship to mathematics anxiety.

The fact that mathematical self-concept correlated
more highly than did mathematics anxiety with many of
the variables used in this study suggests that mathematical
self-concept may be a more powerful and more informative
variable than mathematics anxiety: not only does it
relate more strongly to other variables involved in learning
mathematics, it also supplies more specific information
about the nature of the mathematics learner's difficulty.
Since mathematics anxiety is currently receiving a great
deal of attention as a correlate of mathematics performance
and many mathematics anxiety treatment programs have been
established to deal with this problem, the results of this
study suggest mathematical self-concept as a dimension of

attitude in mathematics learning which has received

little attention but which may be valuable to consider

in both research and treatment of mathematics anxiety.

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Table 1

Items on the Mathematical Self-Concept Scale

1. It takes me much longer to understand mathematical concepts than the average person.

2. I have never felt myself incapable of learning math.

3. I have a mental block when it comes to math.

4. I have a good mind for math.

5. If I can understand a math problem, then it must be an easy one.

6. It has always seemed as if math required brain cells I didn't have.

7. I can understand math better than most people.

8. Whenever I am exposed to math, I feel that it is beyond me.

9. I don't ask questions in math classes because mine sound so stupid.

10. I have no more trouble understanding math than any other subject.

11. I just don't have a mathematical mind.

12. When I have difficulties with math, I know I can handle them if I try.

13. My mathematical ability is above average.

14. I have never been able to think mathematically.

15. I always feel like a dummy in my math classes.

16. I don't have a good enough memory to learn math.

17. I get very tense when I see a math problem because I know I will not be able to do it.

18. I never feel like a mathematical incompetent.

19. Whenever I do a math problem, I am sure that I have made a mistake.

20. I feel secure in my ability to do math.

Table 1 (continued)

21. If my eating depended on my ability to do math,
    I would undoubtedly starve to death.

22. I have no facility with numbers.

23. Whenever I have to take math, I worry about whether
    I can pass.

24. When I have to do math problems, I do not worry about
    whether I will be able to do them.

25. Whenever I do math problems, I end by giving up in
    despair.

26. I never worry about failing math.

27. When I do math, I feel confident that I have done
    it correctly.

Table 2

Correlation Matrix for the Five Tests

Given to Participants[a]

	MSC	MA	AS	ME
Beliefs About Mathematics (BAM)	-.39***	.32***	-.34***	-.28***
Mathematical Self-Concept (MSC)		-.62***	.36***	.18*
Mathematics Anxiety (MA)			-.28**	-.12
Arithmetic Skills (AS)				.32***
Midterm Examination (ME)				

[a]$\underline{N}$ = 92.
*$\underline{p}$ < .05.
**$\underline{p}$ < .005.
***$\underline{p}$ < .001.

Table 3

Correlation of Age and Number of Years Since Last

Mathematics Course with Mathematical Self-Concept

and Mathematics Anxiety[a]

	No. Yrs.	MSC	MA
Age	.59*	-.48*	.45*
Number of Years Since Last Mathematics Course		-.49*	.37*

[a]N = 84.
*p < .001.