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ABSTRACT

The content and construct validity and reliability of the Revised Science Attitude Scale for Preservice Teachers as a scale for measuring the attitude of preservice elementary teachers toward the teaching of science were re-examined. The instrument is intended to measure four subcomponents: comfort-discomfort, need, time, and equipment. Data were generated on two subsamples (n1=59 and n2=60) and the sample (N=378). Frequency, intercorrelations, Cronbach's Alpha, and principal components analysis with varimax rotation were used to analyze the data. Means tended to fall within the 2.00 and 4.00 range with standard deviations hovering around 1.00. Neutral responses beyond 35% were limited to statement 7. Five factors were extracted in the principal components analysis, explaining 55.1% of the variance. Eight statements failed to load on any factor. Statements of teacher anticipation about teaching science heavily loaded on Factor I. Loading equally on Factors I and II were statements in the subcomponent equipment. Of the three statements in the subcomponent time, two loaded on Factor III. Only statements in the subcomponent need loaded on Factor IV and V. Reclassification of some statements seems warranted. (Author)

REVISED SCIENCE ATTITUDE SCALE FOR PRESERVICE ELEMENTARY TEACHERS: RE-EXAMINED

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Abstract

The content and construct valldity and reliability of the Revised Science Attitude Scale for Preservice Teachers as a scale for measuring the attitude of preservice elementary teachers toward the teaching of science were re-examined. The instrument is intended to measure four subcomponents: comfort-discomfort, need, time, and equipment. Data were generated on two subsamples (n_1 = 59 and n_2 = 60) and the sample (N = 378). Frequency, intercorrelations, Cronbach's Alpha, and principal components analysis with varimax rotation were used to analyze the data. Means tended to fall within the 2.00 and 4.00 range with standard deviations hovering around 1.00. Neutral responses beyond 35% were limited to statement 7. Five factors were extracted in the principal components analysis, explaining 55.1% of the variance. Eight statements failed to load on any factor. Statements of teacher anticipation about teaching science loaded on Factor 1. Statements in the subcomponent comfort-discomfort loaded heavily on Factor I. Loading equally on Factors I and II were statements in the subcomponent equipment . Of the three statements in the subcomponent time, two loaded on Factor III. Only statements in the subcomponent need loaded on Factors IV and V. Reclassification of some statements seems warranted.

Purpose of the Study

The purpose of this study was to re-examine the content and construct validity and reliability of the Revised Science Attitude Scale for Preservice Teachers as an instrument measuring the attitude of preservice teachers toward the teaching of science(Thompson & Shrigley, 1986). Thompson and Shrigley as well as Bitner (1993) have recommended that additional data be generated using this scale and that these data be analyzed to provide more information about the validity and reliability of this scale.

Significance of the Study

Approximately one–third of all students dislike science by the end of third grade (AAAS, 1989; Harty & Enochs, 1985), and only one–fifth enjoy science by the end of fifth grade (Harty & Enochs). These negative attitudes toward science begin before college entrance (Mallow, 1981) and quite possibly are traceable to their elementary teachers' less than positive attitudes toward science if indeed attitude toward science and the teaching of science affect whether science is taught, how it is taught, and how much it is taught (Gabel & Rubba, 1979; Harty , Beall, & Scharmann, 1985; Koballa & Crawley, 1985; Mechling & Oliver, 1985; Riley, 1979; Shrigley, 1974; Shrigley & Johnson, 1974;

Thompson & Shrigley, 1986). "Attitudes and behavior are correlates" (Shrigley, 1990, p. 97); therefore, valid and reliable instruments are needed to measure the attitudes of preservice teachers toward the teaching of science. Attention must be given to the instrument's validity, not just its reliability (Thompson & Shrigley,1986).

Six principles guided the revision of the Science Attitude Scale (Thompson & Shrigley). Their results are reported in the instrument section of this paper.

Design and Procedures

Samples

The population consisted of preservice elementary teachers enrolled in "Teaching Science in the Elementary School" at a midwestern university with a student enrollment of approximately 20,000. The Teacher Education Program has an enrollment of approximately 3,300 graduate and undergraduate students. Of those, approximately 1,279 are preservice elementary education majors. Data were generated from two subsamples ($n_1 = 59$; $n_2 = 60$) and the total sample ($N = 378$).

Instrument

Over several semesters during the first week of classes, the Revised Science Attitude Scale for Preservice Teachers (Thompson & Shrigley) was administered to approximately half of the preservice elementary teachers enrolled in the elementary science methods course.

According to Thompson and Shrigley, the Revised Science Attitude Scale for Preservice Teachers measures attitude toward the teaching of elementary school science (see Table 1). This scale consists of 22 attitude statements (12 positive and 10 negative) and is distributed among four subcomponents: "comfort–discomfort of teaching science," "basic need American students have for science," "time required to prepare and teach science," and "handling of science equipment." For the 12 positive statements, the ratings ranged from strongly agree (5) to strongly disagree (1). The reverse ratings, strongly agree (1) to strongly disagree (5), were used for the ten negative statements, reflecting negative attitudes toward the teaching of science. The means and standard deviations ($n_1 = 83$ and $n_2 = 82$) of each subcomponent were: (a)

comfort–discomfort (M = 30.9, SD = 5.9); (b) need (M = 18.8, SD = 3.2); (c) time (M = 11.2, SD = 6.4); and (d) equipment (M = 17.0, SD = 3.3). They reported a coefficient alpha of 0.89 for the Science Attitude Scale, 0.85 for the subscale of positive statements, and 0.75 for the subscale of negative statements. Convergent and divergent validities were established. The majority of the inter-item correlations among the 22 statements were positive. The means on the 22 statements ranged from 2.63 (statement 18) to 4.59 (statement 21).

To establish content validity , they correlated the four subcomponents (N = 226) and used a principal components analysis (N = 221) to extract the common factors. The intercorrelations among the four subcomponents yielded coefficients ranging from 0.46 to 0.70. In the principal components analysis of the revised 22 statement attitude scale, factors generating eigenvalues 1.00 or higher were rotated and revealed four major factors, explaining 62.08% of the variance. Assignment of the statements to a factor was based on the loading of 0.60 or higher on that factor and 0.35 or lower on the other three factors: therefore, statements 5, 7, 10, 12, 13, 19, 20, and 22 loaded on Factor 1; statements 3, 9, 11, 16, and 17 on Factor 2; statements 1, 14, and 18 on Factor 3; and statement 21 on Factor 4. Five statements (2, 4, 6, 8, and 15) failed to load on any of the four factors. Thompson and Shrigley claimed that they did not anticipate loadings on the four factors to match the four subcomponents: comfort-discomfort, need, equipment, and time.

Statistical Analysis of Data Procedures

Frequency , reliability, intercorrelations among subcomponents, and principal components analysis programs (SPSS, 1990) were used to analyze the data. The following criteria plus those delineated in the instrument section were used in the analysis and in the reporting of the data in the present study.

A Likert-type attitude scale should have a mean between 2.00 and 4.00 with a standard deviation hovering around 1.00 and with neutral responses below 35% (Thompson & Shrigley). Neutral statements beyond 35% connote vagueness or ambiguity; skewed distributions imply a factual rather than an evaluative level.

The principal components analysis extracts the maximum variance from data of orthogonal components with the most variance being extracted from the first component and the least from the last component (Tabachnick & Fidell, 1989). The varimax rotation was selected because it maximizes " the variance of the loadings within factors, across variables" (Tabachnick & Fidell, 1989, p. 628). The criteria for using and interpreting a principal components analysis were as follows:

1. A minimum of ten subjects per variable (Nunnally, 1978).
2. Scree test of eigenvalues (Cattell, 1966).
3. Rotation of factors with eigenvalues of 1.00 or higher (Tabachnick & Fidell).
4. Convergence criterion for extraction at 0.001.
5. Convergence criterion for rotation at 0.0001.
6. Assignment to factor if loading is 0.60 or higher on that factor and 0.35 or lower on the other factors.
7. Loading of only one variable on a factor indicates that the factor is "poorly defined" (Tabachnick & Fidell, p. 636).
8. Loadings of two variables on a factor with an intercorrelation of the two variables >.70 and with basically no correlation with the other variables may indicate a reliable factor (Tabachnick & Fidell).

Results

As reported in Table 1, the means and standard deviations were very similar to Thompson and Shrigley's. The means and standard deviations across the two subsamples and the total sample were consistent. The only statement with neutral responses exceeding 35% across the three samples was 7. As recommended by Thompson and Shrigley (1986), no means fell below 2.00 and the standard deviations hovered around 1.00, but the means for ten statements did exceed 4.00 . Four of the five statements in the subcomponent need had means beyond 4.00 as recommended by Thompson and Shrigley (1986); the mean for this subcomponent was 21.16 ($\underline{N} = 378$) (see Table 2). All three of the statements in the subcomponent time had means greater than 4.00; therefore, the mean for the this subcomponent was 12.72. Most of the

adjusted item-total correlations ranged between 0.23 and 0.78. The correlations among the four subcomponents ranged between 0.43 from 0.70 with a standardized item alpha of .82 (see Table 3). These r-values indicate a moderate degree of relationship and yet independence of the four subcomponents. The standardized item alpha for the four subtests ranged from .56 (need) to .83 (comfort-discomfort). Most of the interitem correlations generated by the 22 statements were positive.

Insert Tables 1-3 about here

In the principal components analysis of the revised 22 statement attitude scale, factors generating eigenvalues 1.00 or higher were rotated and revealed five major factors, explaining 55.1% of the variance (see Fig. 1 and Table 4). Factor I accounted for 31.7% of the variance. Eight statements (1, 4, 7, 9, 11, 12, 18, and 22) failed to load on any of the five factors. However, 19 of the 22 statements had a communality of 0.50 or higher, meaning that 50% or more of the variance in the statement is accounted for by the five factors. The loadings for time (2 of the 3), for need (4 of the 5) , and for equipment (4 of 5) were quite impressive while the loadings for the other subcomponent comfort-discomfort (4 of 9) were less impressive. The four statements loading on Factor I do suggest anticipation about teaching science as suggested by Thompson and Shrigley. Of the five loadings of the first two factors, four are from the subcomponent equipment, three from comfort-discomfort, and one from need. Three of the five need variables loaded on Factor IV or Factor V. The intercorrelation (r = .51) of the two need statements loading on Factor IV may not indicate a reliable factor according to Tabachnick and Fidell. Only the statement relating to students' curiosity about science loaded on Factor V . Tabachnick and Fidell cautioned that this may indicate a poorly defined factor.

Insert Fig. 1 and Table 4 about here

Conclusions and Recommendations

The sample had rather positive attitudes toward the teaching of science. In fact, four of the five statements in the subcomponent need and all three of the statements in the subcomponent time had means beyond 4.00 as recommended by the attitude scale developers. If one strictly interprets Thompson and Shrigley's guidelines regarding the range for means in Likert scale, one might conclude that those statements are more factual than evaluative in nature.

The principal components analysis differed, both in the number of factors and in the loadings on factors, from that of Thompson and Shrigley. In the present study, five factors were extracted, explaining 55.1% of the variance; four factors were extracted in the study by Thompson and Shrigley with 62.08% of the variance explained. Of the 5 statements which failed to load on any of the four factors in Thompson and Shrigley study, three were from the need subcomponent, whereas only 1 of the 8 statements not meeting the mineigen in the present study was from the need subcomponent (statement 22). Although the loadings of the statements differed from Thompson and Shrigley's study; in both studies, statement 4 "Teaching science takes too much time." did not load, statement 21 ("Children are not curious about scientific matter.") loaded separately and on the last factor and statement 10 loaded on Factor I. The researcher is inclined to reclassify statements 10 and 17 as comfort-discomfort because the statements relate to demonstrating science phenomena and about having science experiments fail. If these two statements were reclassified, all loadings on Factor I would relate to comfort-discomfort.

Future analysis of this attitude scale might focus on a principal components analysis of just those statements which loaded 0.60 or higher on one factor and 0.35 or lower on the other factors.

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Table 1

Data Summary for 22 Statements on the Revised Science Attitude Scale (n_1 = 59, n_2 = 60, N = 378)

Statements	Subcomponents	Pos Neg	n_1 n_2 N	Adj. Item Total r	M	SD	% Neutral
1. I will feel uncomfortable teaching science.	comfort discomfort	-	1	0.64	3.49	1.06	32
			2	0.50	3.17	1.11	27
			N	0.49	3.43	1.04	25
2. The teaching of science processes is important in the elementary classroom.	need	+	1	0.07	4.42[a]	0.97	3
			2	0.53	4.55[a]	0.77	2
			N	0.18	4.53[a]	0.77	1
3. I fear that I will be unable to teach science adequately.	comfort discomfort	-	1	0.65	3.54	1.09	20
			2	0.63	3.33	1.04	23
			N	0.57	3.43	1.04	18
4. Teaching science takes too much time.	time	-	1	0.35	4.29[a]	0.85	5
			2	0.43	4.40[a]	0.56	3
			N	0.40	4.29[a]	0.71	7
5. I will enjoy the lab period in science courses that I teach.	equipment	+	1	0.75	4.15[a]	0.87	10
			2	0.46	4.35[a]	0.68	12
			N	0.48	4.19[a]	0.87	12
6. I have a difficult time understanding science.	comfort discomfort	-	1	0.55	3.47	1.14	7
			2	0.64	3.45	1.03	15
			N	0.59	3.49	1.08	8
7. I feel comfortable with the science content in the elementary school curriculum.	comfort discomfort	+	1	0.23	3.31	0.93	58[b]
			2	0.26	3.47	0.83	50[b]
			N	0.26	3.36	0.87	46[b]
8. I would be interested in working in an experimental science curriculum.	need	+	1	0.54	3.71	0.93	36*
			2	0.40	3.85	0.84	18
			N	0.47	3.76	0.85	25
9. I dread teaching science.	comfort discomfort	-	1	0.70	4.07[a]	1.00	15
			2	0.77	4.07[a]	0.92	13
			N	0.71	4.06[a]	0.90	10
10. I am not afraid to demonstrate science phenomena in the classroom.	equipment	+	1	0.62	3.76	0.88	17
			2	0.61	3.88	0.90	22
			N	0.64	3.82	0.87	19
11. I am not looking forward to teaching science in my elementary classroom.	comfort discomfort	-	1	0.67	3.93	1.05	12
			2	0.49	3.82	1.05	10
			N	0.57	3.87	0.98	9
12. I will enjoy helping students construct science equipment.	equipment	+	1	0.67	3.90	0.85	15
			2	0.67	4.12[a]	0.78	10
			N	0.64	3.98	0.80	12

Table 1 (cont.)

13. I am willing to spend time setting up equipment for a lab.	time	+	1	0.43	4.19[a]	0.43	2
			2	0.61	4.30[a]	0.62	3
			N	0.50	4.20[a]	0.57	4
14. I am afraid that students will ask me questions that I cannot answer.	comfort discomfort	-	1	0.43	2.53	1.14	12
			2	0.41	2.42	1.11	15
			N	0.46	2.58	1.09	15
15. Science is as important as the 3 R's.	need	+	1	0.55	4.29[a]	0.77	8
			2	0.28	4.18[a]	0.70	7
			N	0.39	4.18[a]	0.73	13
16. I enjoy manipulating science equipment.	equipment	+	1	0.61	3.64	0.87	20
			2	0.51	3.72	0.89	22
			N	0.58	3.69	0.86	21
17. In the classroom, I fear science experiments won't turn out as expected.	equipment	-	1	0.33	3.00	0.98	15
			2	0.43	3.10	0.99	10
			N	0.45	3.01	1.01	16
18. Science would be one of my preferred subjects to teach if given a choice.	comfort discomfort	+	1	0.78	3.15	1.27	20
			2	0.67	3.17	1.18	35[b]
			N	0.65	3.10	1.16	27
19. I hope to be able to excite my students about science.	comfort discomfort	+	1	0.45	4.64[a]	0.48	0
			2	0.47	4.68[a]	0.47	0
			N	0.49	4.55[a]	0.52	0
20. Teaching science takes too much effort.	time	-	1	0.62	4.22[a]	0.59	8
			2	0.52	4.38[a]	0.59	5
			N	0.49	4.24[a]	0.57	7
21. Children are not curious about scientific matters.	need	-	1	0.27	4.51[a]	0.75	5
			2	0.13	4.70[a]	0.50	2
			N	0.23	4.56[a]	0.73	2
22. I plan to integrate science into other areas.	need	+	1	0.45	4.17[a]	0.62	12
			2	0.50	4.30[a]	0.59	7
			N	0.48	4.13[a]	0.71	13
12 Positive Statements 60 (most positive) to 12 (least positive)			1		47.34	5.96	
			2		48.57	5.35	
			N		47.48	5.65	
10 Negative Statements 50 (least negative) to 10 (most negative)			1		37.05	6.00	
			2		36.83	5.60	
			N		36.95	5.65	
Total Attitude			1		84.39	11.30	
			2		85.40	10.01	
			N		84.43	10.43	

Note. The ratings for the twelve positive statements are SA = 5, A = 4, N = 3, D = 2, SD = 1.
Note. The reversed ratings SA = 1, A = 2, N = 3, D = 4, SD = 5 are applied to the ten negative statements.
Note. Standardized Item Alpha for 22 statements: .90 (n_1 = 59), .88 (n_2 = 60), and .89 (N = 378).
[a] Outside 2.00–4.00 range of mean.
[b] Exceeded 35% neutral responses.

Table 2

Comparison of Four Subtests for 22 Statement Attitude Scale (N = 378)

Subtest	# of Items	M	SD	Adj. Item Total r	Stand. Item Alpha
Comfort-Discomfort	9	31.86	5.73	0.67	.83
Need	5	21.16	2.27	0.54	.56
Time	3	12.72	1.41	0.57	.63
Equipment	5	16.32	3.28	0.77	.74
Total	22	84.43	10.43		.82

Table 3

Intercorrelation of the Four Subcomponents on 22 Statements (N = 378)

	1 (comfort-discomfort)	2	3
2 (Need)	0.43		
3 (Time)	0.47	0.50	
4 (Equipment)	0.70	0.55	0.55

Note 1. Standardized Item Alpha = .82.

Table 4

Principal Components Analysis Varimax Rotation for 22 Statements(N = 378)

	Factors					
Item #	I	II	III	IV	V	Commun-alities
1 (c/d)	.56	.31	.06	.13	-.35	.56
2 (need)	.01	-.05	.08	.77	.09	.61
3 (c/d)	.73	.22	.10	-.04	.05	.59
4 (time)	.10	.18	.56	.08	.25	.42
5 (equip)	.10	.71	.13	.04	.20	.58
6 (c/d)	.63	.34	.03	.15	.02	.54
7 (c/d)	.26	-.10	.57	-.18	-.30	.53
8 (need)	.11	.68	.13	.03	.19	.54
9 (c/d)	.59	.44	.27	.07	.02	.62
10 (equip)	.60	.31	.16	.22	.13	.55
11 (c/d)	.39	.43	.35	-.05	-.02	.47
12 (equip)	.28	.55	.43	.10	-.03	.57
13 (time)	.05	.33	.64	.16	10	.55
14 (c/d)	.75	-.02	.12	-.01	-.00	.58
15 (need)	.10	.23	.21	.67	-.06	.55
16 (equip)	.23	.60	.26	.23	-.07	.53
17 (equip)	.71	-.11	.18	.00	.29	.63
18 (c/d)	.48	.46	.24	.26	-.26	.63
19 (c/d)	.10	.27	.60	.20	.10	.49
20 (time)	.18	.14	.64	.25	.11	.53
21 (need)	.09	.15	.15	.02	.71	.56
22 (need)	.22	.28	.26	.37	.41	.50
Percent of Variance	31.7	8.5	5.1	4.9	4.9	55.1

Note 1. Varimax rotation converged in 7 iterations.

Note 2. Eigenvalues : 6.98 (Factor I), 1.87 (Factor 2), 1.12 (Factor III), 1.08 (Factor IV), and 1.07 (Factor V); explained variance: 55.1.

Note 3. Subcomponents are comfort-discomfort (c/d), time (time), need (need), and equipment (equip).

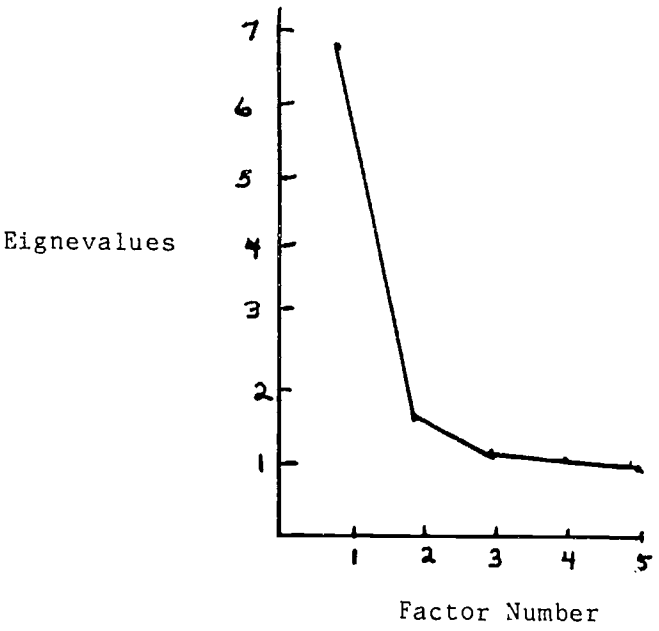

Figure: 1: Plotting the results of the Scree Test