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ABSTRACT

Data indicate that although science is required of all students in elementary school, elementary teachers do not usually teach science as a high priority or in a way that enhances student achievement. A myriad of possible causes for existing voids in this teaching process have been suggested by researchers. Teacher belief systems have been neglected as a possible contributor to behavior patterns which affect science teaching, therefore its investigation is vital to a more complete understanding of teacher behavior. This publication reports on a pilot and a major study in which the combined Personal Science Teaching Efficacy Belief scale and the Science Teaching Outcome Expectancy scale instrument (STEBI) was administered to measure self-efficacy or outcome expectancy. Results of a plot graph illustrated two homogeneous scales for the try-out study. Results of the major study indicate that the STEBI is a valid and reliable tool for studying elementary teacher's beliefs toward science teaching and learning. References, means and standard deviations, corrected item-total scale correlations and factor loadings, factor plot of final factor analysis results, demographic characteristics, final scales, validity coefficients, and scoring instructions for the STEBI are included. (RT)

Toward the Development of an Elementary Teacher's Science Teaching Efficacy Belief Instrument

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Toward the Development of an
Elementary Teacher's Science
Teaching Efficacy Belief Instrument

Introduction

The National Science Board Commission on Precollege Education in Mathematics, Science, and Technology stressed the importance of elementary school science because it is within the formative years that "substantial exposure to mathematical and scientific concepts and processes" is thought to be "critical to later achievement" (1983, p. 22). Though science is required of all students within the elementary years, strong evidence suggests that elementary teachers do not teach science as a high priority (Stake and Easley, 1978; Schoeneberger and Russell, 1986). When elementary science is addressed, it is not usually taught in a way that enhances student achievement (Denny, 1978).

Researchers have suggested a myriad of possible causes for existing voids in elementary science teaching. Abundant attention has been devoted to the investigation of teacher attitude toward science and the effects of these attitudes on subsequent teaching. Teacher belief systems, however, have been neglected as a possible contributor to behavior patterns of elementary teachers with regard to science.

Investigation of teacher beliefs is vital to a more complete understanding of teacher behavior. Koballa and Crawley (1985) defined belief as "information that a person accepts to be true" (p.223). This is differentiated from attitude which is a general positive or negative feeling toward something. Attitudes may be formed on the basis of beliefs, and both attitudes and beliefs relate to behavior.

An example based upon Koballa and Crawley's description, can be made to demonstrate the relationship between beliefs, attitudes and behavior with regard to the elementary science teaching situation. An elementary teacher judges his/her ability to be lacking in science teaching (belief) and consequently develops a dislike for science teaching (attitude). The result is a teacher who avoids teaching science if at all possible (behavior). This strong interrelationship of beliefs, attitudes, and behavior dictates the inclusion of belief measurement in elementary science teaching research which, up until now, has been slighted.

Theoretical Framework

Social learning theory provides the lens through which elementary science teachers' beliefs will be measured. Beliefs have been closely linked to behavior in Albert Bandura's work with phobics and self-efficacy (1977). Bandura suggested that people develop a generalized expectancy about action-outcome contingencies based upon life experiences. Additionally, they develop specific beliefs concerning their own coping abilities. Bandura called this self-efficacy. Behavior, for Bandura, was based upon both factors. Behavior is enacted when people not only expect certain behaviors to produce desirable outcomes (outcome expectancy), but they also believe in their own ability to perform the behaviors (self-efficacy).

Behavior might be predicted by investigating both types of expectancy determinants. Bandura (1977) hypothesized that people high on both outcome expectancy and self-efficacy would act in an assured, decided manner. Low outcome expectancy paired with high self-efficacy might cause individuals to temporarily intensify their efforts, but will eventually lead to frustration. Persons low on both variables would give up more readily if the desired outcomes were not reached immediately.

Related Research

When applied to the study of teacher effectiveness, Bandura's theory might cause one to predict that "teachers who believe student learning can be influenced by effective teaching (outcome expectancy beliefs) and who also have confidence in their own teaching abilities (self-efficacy beliefs) should persist longer, provide a greater academic focus in the classroom, and exhibit different types of feedback than teachers who have lower expectations concerning their ability to influence student learning" (Gibson and Dembo, 1984, p. 570). Such beliefs have been termed teacher efficacy beliefs and refer to the extent to which teachers believe they have the capability to positively affect student achievement.

Within the teacher efficacy belief literature, two dimensions of teacher self-efficacy, that of Teaching Efficacy (Outcome Expectancy) and Personal Teaching Efficacy (Self-Efficacy), have been defined and utilized in subsequent studies. Several studies suggest that teacher efficacy beliefs may account for individual differences in teacher effectiveness (Armor, Conroy-Osequera, Cox, King, McDonnel, Pascal, Pauley, & Zellman, 1976; Berman & McLaughlin, 1977; Brookover, Schweitzer, Schneider, Beady, Flood, & Wisenbaker, 1978; Brophy & Evertson, 1981). Student achievement has also been shown to be significantly related to teacher efficacy belief (Ashton and Webb, 1982). The dimension of Personal Teaching Efficacy has been used to predict teacher behavior with most accuracy (Ashton, Webb, & Doda; 1983).

Yet, the dimension of Personal Teaching Efficacy as defined within the teacher efficacy belief literature differs from Bandura's original description of self-efficacy and outcome expectancy as distinct variables. Researchers have defined this dimension as a combination of both self-efficacy and subsequent contingencies between performance and outcomes (outcome expectancy). Items which contain a combination of the dimensions add confusion to data analysis since they are actually doublebarreled. Thus, if teachers score low on such items, the reason might be due to their belief that they cannot teach or their belief that students can not learn or a combination of the two.

Teacher self-efficacy studies have also tended to focus on investigation of teacher efficacy beliefs in general rather than specific subject areas. For elementary teachers in particular, a subject specific instrument would be more informative. Teacher efficacy beliefs appear to be dependent upon the specific teaching situation. Teachers' overall level of self-efficacy may not accurately reflect their beliefs about their ability to affect science learning. A specific measure of science teaching efficacy beliefs should be a more accurate predictor of science teaching behavior and thus more beneficial to the change process necessary to improve students' science achievement. It is also consistent with Bandura's (1981) definition of self-efficacy as a situation specific construct.

In response to the above limitations, this research project attempted to keep the constructs of teacher self-efficacy and outcome expectancy distinct to facilitate evaluation of both. The instrument developed is also specific to elementary teachers' efficacy beliefs in science teaching. This maintains consistency with Bandura's (1981) definition of self-efficacy belief as a situation specific rather than global construct.

Indeed, teacher efficacy beliefs do appear to be dependent upon the specific teaching situation. Ashton, Webb, and Doda (1983) found that teachers may have higher teacher efficacy with some students than others. This should be true within the elementary classroom and may also prove to vary with subject taught. Teachers' overall level of teacher efficacy belief may not accurately reflect their beliefs about their ability to affect science learning. A specific measure of science teaching efficacy beliefs should be a more accurate predictor of science teaching behavior and thus more beneficial to the change process necessary to improve students' science achievement.

Development

Item Construction and Refinement

Initial science-specific items were modeled after scales designed to measure self-efficacy and outcome expectancy beliefs for teaching behaviors in general (Gibson & Dembo, 1984). All items were modified to include an elementary science classroom setting. The two resulting scales which combine to form the "STEBI" were named the Personal Science Teaching Efficacy Belief scale and the Science Teaching Outcome Expectancy scale. Items were also altered to reflect only self-efficacy or outcome expectancy rather than a combination of both self-efficacy and outcome expectancy. Additional items were created to develop a larger item pool and balance item phrasing, thus controlling for acquiescence responding (Mueller, 1986).

All items were edited for clarity by a measurement expert. The fifty resulting items were submitted to a panel of judges, selected because of their knowledge of the construct being measured. Judges were asked to classify the dimension of each item, rate each scale, and rate the total instrument's items and their representativeness, thus contributing to the instrument's content validity. Items inconsistently classified by three out of the five judges were eliminated.

Response Format and Scoring

The STEBI, like the Teacher Efficacy Scale, utilized a Likert scale format. The response categories were "strongly agree", "agree", "uncertain", "disagree", and "strongly disagree". Scoring was accomplished by assigning a score of five to positively phrased items receiving a "strongly agree" response, a score of four to "agree" and so on throughout the response categories. Negatively worded items were scored in the opposite direction with "strongly agree" receiving a score of one. Item scores of each dimension were summed to calculate two separate scale scores for each respondent.

Try Out Study

The preliminary draft of the STEBI was administered in a try out study to 71 practicing elementary teachers enrolled in graduate courses at a medium-sized midwestern university. The purpose of this phase of the study was to refine the item pool into a more concise and finished scale through utilization of item analysis. Though little problem was evident within the Personal Science Teaching Efficacy Belief scale, item analysis suggested major flaws in many items of the Science Teaching Outcome Expectancy scale. Therefore, factor analysis was completed on both scales before further item selection was done. Factor analysis revealed even more complexity within the Science Teaching Outcome Expectancy scale. Some items ith low corrected item-total correlations appeared to load well on the appropriate factor. Consequently, it was decided to select items on the basis of factor loading since the resulting scale might be so different as to render the initial corrected item-total correlations meaningless.

Examination of the omitted items revealed two patterns. As in the items deleted through expert judgment, it appeared that some items could be interpreted by respondents as referring to themselves rather than teachers in general. Crossloading could thus be explained for these items. The following is an example of such an item: "Many students are unprepared to learn science;

therefore, teaching them science is almost impossible." While some respondents answered in reference to their own teaching abilities (self-efficacy), others answered as intended by referring to expected outcomes to science teaching in general (outcome expectancy).

The second pattern also paralleled what had been found to be prevalent within items omitted by the experts. Oftentimes, items included parents or family as the responsible party for outcome rather than teachers. These items, along with those which appeared to fit no pattern but were inadequate statistically, were omitted. The resulting Science Teaching Outcome Expectancy scale had no negatively phrased items. Additional negative items were created to balance the scale and further test negative items' fit to this scale.

Preliminary data was also collected on validity criteria selected on the basis of their past correlation to teaching efficacy beliefs or their hypothesized relationship to science teaching efficacy beliefs. Criteria assessed were self-reports of years spent teaching at the elementary level, subject preference, time spent teaching science, utilization of activity-based science instruction, acceptance of responsibility for science teaching, self-rating of effectiveness in elementary science teaching, and subject preference as measured by the Subject Preference Inventory (Markle, 1978). All validity coefficients were expressed as Pearson Product-Moment Correlations.

<u>Results of Try Out Study</u>

Means and standard deviations for items and total scales are contained in Table 1. Information on item phrasing and items omitted after analysis are also included. Due to missing data, analysis was completed on sixty-five cases.

Reliability analysis of the Personal Science Teaching Efficacy Belief scale produced an alpha of 0.92. All but two of the twenty-four items attained a corrected item-total correlation of 0.42 and above (See Table 2). In order to abbreviate the scale for the main study, the six items with the lowest corrected item-total correlation were omitted. All remaining correlations were 0.50 and above. Further refinement of the scale was done using factor analysis. Resulting factor loadings revealed little problem with the items of this scale (See Table 2). Only two items correlated more with the Science Teaching Outcome Expectancy scale than their own, while two others correlated closely with both scales. The four were omitted. Repeated reliability and factor analysis of the modified scale resulted in an alpha of 0.91 and corrected item-total correlations of 0.50 and above for all items. Factor loadings revealed items which appeared to be homogeneous and distinct.

Reliability analysis of the Science Teaching Outcome Expectancy scale resulted in an alpha of 0.74, with item-total correlations revealing many weak items. After factor analysis was employed to aid in selection of items, reliability analysis was again run with a resulting alpha of 0.73 (See Table 3). Corrected item-total correlations were raised to 0.36 and above. Factor analysis for the revised scale were much improved, with all items correlating highly with their own scale. The resulting plot graph clearly illustrates two homogeneous scales (See Figure A).

Major Study

The refined Science Teaching Efficacy Belief Scale was administered to a new and larger sample of practicing elementary teachers (N=331), both rural and urban. A one-tailed t-test was used to insure that no significant differences existed between rural and urban samples for both scales.

Instrument reliability was again estimated through the internal consistency procedure described previously. Additional items which did not have a high positive discrimination index were also rejected.

Factor analysis was again used to determine the number of significant factors. A second factor analysis, limited to the final number of factors, was also employed to determine whether or not each dimension's items correlated with the correct scale score. Items that crossloaded or loaded into the wrong factor were eliminated.

Results of Major Study

Demographic characteristics of the major study's sample are illustrated in Table 4. A majority of the respondents were white and female. All elementary grade levels were represented in addition to teachers of varied experience levels. Rural and urban teachers were also included in the sample with no significant difference between the two sub-groups identified by post hoc t-tests. Additional post hoc t-tests were run on the scale scores of all other demographic characteristics. Only gender exhibited a significant difference, with significance favoring males on the Personal Science Teaching Efficacy Belief scale at the 0.05 level.

Means and standard deviations for items and total scale scores are shown in Table 5.

Item analysis was again conducted on both scales. For the Personal Science Teaching Efficacy Belief scale, an alpha of 0.91 was achieved. All items had corrected item-total correlations of 0.53 and above except for two (See Table 6). These were deleted, increasing the balance of item phrasing in this scale and raising alpha to 0.92.

The Science Teaching Outcome Expectancy scale produced an alpha of 0.76. Corrected item-total correlation of all items but two was 0.34 and above. Two items were removed raising alpha to 0.77.

Factor analysis of the remaining 25 items (listed in Table 7) called for all available factors, resulting in five. Of these factors, however, only two had an eigenvalue greater than one, thus support of two primary factors was achieved (Tucker, Koopman, & Linn, 1969). A "scree test" (Cattell, 1966) also suggested that only two factors should be considered in subsequent analyses.

A second factor analysis calling for two factors was run. Factor one, Personal Science Teaching Efficacy Belief, had an eigenvalue of 6.26 and accounted for 25.0 percent of variance. Factor two, Science Teaching Outcome Expectancy, had an eigenvalue of 2.71 and accounted for 10.8 percent of the variance. Resulting intercorrelations revealed two groups of items. The items referring to Science Teaching Outcome Expectancy correlated highly among themselves as did the items referring to Personal Science Teaching Efficacy Beliefs (Table 8). The correlations between the two dimension's items, however, were not as high. This pattern indicates discrete factors and enhances construct validity (Ghiselli, Campbell, & Zedeck, 1981). The factor plot (Figure B) also illustrates the homogeneity within and distinctiveness between the scales.

Validity Criteria Analysis

Table 9 contains Pearson r's for all criteria. All criteria assessed within the major study were significantly correlated with at least one scale. All correlations were also in a positive direction.

Discussion

With regard to reliability, both scales demonstrated their adequacy. The lower alpha of the Science Teaching Outcome Expectancy scale seems consistent with past research efforts in which this construct was most difficult to define and measure (Gibson and Dembo, 1984). This lower reliability might also be due to multiple variables contributing to the construct as defined by the item set. For example, teacher's science background, inadequacy of student's science background, and low-motivated students are variables which may have been experienced by the same teacher in different ways. This contributes to the complexity of the construct. Consequently, teachers may respond high to one item and low to another item resulting in a less consistent response set.

Though it is true that multiple variables are also evident within the Personal Science Teaching Efficacy Belief scale (answering students' questions, explaining experiments, monitoring experiments..), these variables appear to be more consistently experienced by teachers. In other words, teachers with low Personal Science Teaching Efficacy Belief tend to consistently rate themselves as low in self-efficacy belief no matter what the science activity.

The internal nature of these items in comparison to those of the Science Outcome Expectancy scale may also contribute to its higher reliability. Teachers may more consistently rate those items which deal with themselves rather than external factors over which they may feel they have no control. For example, it may be easier for teachers to evaluate their own personal behaviors as in the Personal Science Teaching Efficacy Belief scale than to decide possible outcomes dependent upon what they may view as external factors.

Factor analysis supported the contention that the scales are distinct and measurable constructs. As predicted by social learning theory, a small, significant level of correlation was found between the scales. Nevertheless, factor analysis clearly demonstrated that the scales measured two discrete and homogeneous constructs. This distinction is vital to a more comprehensive understanding of teacher behaviors.

The confirmation of the majority of the hypothesized relationships affirms the described nature of the constructs. The scale scores function as expected within the nomological network hypothesized. This suggests that the measures may now be meaningfully employed in the evaluation of the described constructs and the subsequent prediction of theoretically related measures.

Conclusions

Results of this study indicate that the STEBI is a valid and reliable tool for studying elementary teachers' beliefs toward science teaching and learning. With this tool, a more complete perspective of elementary science teaching is possible, since it allows investigation of teacher belief systems to supplement the existing research base which includes study of teachers' attitude and behaviors in the area of science teaching.

The STEBI as a measurement tool can lead to further understanding of teacher behavior, which in turn can facilitate the development of strategies which may assist in teacher preparation and teacher inservice designed to improve elementary science teaching. Effective science instruction is crucial at all levels of schooling, especially the elementary level. If students are to be prepared for a technical world, increasingly dependent upon scientific understandings; they must be exposed to teachers who devote time and effort to science instruction--teachers who are high in science teaching self-efficacy and outcome expectancy. Through further research utilizing the STEBI, more teachers might be assisted toward attainment of higher science teaching efficacy beliefs.

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TABLE 1
INITIAL MEANS AND STANDARD DEVIATIONS
TRY OUT STUDY

	MEASURE	POS-NEG	MEAN	STD DEV
PERSONAL	ITEM 1 *	P	3.66	0.83
SCIENCE	ITEM 2 *	P	3.60	1.16
TEACHING	ITEM 3 *	P	3.59	1.06
EFFICACY	ITEM 4 *	P	3.97	0.77
BELIEF	ITEM 5	P	3.88	0.83
SCALE	ITEM 6	N	3.40	1.01
ITEMS	ITEM 7	N	3.95	0.82
	ITEM 8 *	P	3.72	0.91
	ITEM 9	P	3.85	0.71
	ITEM 10 *	N	3.80	0.71
	ITEM 11	N	3.02	0.78
	ITEM 12	N	3.89	0.81
	ITEM 13 *	P	3.72	0.63
	ITEM 14	P	3.97	0.66
	ITEM 15 *	N	3.05	0.96
	ITEM 16	N	3.40	1.12
	ITEM 17	N	3.58	0.93
	ITEM 18	P	4.02	0.52
	ITEM 19	N	3.72	0.98
	ITEM 20	N	3.52	1.16
	ITEM 21	N	3.91	0.72
	ITEM 22	P	4.31	0.64
	ITEM 23	N	3.91	0.80
	ITEM 24 *	N	3.51	1.21
	TOTAL SCALE		89.75	12.64
SCIENCE	ITEM 1	P	3.63	1.08
TEACHING	ITEM 2	P	3.83	0.93
OUTCOME	ITEM 3	P	3.85	0.91
EXPECTANCY	ITEM 4 *	N	3.92	0.87
SCALE	ITEM 5 *	N	3.95	0.82
ITEMS	ITEM 6 *	N	4.32	0.64
	ITEM 7 *	N	2.75	0.98
	ITEM 8 *	N	4.11	0.75
	ITEM 9 *	N	4.06	0.75
	ITEM 10 *	N	4.11	0.75
	ITEM 11	P	3.71	0.84
	ITEM 12	P	4.02	0.70
	ITEM 13	P	3.57	0.84
	ITEM 14 *	N	3.09	1.11
	ITEM 15	P	3.60	0.79
	ITEM 16	P	3.63	0.76
	ITEM 17 *	[illegible]	3.66	0.67
	ITEM 18 *	N	4.14	0.83
	ITEM 19 *	P	3.99	0.72
	TOTAL SCALE		72.16	6.69

* ITEMS OMMITTED AFTER RELIABILITY AND FACTOR ANALYSIS

TABLE 2
INITIAL CORRECTED ITEM-TOTAL SCALE CORRELATIONS AND FACTOR LOADINGS
TRY OUT STUDY

	MEASURE	POS-NEG	I-T COR	FACTOR LOADINGS FACT 1	FACT 2
PERSONAL	ITEM 1 *	P	0.49	0.42	0.39
SCIENCE	ITEM 2 *	P	0.55	0.47	0.39
TEACHING	ITEM 3 *	P	0.54	0.47	0.47
EFFICACY	ITEM 4 *	P	0.45	0.52	-0.04
BELIEF	ITEM 5	P	0.57	0.59	-0.10
SCALE	ITEM 6	N	0.69	0.66	0.18
ITEMS	ITEM 7	N	0.54	0.66	0.08
	ITEM 8 *	P	0.68	0.59	0.35
	ITEM 9	P	0.64	0.58	0.24
	ITEM 10 *	N	0.29	0.46	-0.41
	ITEM 11	N	0.54	0.64	-0.10
	ITEM 12	N	0.66	0.69	-0.04
	ITEM 13 *	P	0.29	0.38	-0.23
	ITEM 14	P	0.79	0.77	0.23
	ITEM 15 *	N	0.48	0.50	-0.05
	ITEM 16	N	0.54	0.56	-0.13
	ITEM 17	N	0.67	0.72	-0.10
	ITEM 18	P	0.51	0.55	0.10
	ITEM 19	N	0.62	0.62	0.01
	ITEM 20	N	0.51	0.52	0.10
	ITEM 21	N	0.63	0.70	-0.09
	ITEM 22	P	0.62	0.66	0.21
	ITEM 23	N	0.78	0.78	0.13
	ITEM 24 *	N	0.42	0.44	0.00
	TOTAL SCALE		ALPHA=.92		
SCIENCE	ITEM 1	P	0.11	-0.20	0.64
TEACHING	ITEM 2	P	0.00	-0.16	0.64
OUTCOME	ITEM 3	P	0.24	0.08	0.49
EXPECTANCY	ITEM 4 *	N	0.27	0.34	-0.34
SCALE	ITEM 5 *	N	0.43	0.64	-0.14
ITEMS	ITEM 6 *	N	0.46	0.48	0.06
	ITEM 7 *	N	-0.14	0.33	-0.64
	ITEM 8 *	N	0.40	0.40	-0.16
	ITEM 9 *	N	0.57	0.62	-0.05
	ITEM 10 *	N	0.47	0.42	-0.03
	ITEM 11	P	0.49	0.26	0.32
	ITEM 12	P	0.58	0.34	0.43
	ITEM 13	P	0.34	-0.04	0.50
	ITEM 14 *	N	0.35	0.48	0.04
	ITEM 15	P	0.45	0.28	0.40
	ITEM 16	P	0.35	0.00	0.61
	ITEM 17 *	P	0.18	0.13	0.20
	ITEM 18 *	N	0.32	0.36	-0.04
	ITEM 19 *	P	0.45	0.40	0.43
	TOTAL SCALE		ALPHA=.74		

* ITEMS OMITTED AFTER RELIABILITY AND FACTOR ANALYSIS

TABLE 3

FINAL CORRECTED ITEM-TOTAL SCALE CORRELATIONS AND FACTOR LOADINGS

TRY OUT STUDY

	MEASURE	POS-NEG	I-T COR	FACTOR LOADINGS FACT 1	FACT 2
PERSONAL SCIENCE TEACHING EFFICACY BELIEF SCALE ITEMS	ITEM 5	P	0.57	0.65	-0.21
	ITEM 6	N	0.68	0.72	0.08
	ITEM 7	N	0.53	0.54	0.20
	ITEM 9	P	0.57	0.62	0.10
	ITEM 11	N	0.57	0.63	-0.02
	ITEM 12	N	0.65	0.72	-0.11
	ITEM 14	P	0.77	0.80	0.17
	ITEM 16	N	0.51	0.60	-0.18
	ITEM 17	N	0.69	0.75	-0.14
	ITEM 18	P	0.54	0.59	0.03
	ITEM 19	N	0.63	0.70	0.06
	ITEM 20	N	0.51	0.58	0.03
	ITEM 21	N	0.64	0.69	-0.01
	ITEM 22	P	0.65	0.69	0.18
	ITEM 23	N	0.75	0.79	0.12
	TOTAL SCALE		ALPHA=.91		
SCIENCE TEACHING OUTCOME EXPECTANCY SCALE ITEMS	ITEM 1	P	0.50	-0.17	0.67
	ITEM 2	P	0.37	-0.11	0.53
	ITEM 3	P	0.38	0.07	0.47
	ITEM 11	P	0.37	0.16	0.51
	ITEM 12	P	0.37	0.27	0.49
	ITEM 13	P	0.53	-0.11	0.69
	ITEM 15	P	0.37	0.21	0.55
	ITEM 16	P	0.50	-0.07	0.71
	TOTAL SCALE		ALPHA=.73		

Figure A.

Factor Plot of Final Factor Analysis Results
Try Out Study

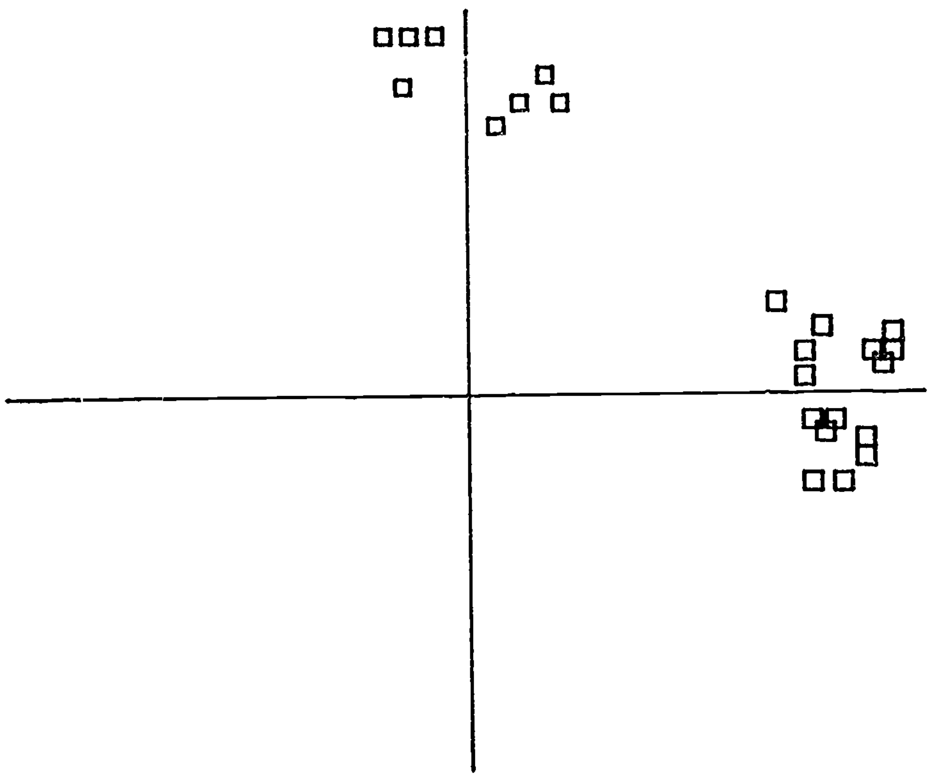

TABLE 4
DEMOGRAPHIC CHARACTERISTICS OF MAIN STUDY SUBJECT SAMPLE
AND BREAKDOWNS OF SCALE SCORES BY SUBGROUPS
(N = 332)

VARIABLE	N	%	MEAN SESCALE	MEAN OESCALE
GENDER				
FEMALE	288	88%	55.48	49.41
MALE	39	12%	58.90 *	50.10
RACE				
WHITE	302	98%	SAMPLE INADEQUATE	
BLACK	4	1%		
OTHER	2	1%		
GRADE TAUGHT				
KINDERGARTEN	26	8%	58.52	48.58
FIRST	52	16%	55.88	49.28
SECOND	48	15%	54.70	50.96
THIRD	44	13%	54.38	49.75
FOURTH	57	17%	57.51	49.64
FIFTH	51	16%	55.54	49.00
SIXTH	40	12%	55.44	48.49
COMBINATION	11	3%	56.54	48.09
YEARS TAUGHT				
1 - 5	53	17%	54.86	49.75
6 - 10	54	17%	53.77	50.08
11 - 15	58	18%	54.95	50.25
16 - 20	62	19%	57.57	48.68
21 - 25	60	19%	56.54	48.75
26 - 30	23	7%	57.[illegible]3	49.83
> 30	11	3%	59.91	48.45
DISTRICT SIZE				
< 200	7	2%	58.86	50.17
200 - 399	1	0%	56.00	50.00
400 - 999	26	8%	53.24	47.04
1000 - 1799	20	6%	55.20	49.84
1800 - 4999	24	7%	55.50	49.50
5000 - 9999	6	2%	54.80	48.75
> 10,000	246	75%	56.24	49.64

* Significantly different at the .05 level (SESCALE only)

TABLE 5
INITIAL MEANS AND STANDARD DEVIATIONS
MAIN STUDY

	MEASURE	POS-NEG	MEAN	STD DEV
PERSONAL	ITEM 1	P	3.80	0.91
SCIENCE	ITEM 2	N	3.38	1.11
TEACHING	ITEM 3 *	N	4.14	0.73
EFFICACY	ITEM 4	P	3.73	0.83
BELIEF	ITEM 5	N	3.52	0.96
SCALE	ITEM 6	N	3.84	0.89
ITEMS	ITEM 7	P	3.80	0.83
	ITEM 8 *	N	3.56	1.08
	ITEM 9	N	3.63	0.93
	ITEM 10	P	3.78	0.77
	ITEM 11	N	3.49	1.01
	ITEM 12	N	3.41	1.14
	ITEM 13	N	3.73	0.80
	ITEM 14	P	4.22	0.63
	ITEM 15	N	3.76	0.86
	TOTAL SCALE		55.80	9.19
SCIENCE	ITEM 1	P	3.71	0.93
TEACHING	ITEM 2 *	N	4.08	0.92
OUTCOME	ITEM 3	P	3.77	0.83
EXPECTANCY	ITEM 4	P	3.06	0.97
SCALE	ITEM 5	P	3.90	0.69
ITEMS	ITEM 6	N	2.77	0.87
	ITEM 7	P	3.62	0.77
	ITEM 8 *	P	3.68	0.84
	ITEM 9	N	3.53	0.95
	ITEM 10	P	3.50	0.80
	ITEM 11	P	3.50	0.78
	ITEM 12	P	3.77	0.70
	ITEM 13	N	3.57	0.88
	ITEM 14	N	3.00	1.03
	TOTAL SCALE		49.46	5.95

* ITEMS OMMITTED AFTER RELIABILITY AND FACTOR ANALYSIS

TABLE 6
INITIAL CORRECTED ITEM-TOTAL SCALE CORRELATIONS
MAIN STUDY

	MEASURE	POS-NEG	I-T CORR
PERSONAL	ITEM 1	P	0.53
SCIENCE	ITEM 2	N	0.64
TEACHING	ITEM 3 *	N	0.41
EFFICACY	ITEM 4	P	0.65
BELIEF	ITEM 5	N	0.62
SCALE	ITEM 6	N	0.64
ITEMS	ITEM 7	P	0.70
	ITEM 8 *	N	0.47
	ITEM 9	N	0.72
	ITEM 10	P	0.62
	ITEM 11	N	0.69
	ITEM 12	N	0.66
	ITEM 13	N	0.69
	ITEM 14	P	0.59
	ITEM 15	N	0.68
	TOTAL SCALE		ALPHA=.91
SCIENCE	ITEM 1	P	0.39
TEACHING	ITEM 2 *	N	0.14
OUTCOME	ITEM 3	P	0.43
EXPECTANCY	ITEM 4	P	[illegible]7
SCALE	ITEM 5	P	[illegible]
ITEMS	ITEM 6	N	[illegible]
	ITEM 7	P	0.35
	ITEM 8 *	P	0.25
	ITEM 9	N	0.41
	ITEM 10	P	0.48
	ITEM 11	P	0.58
	ITEM 12	P	0.43
	ITEM 13	N	0.38
	ITEM 14	N	0.34
	TOTAL SCALE		ALPHA=.76

* ITEMS OMMITTED AFTER RELIABILITY AND FACTOR ANALYSIS

TABLE 7
Final Scales

Please indicate the degree to which you agree or disagree with each statement below by circling the appropriate letters to the right of each statement.

SA = STRONGLY AGREE
A = AGREE
UN = UNCERTAIN
D = DISAGREE
SD = STRONGLY DISAGREE

1.	When a student does better than usual in science, it is often because the teacher exerted a little extra effort.	SA A UN D SD
2.	I am continually finding better ways to teach science.	SA A UN D SD
3.	Even when I try very hard, I do not teach science as well as I do most subjects.	SA A UN D SD
4.	When the science grades of students improve, it is often due to their teacher having found a more effective teaching approach.	SA A UN D SD
5.	I know the steps necessary to teach sc[illegible]e concepts effectively.	SA A UN D SD
6.	I am not very effective in monitoring science experiments.	SA A UN D SD
7.	If students are underachieving in science, it is most likely due to ineffective science teaching.	SA A UN D SD
8.	I generally teach science ineffectively.	SA A UN D SD
9.	The inadequacy of a student's science background can be overcome by good teaching.	SA A UN D SD
10.	The low science achievement of some students cannot generally be blamed on their teachers.	SA A UN D SD
11.	When a low-achieving child progresses in science, it is usually due to extra attention given by the teacher.	SA A UN D SD
12.	I understand science concepts well enough to be effective in teaching elementary science.	SA A UN D SD
13.	Increased effort in science teaching produces little change in some students' science achievement.	SA A UN D SD

14. The teacher is generally responsible for the achievement of students in science. SA A UN D SD

15. Students' achievement in science is directly related to their teacher's effectiveness in science teaching. SA A UN D SD

16. If parents comment that their child is showing more interest in science at school, it is probably due to the performance of the child's teacher. SA A UN D SD

17. I find it difficult to explain to students why science experiments work. SA A UN D SD

18. I am typically able to answer students' science questions. SA A UN D SD

19. I wonder if I have the necessary skills to teach science. SA A UN S SD

20. Effectiveness in science teaching has little influence on the achievement of students with low motivation. SA A UN D SD

21. Given a choice, I would not invite the principal to evaluate my science teaching. SA A UN D SD

22. When a student has difficulty understanding a science concept, I am usually at a loss as to how to help the student understand it better. SA A UN D SD

23. When teaching science, I usually welcome student questions. SA A UN D SD

24. I do not know what to do to turn students on to science. SA A UN D SD

25. Even teachers with good science teaching abilities cannot help some kids to learn science. SA A UN D SD

TABLE 8

FINAL CORRECTED ITEM-TOTAL SCALE CORRELATIONS AND FACTOR LOADINGS

MAIN STUDY

	MEASURE	POS-NEG	I-T CORR	FACTOR LOADINGS FACT 1	FACT 2
PERSONAL	ITEM 1	P	0.53	0.54	0.07
SCIENCE	ITEM 2	N	0.64	0.67	-0.02
TEACHING	ITEM 4	P	0.66	0.69	0.04
EFFICACY	ITEM 5	N	0.62	0.64	0.04
BELIEF	ITEM 6	N	0.65	0.68	-0.04
SCALE	ITEM 7	P	0.71	0.75	0.00
ITEMS	ITEM 9	N	0.72	0.75	0.05
	ITEM 10	P	0.62	0.67	-0.01
	ITEM 11	N	0.70	0.76	-0.09
	ITEM 12	N	0.65	0.69	-0.07
	ITEM 13	N	0.68	0.72	-0.07
	ITEM 14	P	0.60	0.60	0.08
	ITEM 15	N	0.67	0.69	0.02
	TOTAL SCALE	N	ALPHA=.92		
SCIENCE	ITEM 1	P	0.37	0.06	0.44
TEACHING	ITEM 3	P	0.44	-0.05	0.53
OUTCOME	ITEM 4	P	0.49	-0.14	0.57
EXPECTANCY	ITEM 5	P	0.31	0.07	0.35
SCALE	ITEM 6	N	0.36	-0.07	0.39
ITEMS	ITEM 7	P	0.36	-0.03	0.43
	ITEM 9	N	0.40	0.08	0.41
	ITEM 10	P	0.49	-0.01	0.61
	ITEM 11	P	0.58	-0.05	0.70
	ITEM 12	P	0.44	-0.01	0.52
	ITEM 13	N	0.36	0.16	0.35
	ITEM 14	N	0.35	0.04	0.37
	TOTAL SCALE		ALPHA=.77		

Figure B.

Factor Plot of Final Factor Analysis Results
Main Study

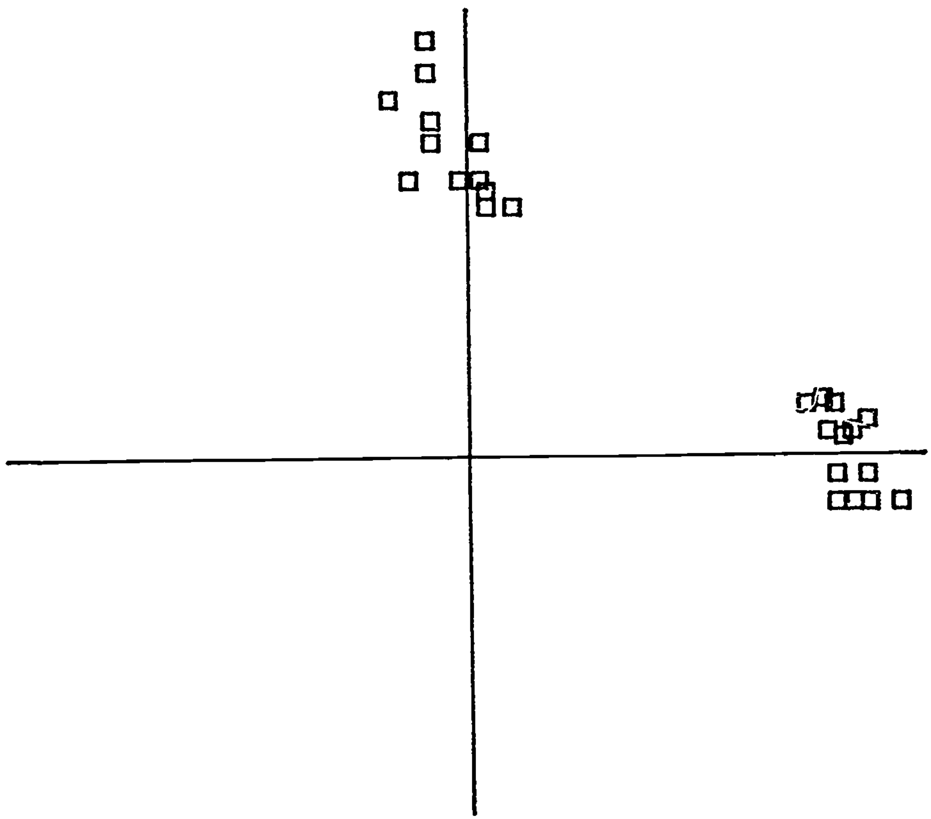

TABLE 9
VALIDITY COEFFICIENTS: MAIN STUDY
(N = 305) ***

VALIDITY CRITERIA	SESCALE r	OESCALE r
YEARS EXPERIENCE AS A TEACHER	.14 **	-.07
CHOICE OF TEACHING SCIENCE	.57 **	.08
TIME TEACHING SCIENCE	.41 **	.15 **
USE OF ACTIVITY-BASED TEACHING	.35 **	.03
SCIENCE TEACHING SELF RATINGS	.66 **	.18 **
SUBJECT PREFERENCE	.57 **	.12 *
PRINCIPAL RATING	.31 *	.00
SESCALE		.19 **
OESCALE	.19 **	

* $p < .06$
** $p < .01$
*** N for the principal rating coefficient was only 28.

SCORING INSTRUCTIONS FOR THE "STEBI"

Step 1. Reverse Selected Response Values

The following items must be reverse scored in order to produce consistent values between positively and negatively worded items. Reversing the scores on these items will produce high scores for those high and low scores for those low in efficacy and outcome expectancy beliefs.

item 1	item 9	item 15
item 2	item 11	item 16
item 4	item 12	item 18
item 5	item 14	item 23
item 7		

In SPSSx, this reverse scoring is easily accomplished with the "RECODE" command. For example, recode item 1 with the following command:

```
RECODE  ITEM1 (5=1) (4=2) (2=4) (1=5)
```

Step 2. Sum Scale Items

Items from the two scales are scattered randomly throughout the STEBI. The scale designed to measure efficacy beliefs consists of:

item 2	item 12	item 21
item 3	item 17	item 22
item 5	item 18	item 23
item 6	item 19	item 24
item 8		

The scale for outcome expectancies consists of:

item 1	item 10	item 15
item 4	item 11	item 16
item 7	item 13	item 20
item 9	item 14	item 25

In the computer program, do <u>NOT</u> sum scale scores before the RECODE procedures have been completed. In SPSSx, this summation may be accomplished by the following COMPUTE commands:

```
COMPUTE  ESCALE=ITEM2+ITEM3+ITEM5+ITEM6+ITEM8+ITEM12+ITEM17+
          ITEM18+ITEM19+ITEM21+ITEM22+ITEM23+ITEM24
COMPUTE  OESCALE=ITEM1+ITEM4+ITEM7+ITEM9+ITEM10+ITEM11+ITEM13+
          ITEM14+ITEM15+ITEM16+ITEM20+ITEM25
```