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ABSTRACT

This report presents the results of a mail survey conducted to ascertain Texas elementary teachers' opinions of their level of preparedness to implement the Texas Essential Knowledge and Skills (TEKS) science curriculum. Most of the teachers (89%) had read the TEKS science curriculum requirements, and many (55.9%) did not think the requirements would place an undue or unattainable burden on them. Teachers were almost evenly split on whether or not they felt prepared to teach the material mandated by the requirements, and a majority (64%) felt they were not adequately prepared by their college education. About one half of the teachers believed they were adequately trained in these science process skills and had actual practice in the use of the scientific method. Most of the teachers (68.5%) reported that they were already teaching TEKS, and only 40% believed more science teaching would result from the new curriculum. (WRM)

NORTH TEXAS TEACHERS' PREPARATION TO IMPLEMENT THE TEXAS SCIENCE CURRICULUM (TEKS)

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NORTH TEXAS TEACHERS' PREPARATION TO IMPLEMENT THE TEXAS SCIENCE CURRICULUM (TEKS)

The National Science Education Standards and Project 2061 have created an impetus for changing the way science is taught at the elementary school level. States throughout the nation have attempted to follow suit with revision of their science curriculum. The Texas Essential Knowledge and Skills (TEKS) is the new curriculum for the state as of September 1, 1998. Prior to implementation, the TEKS underwent rigorous development by teams of teachers, curriculum specialists, university professors, business people, parents, and other professionals. The resulting drafts underwent an arduous review, criticism, and rewrite. The required science TEKS emphasize both science content knowledge and the use of science process skills. Science inquiry and process skills include such activities as constructing hypotheses, experimental design, eliminating variables, gathering data, analyzing data, replicating results, and deriving appropriate conclusion. The science TEKS follow the National Science Education Standards in the emphasis of science inquiry as a chief means for science instruction and differ significantly from the prior curriculum in this regard. As a new curriculum was being implemented without widespread professional development related to the curriculum, the issue of elementary teachers' ability to successfully implement the curriculum came into question.

Ogden, Horn, and Chao (1992)in a earlier survey concluded that science teachers in Northeast Texas are willing, but perhaps uninformed and undersupplied who tend to teach largely by lecture or demonstration. This type of teaching is not in line with the demands of the new curriculum which advocates inquiry-based science. Northeast Texas elementary teachers are not unlike teachers throughout the nation. Elementary school teachers are often ill-prepared to teach science due to the limited nature of their science background (Czerniak, 1989). The few science courses they take usually consist of lecture/memory format with little (if any) opportunity to develop abilities in science process skills and inquiry-based science. Often, science teachers perceive that they do not have the ability to bring about change due to lack of resources, administrative organization, and lack of staff development (Haney, Czerniak, & Lumpe, 1996).

Of primary focus in the TEKS science requirements is use of science process skills, such has forming hypotheses, designing experiments, controlling variables, doing replicates, and forming reasonable conclusions. If teachers expect students to be able to learn the processes of science, they must have a command of the process skills themselves (Radford, et. al. 1992). The "Test of Integrated Process Skills" (TIPS) was developed to evaluate ability in using science process skills (Dillashaw and Okey's, 1980). Versions of the TIPS test have been used with various populations, including preservice teachers (see for example, Downing & Gifford, 1996; & Downing, Filer, & Chamberlain, 1997). The assumption was made that this test would be appropriate for inservice teachers as well.

METHODOLOGY

A mail survey was conducted to ascertain the teachers' opinion of their level of preparedness to implement the TEKS and to test their understanding of science process skills. Questionnaires were sent to three randomly-chosen elementary or intermediate school in each of the 15 northeast Texas counties. A packet of ten surveys were sent to the principal of each school with a request for permission to use their school as part of the survey. If they agreed, the surveys were distributed to teachers within the school and returned anonymously. A total of 450 questionnaires were mailed to 45 schools. The survey (appendix 1) was developed by the researchers and intended to capture the teachers' self-reported perception of their ability to implement the TEKS, along with demographic information.

In order to determine the teachers' understanding and abilities in science process skills, a modified version of the TIPS test was included with the survey. The test (appendix 2) was a limited version of the TIPS test with seven multiple-choice questions covering several aspects of science process skills, specifically questions concerning hypotheses, control variables, independent and dependent variables, graphing, and forming conclusions. While a longer test would have given more reliable information, the decision was made to use the shorter version in order to increase the return rate.

RESULTS

Demographic information gathered from the survey indicate that the population was similar in many respects to widely held perceptions about elementary science teachers. The population was largely female (94.6%) and Caucasian (96.4%). This relatively low ethnic diversity is typical of the general population of northeast Texas. Age levels of the teachers were fairly evenly distributed with 15 – 30% in their twenties, thirties, forties and fifties and less than 4% in their sixties.

Professional Demographic questions included teachers' years of experience, degree status, years since last college course (Table 1). Approximately 50% had 10 or fewer years of teaching experience. Only 33.3% had last attended any type of college science course within the last five years, while 30% had not attended a college science course for 12 years or more. Most teachers possessed Bachelors degrees (65.8%), while 34.2% had earned a Masters degree.

Table 1: Teachers' Professional Demographics

Years Experience		Degree Status		Years since last college science course		
< 1	-- 2.7%	Bachelor's Degrees		0-2	20 =	18.0%
1-5	-- 22.5%	B. in Educ.	25 = 22.5%	3-5	17 =	15.3%
6-10	-- 22.5%	BA or BS	13 = 11.7%	6-8	20 =	18.0%
11-15	-- 22.5%	Bachelor's plus	35 = 31.5%	9-11	20 =	18.0%
16-20	-- 9.9%	Total	73 = 65.8%	12+	34 =	30.6%
21	--19.8%					
		Master's Degrees				
		M. in Educ.	17 = 15.3%			
		MA or MS	11 = 9.9%			
		Master's plus	10 = 9.0%			
		Total	38 = 34.2%			
		Working on doctorate	0			

Teachers were also asked about the number of college courses completed in each of several science areas. The results of this question are shown in Table 2. It is clear that the majority of teachers have had between one and three courses in science teaching, general Earth science, and biological sciences, but most have not had even a single course in chemistry, physics, or specific areas of the Earth sciences. Twenty one percent had not had even a single course focusing on science teaching.

School setting and grades the teachers taught were also identified. Most of the teachers (96.1%) reported their schools as being rural, with the remaining reporting urban or suburban schools. Just over half (56.8%) of the teachers taught K–3, while 37.8% taught grades 4–5, and only 9.9% taught 6–8. The low number of 6-8 grade teachers is an artifact of the school selection process which focused on elementary and intermediate schools. These percentages total over 100% due to reported teaching in multiple categories.

Table 2: Number of College Courses Completed in Science Subjects

Biological Science	Chemistry	Physics
0 20 = 18.0%	0 84 = 75.7%	0 87 = 78.4%
1 38 = 34.2%	1 17 = 15.3%	1 16 = 14.4%
2-3 40 = 36.0%	2-3 7 = 6.3%	2-3 6 = 5.4%
4+ 13 = 11.7%	4+ 3 = 2.7%	4+ 2 = 1.8%
General Earth Science	Geology	Astronomy
0 37 = 33.3%	0 79 = 71.2%	0 93 = 83.8%
1 43 = 38.7%	1 22 = 19.8%	1 18 = 16.2%
2-3 25 = 22.5%	2-3 9 = 8.1%	2-3 0
4+ 6 = 5.4%	4+ 1 = 0.9%	4+ 0
Science teaching	Meteorology	Oceanography
0 24 = 21.6%	0 97 = 87.4%	0 104 = 93.7%
1 61 = 55.0%	1 13 = 11.7%	1 7 = 6.3%
2-3 24 = 21.6%	2-3 1 = 0.9%	2-3 0
4 2 = 1.8%	4+ 0	4+ 0

Self-Assessment for TEKS Preparation

Many teachers said they didn't know *anything* about the TEKS curriculum changes until they reported back to school in August of 1998, although the TEKS had been officially adapted by the State Board of Education in July of 1997. They were thus faced, completely by surprise, with the onerous task of reevaluating and possibly revamping of their course material as the school year began.
Table 3 contains the results of the TEKS preparedness questions. Most of the teachers (89%) had read the TEKS science curriculum requirements by the time they were presented with our questionnaire in November 1998. Many teachers (55.9%) did not think the requirements would place an undue or unattainable burden on them. Teachers were almost evenly split on whether or not they felt prepared to teach the material mandated by the requirements, and a majority (64.0%) felt they were not adequately prepared by their college education. About one-half of the teachers believed they were adequately trained in these science process skills and had actual practice in the use of the scientific method. Most teachers (68.5%) reported that they were already teaching the TEKS and only 40% believed more science teaching would result from the new curriculum.

Table 3: Teachers Assessment of Preparedness for teaching TEKS science requirements

Question	Yes	No	Undecided/ No answer
1. Read TEKS?	89.2%	9.0%	1.8%
2. Undue burden?	38.7%	55.9%	5.4%
3. Currently prepared	52.3%	46.8%	0.9%
4. Adequately prepared by college?	34.2%	64.0%	1.8%
5. Trained in science process skills?	50.5%	46.8%	2.7%
6. Practiced in scientific method?	45.0%	54.1%	0.9%
7. Already teaching TEKS?	68.5%	27.0%	4.5%
8. Will TEKS increase science teaching?	40.5%	56.8%	2.7%

Science Process Skills Test

The seven multiple-choice questions covered several aspects of science process skills, specifically questions concerning hypotheses, control variables, independent and dependent variables, graphing, and forming conclusions. The teachers responding the survey did not have a very good command of the process skills as measured by this test. The mean score on the test was 49.2%. Only one of the seven questions was answered correctly by over 70% of respondents. The question with the highest percentage (80.2%) correct answers dealt with graphing, while the lowest were control variables (23.4%) and hypotheses (34.2%).

Table 6: Science Process Skills—Content Test

Question Topic	Number correct
Hypotheses	38 = 34.2%
Control variables	54 = 48.6%
Control variables	26 = 23.4%
Dependent variables	62 = 55.9%
Independent variables	68 = 61.3%
Graphing	89 = 80.2%
Drawing Conclusions	45 = 40.5%
Total Mean Score = 49.2%	Standard deviation = 23.0

DISCUSSION

There are several issues that serve as limitations for this study. The low return rate of 25% is a concern; however, this may not represent an actual return rate. The method of distributing the surveys through the principal does not guarantee that all surveys were received by teachers. Additionally, some of the smaller schools may not have had enough teachers in order to complete the ten surveys included in each mailing. Although there is no way to determine the impact of these items, including these factors would likely increase the return rate. The limited number of items on the modified TIPS is an area of concern. However a longer test would possibly not have been completed by many of the teachers.

The science background and teaching experience of these teachers is similar to results from other studies. Rural teachers are less likely to have advanced degrees and have taken fewer science courses (Carlsen & Monk, 1992). Teachers in rural schools often do not have the opportunities to attend professional development and interact with other teachers. This may have been a contributing factor to the unpreparedness to implement the TEKS. Small schools often adopt the same programs and practices as larger schools without undergoing the development process often present with the adoption (Shroyer & Enochs, 1987). While many of the teachers felt they were already implementing the TEKS, observations by the authors do not support this feeling. Most science teaching (when science is taught) in the area consists of reading, demonstration, and teacher-directed activities. Although the content may be covered, it is not covered in ways consistent with the inquiry-based TEKS.

The results of the modified TIPS test are not surprising. Elementary teachers' lack of experience in "science as inquiry" or "science as process" would not lead to abilities in this area. Many teachers science learning experiences consist almost totally of lecture/memory courses with little experience in utilizing the processes of science.

A newly NSF funded Rural Systemic Initiative is being implemented in several of the counties in the surveyed population. This initiative will likely have an impact on the teachers attitude toward and abilities to implement the science TEKS through inquiry-based science as well as the content covered.

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Appendix 1

The following questions ask you to assess your own abilities and preparation for implementing the TEKS science curriculum requirements.

1. Have you read the TEKS science curriculum requirements for the grades you teach?

   Yes No Comment:

2. Do you feel that the new TEKS science curriculum requirements will place an undue or unattainable burden on Texas elementary school teachers?

   Yes No Comment:

3. Do you feel adequately prepared at the present time to teach these science curriculum requirements?

   Yes No Comment:

4. Do you feel that you were adequately prepared by your college education to teach these science curriculum requirements?

   Yes No Comment:

5. Do you believe that, as a result of the TEKS science curriculum requirements, you will be teaching more science in you classrooms than you did previously?

   Yes No Comment:

6. Have you been adequately (in your opinion) trained in the use of science process skills (forming hypotheses, identifying variables, drawing conclusions, etc.)?

   Yes No Comment:

7. Have you had sufficient actual practice in using the scientific method, so that you will feel comfortable in teaching it?

   Yes No Comment:

8. Have you already been teaching most of the concepts and the science process skills stipulated within the TEKS science curriculum requirements?

   Yes No Comment:

<u>Further Comments</u>:

The following questions relate to science process skills, and will help us in further evaluating Texas elementary teachers degree of preparation for teaching the TEKS science curriculum requirements. Please answer to the best of your ability:

_____ 9. Becky delivers what she considers a clear, well organized lecture, but she notices than no one is asking questions. She hypothesizes that the reason no one is asking questions is that the class understands the material. She gives a test covering the material, and determines that, if the class average is 85% or higher, then the class did understand the material. Once the test is graded, the teacher finds that the class average is 65%. Which of the following is a valid conclusion on the basis of this test?

(a) The reason that no one was asking questions is that they didn't understand the material.
(b) Not asking questions indicates that the class doesn't understand the material.
(c) Not asking questions does not indicate that the class understands the material.
(d) Asking or not asking questions has no relationship to whether or not the class understands the material.

Jim wanted to study the affect of water on plant growth. He planted 20 bean seeds in 20 separate small clay flower pots, filling 10 of them with sand (to allow water to run through rapidly), and 10 with loam (which would retain the water for a longer time). He set all 20 pots in the same window, allowing each the same amount of light each day. The seeds in the sand were watered with 1/4 cup of water per day, while the seeds in loam were watered with 1/2 cup of water each day. At the end of 20 days, Jim weighed each plant.

_____ 10: What is the hypothesis being tested?

(a) Plants grow better in loam than in sand.
(b) Plants given more water will grow better than plants given less water.
(c) Loam retains water better than sand.
(d) Plants grown in sand require less water than plants grown in loam.

_____ 11. Which of the following was a control variable?

(a) Amount of water given each plant.
(b) Type of soil in which each plant grew.
(c) Weight of each plant at the end of 20 days.
(d) The amount of light allowed each plant.

_____ 12. Which of the following was the independent or manipulated variable?

(a) Amount of water given each plant.
(b) Type of soil in which each plant grew.
(c) Weight of each plant at the end of 20 days.
(d) The amount of light allowed each plant.

_____ 13. Which of the following was the dependent or responding variable?

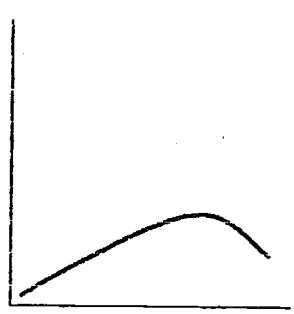
(a) Amount of water given each plant.
(b) Type of soil in which each plant grew.
(c) Weight of each plant at the end of 20 days.
(d) The amount of light allowed each plant.

____ 14. Which of the following should have been a control variable, but was not?
(a) Amount of water given each plant.
(b) Type of soil in which each plant grew.
(c) Weight of each plant at the end of 20 days.
(d) The amount of light allowed each plant.

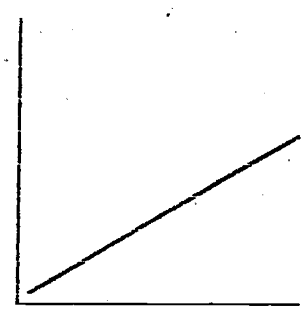
In another experiment, Daphnia watered several bean plants with varying amounts of water. At the end of 20 days, she weighed the plants and gathered the following data:

Amount of water	Weight of plant
1 teaspoon	.25 oz
2 teaspoon	.28 oz
3 teaspoons	.36 oz
4 teaspoons	.5 oz
5 teaspoons	.8 oz
6 teaspoons	1.1 oz
7 teaspoons	.75 oz
8 teaspoons	.31 oz

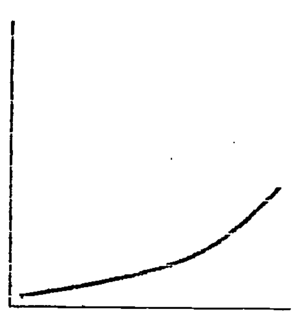
____ 15. Which of the following graphs most accurately represents the data?



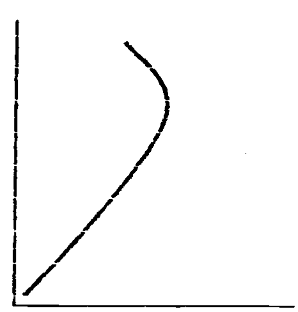
graph 1



graph 3



graph 2



graph 3

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