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ABSTRACT

Any effort to reform science education in the schools must include input from the nation's science teachers concerning what they need to do in order to improve instruction and student performance. Science teachers in rural schools have many needs that differ from those in more urbanized areas. A survey of science teachers in Arkansas, Illinois, Oklahoma, Kansas, Tennessee, and Texas secured responses from 1,507 teachers, about one third of those surveyed. More than half of teachers in five states were over 40 years old. Over half of teachers in all states had more than 10 years experience, and over 25 percent in five states had more than 20 years experience. In all states except Kansas, the majority held a master's degree or higher. Percentage of respondents teaching in a rural area or small town was 62-89 percent. The majority of teachers in four states had three or more daily class preparations, and 62 percent of Kansas teachers had over four. In four states, over half of respondents reported that their equipment and supplies were nonexistent or barely adequate, over 40 percent had no computers for student use, and 21-34 percent did not have laboratory classes. In all states, science instructional resources were rated as inadequate or poor by 34-63 percent of respondents. With regard to instructional strategies, a large majority used lecture, demonstration, and cooperative learning; 33-53 percent never used peer teaching. Results indicate a widespread need for equipment, supplies, materials, and planning time. Without these things, little science can be done in the classroom. Instead, science as product will be read. (SV)

RURAL SECONDARY SCHOOL SCIENCE TEACHERS: WHAT THEY NEED TO BE SUCCESSFUL

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"Schools asked to make science meaningful" was the headline from USA Today on October 26,1993. The accompanying article summarized highlights of the American Academy of Science's recommendations for the science curriculum in the nation's schools which were delineated in The Benchmarks for Science Literacy. A primary recommendation of the academy was to reduce the scope of the science curriculum, to teach fewer things but teach them better. This newspaper article was similar to other popular press reports which identified problems and suggested solutions to the problems in science instruction in the nation's schools.

The popular press has not had a monopoly on pointing out the problems of teaching science in American schools. A review of professional literature consistently showed that American students were not performing well in the science curriculum. Accounts of American students' poor performance in science were documented by a variety of sources including the Holmes Group (1986), and the Carnegie Forum on Education and the Economy (1986). These widely read reports have impacted the nation's educational and political policy makers.

These policy makers are acutely aware of the poor performance of American students in science and are cognizant of the ramifications of failing to correct this problem. They are aware that the security and economic well-being of the nation are at-risk if this problem is not ameliorated.

Many different groups and individuals have offered suggestions regarding the causes of students' low performance in science. These individuals and groups have also proposed changes in the science curriculum which they believe would enhance the science achievement of American students. While these recommendations are

somewhat diverse, one thread of commonalty is the need to focus the reform efforts upon the nation's science teachers. This appears to be a reasonable approach for any program designed to improve the performance of American students.

For a reform program to be implemented successfully in the science curriculum, the reform program must have the support of the teachers whose lives and careers will be impacted by the project. Theorists and practitioners are aware that people tend to support that which they help create (Campbell, 1985) and that efforts to impose changes upon participants without their support frequently result in behaviors which ensure the failure of that project. Therefore, any efforts to reform the science curriculum in the schools must focus upon the nation's science teachers and include significant input from them concerning what they need to improve their instruction and their students' performance.

This need for securing input from teachers prior to proposing changes in their curriculum is particularly important for projects that involve rural schools. Science teachers who work in a rural setting have problems that are not often experienced by their urban and suburban counterparts. Lomtey and Swanson (1989) compared rural and urban schools and found that rural schools' financial support was generally less than that of urban schools and that the rural schools' curricula were frequently more limited than that of their urban counterparts. Nachtdigal (1982) reported that when the accepted standards of excellence typically employed by accrediting agencies--teacher certification standards, course offerings, library services and per child expenditures--are used to compare urban and rural schools, rural schools rarely compare favorably to urban schools.

It appears that the teachers of science in the rural schools have many, and somewhat different, challenges in their efforts to provide a science curriculum that will provide appropriate opportunities for their students to successfully master the content and skills deemed crucial in today's world. The purpose of this study was to determine the needs of rural science teachers. This paper addresses the demographics of the respondents and selected findings of the study.

This study originated at a professional conference when a group of science educators discussed the problems of teaching science in rural schools. This group chose to continue their discussion at a later time and to form an organization which was devoted to the issues associated with teaching science in rural schools. The organization became known as The National Committee for the Study of Options for a Rural Science Agenda. The group concluded that the most effective method of determining the needs of rural science teachers was to survey a large group of those teachers from a wide geographic area.

The survey instrument chosen for this study was adapted from a needs assessment instrument with established validity and reliability, the Moore Assessment Profile (Moore's 1977). This instrument was revised by Zuiub and Rubba (1983), and this version was named the Science Teacher Inventory of Needs (STIN). The STIN was revised by Baird and Rowsey (1989) and became the STIN 2. According to Baird and Rowsey, this survey instrument maintained validity and reliability when field-tested on 40 secondary science teachers. The instrument was revised again by The National Committee for the Study of Options for A Rural Science Agenda in 1991, using adaptation procedures similar to those employed by Baird and Ramsey, and is

known as STIN 3.

The National Committee for the Study of Options for a Rural Science Agenda attempted to survey states from a geographic area of the nation that contained rural schools. The STIN 3 was administered to science teachers from Arkansas, Illinois, Oklahoma, Kansas, Tennessee and Texas in 1991 and 1992. By July 30,1992, responses were secured from 1507 teachers, approximately one-third of those surveyed.

The STIN 3 survey instrument provided researchers with data, including demographic information, about the science teachers who responded to the survey. An analysis of the demographic data revealed that the science teachers were varied in several respects. The first five tables report demographic information regarding the subjects' gender, age, experience, degree level, and school type in percentages and state-by-state for the 1507 science teachers studied. Table 1 provides a summary of gender differences of the science teachers included in this study.

Table 1
Gender Percentages By State

State	Male	Female
ARKANSAS	67.3	32.7
ILLINOIS	38.4	61.6
OKLAHOMA	47.5	52.5
KANSAS	68.4	31.6
TENNESSEE	59.5	40.0
TEXAS	56.8	49.2

The percentages of science teachers in varying age ranges are found in Table2. An inspection of the table reveals a "slight" graying of the force, although it is somewhat less pronounced in Kansas and Oklahoma. Overall, there is consistency among the states.

Table 2
Age Range Percentages By State

State	<24	25-30	31-40	41-50	>50
ARKANSAS	0.0	7.1	27.7	43.8	21.4
ILLINOIS	1.6	10.1	25.4	44.0	18.9
OKLAHOMA	5.0	15.4	34.6	35.0	10.0
KANSAS	3.3	12.3	32.5	32.0	20.0
TENNESSEE	0.5	9.5	31.5	40.5	18.0
TEXAS	3.3	10.9	31.1	42.1	12.6

Table 3 contains information about the experience levels of the science teachers included in this study. This table corroborates the aging aspect noticed in Table 2

Table 3
Years of Experience In Percentages By State

State	<3	4-10	11-20	21-30	>30
ARKANSAS	4.5	23.2	47.3	22.3	2.7
ILLINOIS	3.2	15.8	32.8	35.2	7.9
OKLAHOMA	12.5	31.7	33.8	20.4	1.7
KANSAS	12.5	26.6	35.3	18.3	7.3
TENNESSEE	6.0	27.0	33.0	29.5	3.5
TEXAS	11.5	21.3	41.5	23.5	2.7

Table 4 includes information about the education level of the science teachers who responded to the survey, another concern of the study. All of the states show 50% or more of their science teachers having a master's degree or higher level of education except Kansas where the figure (rounded) is 35%, an interesting finding without a clear rationale.

Table 4
Educational Degree Levels In Percentages By State

State	None	Bacc.	Master	Master +	Higher
ARKANSAS	0.0	48.5	21.6	27.0	2.7
ILLINOIS	0.3	50.1	15.6	34.0	0.0
OKLAHOMA	1.3	46.0	23.4	28.9	0.4
KANSAS	1.0	60.6	10.0	24.4	4.0
TENNESSEE	0.5	36.0	30.0	29.5	3.5
TEXAS	0.5	43.7	23.5	31.1	1.1

Table 5 identifies the type of school in which the science teachers works. The story is told in the numbers of teachers in the rural and small city categories.

Table 5
School Type Percentages By State

State	Rural	Small City	Suburban	Big City	Other
ARKANSAS	52.3	30.6	6.3	9.0	1.8
ILLINOIS	55.0	30.2	7.1	5.2	2.5
OKLAHOMA	18.8	44.2	25.0	11.3	5.0
KANSAS	62.5	26.1	5.0	1.5	5.0
TENNESSEE	42.0	23.0	17.0	16.0	0.5
TEXAS	44.8	31.1	15.8	6.6	1.6

An examination of the data concerning the demographic elements considered in the study shows considerable variation. Tables 1-5 present some of this variation among the responding science teachers in the different states. For example, 68.4 percent of the surveyed science teachers in Kansas were male compared to 38.4 percent in Illinois with, of course, the opposite results for females. Why Illinois varied so much from the other five states is unclear.

Much like the gender variances that were found when a comparison was made among the states, the ages of the subjects also varied from state to state. Twenty-one percent of the teachers in Arkansas were more than 50 years old while Oklahoma only had ten percent of its science teachers in that category. The small percentage of Oklahoma teachers more than 50 years of age impacted the state in the category of over 30 years of teaching experience. Less than two percent of the Oklahoma teachers surveyed had more than 30 years of experience, but nearly four times as many teachers surveyed in Illinois had thirty or more years of experience.

While some of these findings can be easily explained, the researchers do not have the reason(s) for some of the other findings. For example, why did Oklahoma and Texas have the lowest percentages of teachers who were more than 50 years old, and why was there so much variance between Oklahoma and Illinois for the first two and last two categories in Table 3 regarding years of experience? These percentages for Oklahoma are probably attributable to changes in legislation which enabled Oklahoma teachers to retire earlier than had been previously possible.

The gender differences found when Kansas and Illinois were compared were more difficult to understand. A similar number of rural teachers were surveyed in both

states, and the states are in relatively close geographic proximity. There are additional findings in the demographic sections of the study that are not totally understood but which do provide some valuable insights into the needs of science teachers. The nondemographic sections of the study provide further and more direct information about the needs of these rural science teachers.

The survey revealed that a significant portion of the 1507 science teachers prepared and taught several different science courses daily. The difference among the states is conspicuous regarding this factor. For example, 62.3 percent of Kansas science teachers reported that they had more than four different daily preparations while only 8.2 percent of the Texas teachers had to make more than four. This anomaly can be partly explained by noting that in Kansas a much smaller number of secondary teachers were surveyed and/or returned their questionnaires. Table 6 shows the percentages of teachers by state and their respective number of daily preparations.

Table 6
Number of Daily Class Preparations

State	1	2	3	4	>4
ARKANSAS	17.1	26.1	27.0	8.1	21.6
ILLINOIS	13.4	31.0	26.8	16.2	12.6
OKLAHOMA	24.2	37.5	21.3	7.9	9.2
KANSAS	6.3	8.0	11.5	12.0	62.3
TENNESSEE	20.5	33.5	24.5	9.0	12.5
TEXAS	23.0	36.1	17.5	15.3	8.2

Without adequate preparation time, equipment, and supplies, it is not possible

to employ teaching methodology that has been shown to be effective. Without these resources, even a knowledgeable and skilled teacher is severely or totally stymied in attempting to conduct an inquiry lesson. Science as a process will not be conducted either by the teacher or student, but science as a product will be read.

The study revealed that when science teachers were asked to rate the adequacy of their equipment and supplies, more than 50 percent of the teachers from five of the six states indicated that these were nonexistent or barely adequate. Almost 18 percent of the teachers from Arkansas reported that their students did not have access to any science equipment and supplies. Although Illinois and Texas were distinctively ahead in the first category, inspection of the adequate and more than adequate categories shows that no pride should be taken by any of the states. Table 7 provides data concerning the teachers' perception of the adequacy of their science equipment and supplies.

Table 7
Adequacy of Equipment and Supplies

State	None	Barely Adeq.	Adequate	>Adequate	Not Sure
ARKANSAS	17.9	55.4	20.5	5.4	0.9
ILLINOIS	1.9	43.2	41.8	13.1	0.8
OKLAHOMA	10.8	48.8	30.0	9.6	5.0
KANSAS	12.8	45.8	31.0	9.0	1.5
TENNESSEE	9.0	51.5	28.0	9.5	0.5
TEXAS	1.6	42.1	42.6	13.7	0.0

As would be expected, the teachers who reported that the equipment and supplies needed to conduct science classes were nonexistent or barely adequate,

also reported that their students did not have computers to use in their classes. Table 8 presents data about the availability of computers in the science programs surveyed.

Table 8
Number of Computers In Percentages

State	None	1-2	3-4	5-10	>10
ARKANSAS	56.3	25.0	4.5	2.7	11.6
ILLINOIS	28.1	41.0	4.4	4.4	22.1
OKLAHOMA	40.8	26.3	4.2	6.3	22.5
KANSAS	25.9	42.8	5.5	9.1	16.6
TENNESSEE	46.5	27.8	4.0	5.1	16.7
TEXAS	48.1	31.1	3.3	4.4	13.1

Tables six, seven, and eight report data that indicate that many of the science teachers surveyed were asked to make several preparations each day and taught their classes without the equipment and supplies that they deemed necessary. Without adequate preparation time and without appropriate supplies, these teachers are often forced to reduce or eliminate the number of laboratory opportunities for their students. Table 9 presents data about the frequency of these laboratory opportunities.

Table 9
Frequency of Lab Classes In Percentages

State	<1/Mo.	1/Mo.	2/Mo.	Weekly	More
ARKANSAS	34.2	27.0	24.3	12.6	1.8
ILLINOIS	6.6	13.9	29.8	35.5	14.2
OKLAHOMA	20.5	20.1	30.5	15.1	13.8
KANSAS	30.3	16.0	22.3	22.1	9.3
TENNESSEE	22.0	24.0	27.5	19.5	5.0
TEXAS	3.8	3.2	22.4	42.6	23.0

Students must have laboratory classes to learn science effectively, but Table 9 shows that relatively few students are provided with ample opportunities to participate in laboratory classes. These opportunities will probably not be expanded until science teachers are provided with the equipment and supplies needed to conduct laboratory classes and the time to plan those classes.

For progress to be made, the needs of science teachers must be addressed. It is important to recognize that these are not limited to the equipment and supplies, computers, and planning time needed to conduct laboratory experiences for students. The science teachers surveyed in this study also reported that other resources needed for instruction were often inadequate for them to be successful not only in a laboratory setting but also in other instructional settings. Unfortunately, science teachers often find that the only instructional materials provided by the school are textbooks. When the science teachers surveyed were asked to describe the adequacy of science resources, patterns similar to, but not as pronounced as, those regarding equipment and supplies and computers were found. Table 10 presents this information.

Table 10
Science Resources In Percentages

State	Less than Adequate	Poor	Adequate	Very Adeq.	Exceptional
ARKANSAS	21.4	42.0	32.1	2.7	1.8
ILLINOIS	5.2	29.0	48.8	15.9	1.1
OKLAHOMA	13.4	32.8	42.4	10.9	0.4
KANSAS	16.2	35.9	41.2	6.1	0.8
TENNESSEE	11.6	33.3	44.9	8.1	2.0
TEXAS	10.4	30.1	50.8	7.7	1.1

Between thirty-four percent (Illinois) and sixty-three percent (Arkansas) of the teachers surveyed reported that the resources available for use in science classes were inadequate or poor. It is reasonable to conclude that without the proper teaching materials, teachers are likely to select less effective instructional strategies to teach science. However, it appears that even with the problems identified, these teachers are attempting to employ a wide range of instructional strategies. These include, but are not limited to, the lecture, demonstration, peer teaching, and cooperative learning. While some teachers reported that they never employed more than one of these strategies, generally each of these instructional approaches was selected by many of those teachers surveyed. Tables 11 - 14 provide data concerning the frequency of use of these four teaching strategies.

Table 11
Frequency of Lecture In Percentages

State	Never	< 1/P/Mo.	1/P/Mo.	2/P/Mo.	Weekly
ARKANSAS	0.9	3.6	1.8	0.9	92.3
ILLINOIS	1.1	1.6	1.6	5.5	90.1
OKLAHOMA	2.1	3.8	3.8	3.8	82.5
KANSAS	8.3	7.3	7.8	13.6	63.1
TENNESSEE	0.5	1.0	1.5	6.1	90.7
TEXAS	1.6	2.2	1.6	6.6	87.9

Table 12
Frequency of Demonstration In Percentages

State	Never	< 1/P/Mo.	1/P/Mo.	2/P/Mo.	Weekly
ARKANSAS	0.0	8.1	23.4	27.0	41.4
ILLINOIS	1.1	7.9	20.0	27.1	43.8
OKLAHOMA	1.7	16.3	25.9	19.7	36.4
KANSAS	2.5	15.8	24.1	24.1	33.6
TENNESSEE	0.0	10.6	18.7	33.3	37.4
TEXAS	0.5	10.4	19.7	24.6	44.8

Table 13
Frequency of Peer Teaching In Percentages

State	Never	< 1/P/Mo.	1/P/Mo.	2/P/Mo.	Weekly
ARKANSAS	40.5	36.9	14.4	2.7	5.4
ILLINOIS	50.4	33.2	8.5	4.7	3.3
OKLAHOMA	47.3	29.3	10.0	5.9	7.5
KANSAS	52.6	27.6	9.5	3.8	6.5
TENNESSEE	32.5	38.0	9.5	8.5	9.5
TEXAS	37.2	32.8	12.0	6.0	12.0

Table 14
Frequency of Cooperative Learning In Percentages

State	Never	< 1/P/Mo.	1/P/Mo.	2/P/Mo.	Weekly
ARKANSAS	12.6	31.5	23.4	17.1	15.3
ILLINOIS	12.3	28.2	20.5	17.5	21.4
OKLAHOMA	10.4	24.2	22.9	17.5	25.0
KANSAS	10.6	19.9	24.9	19.1	25.4
TENNESSEE	11.2	25.9	28.4	15.5	18.5
TEXAS	4.9	22.4	23.5	16.4	32.8

In conclusion, selected criticisms of the nation's science programs were reviewed in this study. The criticisms leveled at the nation's science programs generally are based upon genuine concerns for quality science instruction for the nations' students. The rationales developed by the groups which find fault with the science curriculum and instruction are often valid. The nation is at risk when the graduates of the nation's schools do not perform as well in science as their counterparts from other industrialized nations in the world. These criticisms must be addressed for the problems are real, and they are significant.

This study was designed to determine what is needed in the nation's rural science programs to produce greater student achievement. It was based upon the assumption that no one knows more about what is needed than the teachers who are providing instruction in rural science programs. More than 1500 science teachers from six states provided data by completing the Science Teacher Inventory of Needs (STIN 3). The data revealed that while there were wide variations in the conditions for teaching among the 1507 survey respondents, there are common factors which detrimentally impact science instruction in many schools across the six states surveyed.

These rural science teachers need more adequate resources to effectively assist their students in learning science. Without the proper equipment, supplies, and materials, little science can be done in their classrooms. Instead, science as product will be read. These rural science teachers also need adequate planning time to prepare for laboratory classes and other classes which employ inquiry and discovery teaching strategies.

An examination of the data of the study revealed that a high percentage of the teachers in the rural areas were not using inquiry or discovery methodologies, cooperative learning strategies, or computers in science. Therefore, it seems reasonable to conclude that many of these science teachers will need the benefit of inservice training to assist them in using the newer teaching strategies and materials that are currently available. Rural secondary science teachers do need more adequate resources, inservice training, and time to improve genuine science teaching and learning, and the nation needs better science teaching and learning.

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