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ABSTRACT

Mandates for improvement in the quality of instruction at the precollege level require that improved continuing educational opportunities by made ava'lable to the teachers of all science subjects. Physical science courses, along with biology, make up the general science requirement used by most high school students to meet graduation requirements. Inservice programs should be provided for the teachers of physical science to help them keep up with the rapid changes that are made in their field. This project sought to field-test the pilot version of an instrument adapted from the questionnaire used in Weiss' 1985-86 National Survey of Science and Mathematics Education for use with the physical science teachers in Texas. Information was sought regarding the characteristics of Texas physical science teachers and their science education research interests. The preliminary results of this survey and a copy of the instrument are presented in this paper. (CW)

ASSESSING THE NEEDS OF PHYSICAL SCIENCE TEACHERS IN TEXAS

Presented by

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Mandates for dramatic improvement in the quality of pre-college science instruction require that improved continuing educational opportunities be made available to teachers of all science subjects, but particularly teachers of physical science. It is the physical science course, along with biology, which is offered as a general education science course, enrolled in by most students, regardless of ability or educational goals, to meet graduation requirements. Inservice programs must be provided for physical science teachers to become acquainted with the rapid changes taking place in the subjects they teach, the interactions and mutually supportive roles played by science and technology, and the emerging issues in technology. Professional programs designed to accomplish these goals will require collaboration among universities, business, and schools.

Purpose

This project sought to field test the pilot version of an instrument, "Physical Science Teacher Questionnaire", adapted from the teacher questionnaire used in the 1985-86 National Survey of Science and Mathematics Education (Weiss, 1988). The teacher questionnaire instrument used in the Weiss study was modified for use with physical science teachers in Texas. In addition to the outcomes examined in the Weiss study information was sought regarding the science education research interests of physical science teachers using questions included in a nationwide survey of science teachers (Gabel, Samuel, Helgeson, Novak, & Butzow, 1986). Preliminary results of the field test are presented in this paper.

Background

The past five years are best described as a period of research, recommendation, and reform regarding precollege education. More than 200 local, state, and national task forces have studied the schooling process and issued reports criticizing the state of precollege education. Particularly hard hit have been precollege programs in science and mathematics. That achievement in these subjects has undergone a sharp decline in the past 20 years has been well documented at local, state, and national levels. Results of the 1986 National Assessment offer scant evidence, if any, that the level of science proficiency has changed. In its report, The Science Report Card, the

National Assessment of Educational Progress (Mullis & Jenkins, 1988) warns that "only seven percent of the nation's 17-year-olds have the prerequisite knowledge and skills thought to be needed to perform well in college-level science courses" (Mullis & Jenkins, 1988, p 6). Students' understanding of the physical sciences (physical science, physics, and chemistry) is particularly disturbing. Males exhibit a greater understanding of physical science than do females beginning as early as grade 3, and the gap only increases by grades 7 and 11, particularly in their level of understanding of physics. Even greater disparities exist in understanding of the physical sciences when the results are examined by students' ethnicity. White students outperform their Hispanic and Black counterparts beginning in grade 3 and continuing through grades 7 and 11.

Improved instruction in the language of science will not prepare today's students to face tomorrow's world. Changing wor and national economies have made obsolete the learning of only basic vocabulary and minimal problem solving skills in science and mathematics. Low skilled industrial jobs, traditionally available in great numbers to high school graduates, long ago shifted from the United States to Japan and more recently on to Korea. Korean factory workers are well trained in the basic problem solving skills needed in science and mathematics, moreover they are willing to work long hours for low pay with the hope of improving their standard of living. The shift in technology and its invested capital to Japan and now on to Korea poses serious threats in the coming years to the high standard of living traditionally enjoyed by all Americans.

To protect and sustain the economic security and high standard of living traditionally enjoyed by all its citizens America's schools must graduate students who can reason and perform complex, non-routine tasks related to science and mathematics. People who are equipped to reason and think independently will be best prepared to function in, what has come to be called, a knowledge based economy, where the productivity of goods and services will be driven by highly advanced and sophisticated technology. To produce citizens of this high caliber the current educational system does not need to be repaired, in the words of the Carnegie Corporation's Task Force on Teaching as a Profession; instead "... it must be rebuilt to match the drastic change needed in our economy if we are to prepare our children for productive lives in the 21st century" (1986, p 14).

Although the complexity of the problem related to students' lack of proficiency of science is widely acknowledged, the finger of blame has come to rest all too often on the declining quality of science teachers. Academically talented teachers are seldom attracted to teaching, the reports show, and those who become teachers are among the first to leave the profession. Moreover, studies of elementary and secondary curricula have shown that too many students study too little science. This finding has led many states to increase the time spent on science instruction in the elementary schools and raise the requirements in science for high school graduation. Increased graduation requirements along with more stringent course expectations for students have exacerbated the problem of the declining quality of science teachers.

Schools and school districts have been placed in a bind. Increased course and graduation requirements in science necessitate the hiring of more and better qualified science teachers. Unable to find qualified or certified science teachers some school districts have resorted to "making do in the classroom". In their report titled "Making Do in the Classroom: A Report on the Misassignment of Teachers"(Robinson, 1985), the Council for Basic Education and the American Federation of Teachers provided state by state documentation to show that assigning teachers to teach subjects for which they have little academic preparation is completely legal. Faced with the task of offering more sections of existing science courses, school districts have exercised their legal authority and have assigned teachers to teach science courses for which they have limited academic preparation. Unfortunately, only a few states maintain records to document the extent to which teachers are misassigned.

The crisis in science education in Texas mirrors that of the nation. In its report titled Study of the Availability of Teachers for Texas Public Schools, the Texas Education Agency (1984) documented the extent of the teacher supply/demand crisis in secondary science education. For several years teachers certified to teach science have been among the greatest in demand yet shortest in supply. For example, the applications to openings ratio for science teachers at the beginning of the 1983-84 school year was next to the lowest, exceeded only by mathematics. The shortage of applicants to fill teaching vacancies in science in the 1983-84 school year resulted in the hiring of 1 out of 5 teachers who were less than qualified to teach science.

Out-of-field teaching can and does occur in Texas. A school district need only issue to any certified teacher an Emergency Permit (<12 semester hours preparation) or a Temporary Classroom Assignment Permit (≥12 semester hours preparation). No records are maintained by the Texas Education Agency as to the extent to which school districts issue either Emergency or Temporary Classroom Assignment Permits. The misassignment of teachers is both legal and a common practice.

Method

The secondary science teacher questionnaire used in the 1985 National Survey of Science and Mathematics Education was modified for use with teachers of physical science in Texas. Modification included the deletion of all questions pertaining to background information on the school, since this information would be available and used in the selection of schools and teachers to participate in the statewide study of physical science education. Moreover, items were deleted from the Weiss survey instrument that referred to means designed by school districts to attract more and better science teachers to the classroom, enrollment and instructional practices in non-physical science classes, and science/physical science textbooks not approved for local adoption in Texas. In addition, 23 items used in a prior nationwide study (Gabel, Samuel, Helgeson, Novak, & Butzow, 1986) were added to the instrument to determine teachers' perceptions of the research needs in physical science education. The Physical Science Teacher Questionnaire contained 51 of the 55 items included on the instrument used in the Weiss study, 23 items from the Gabel survey, and 4 items developed specifically for the physical science survey.

The Physical Science Teacher Questionnaire was administered to secondary science teachers enrolled in the Institute in Physical Science, an Education for Economic Security Act, Title II summer program funded by the Texas Higher Education Coordinating Board. A total of 30 secondary teachers were enrolled in the Institute in Physical Science, Summer Program. Of the 30 teachers enrolled in the Institute, 28 held secondary teaching certificates, 1 was completing certification program while teaching, and 1 was not certified or teaching. Nine secondary teachers held single subject, non-science certificates (Non-Sci); eighteen held single subject, science certificates (SS-Sci) but not physical science; and four held single subject, physical science certificates (SS-PS). Thirteen teachers were certified as composite science (Comp Sci).

Fourteen teachers taught one or more physical science classes during the Spring semester, 1988. The fourteen teachers taught a total of forty-seven (47) classes of physical science. Nine teachers taught one to four physical science classes while teaching other subjects. Five teachers taught four to six physical science classes exclusively. Experienced secondary teachers who had not taught physical science were asked to complete the survey using their knowledge of the status of physical science instruction in the school in which they were presently teaching.

Results

Results of the field test of the Physical Science Teacher Questionnaire are presented in six sections, arranged according tho the section headings included on the survey questionnaire. For convenience information is presented in text form only. A copy of the survey instrument is included in the Appendix, along with the results of the field test reported in this paper.

Background Information

The 23 individuals who completed the survey are equally divided between males and females (one teacher omitted the gender item), but are not well distributed among ethnic groups. There were 19 whites and only 1 black, 1 Hispanic, 1 Asian, and 1 Middle Easterner. The average age of the respondents was 39 with a standard error of 1.3. The majority of these teachers (15) worked in schools in rural areas and towns containing populations less than 100,000. Of the rest, 3 came from major urban schools, 2 from major suburban schools, and 2 from a central city or a suburb of a city. The average enrollment of all of their schools was 766 with a standard error of 122. As we would expect, there was quite a wide variance in school size with a minimum enrollment of 108 and a maximum of 2200.

Only one of the 23 respondents had not taught any science or physical science at the time of the survey. The other twenty two had taught a variety of science classes over the last three years. Between them they taught an average of 8 years of science (standard error: 0.8) and an average of 4 years of physical science (standard error: 0.9). Two had taught general science, 14 life sciences, 5 chemistry, 5 physics, and 6 had taught in the Earth/space sciences. However, only 12 had taught physical science in the last three years. Eight of the respondents had never taught physical science and 2 had taught physical science sometime in their career but not during the past three years.

Science Instruction in the School

This section presents an overview of the way science instruction was handled in the schools. One common problem for teachers was the need to teach more than one subject in one classroom. Four of the respondents taught biclogy and Earth science five days a week, 55 minutes a day, and one of them taught a chemistry class as well, in the same classroom that they taught physical science. Another teacher had one class of physics along with four physical science classes. Respondents teaching courses other than physical science also taught more than one subject in their classroom. For example, biology and Earth science were often taught in the same room as were chemistry and physics.

Our data support the common notion that primarily ninth graders enroll in physical science, though many of the teachers report having a number of tenth graders as well. However, our data do not uphold the belief that many physical science teachers are teaching outside their major area of certification. In fact, only three of the respondents say that they were teaching out of their area of certification, and the courses they were teaching were math and Earth science, not physical science. Teachers participating in the Institute in Physical Science most likely are not representative of all Texas' teachers assigned to teach physical science.

Schools are getting some assistance from private industry in their efforts to teach science, though not as much as we might hope. Seven of the respondents reported receiving some sort of aide from private companies during the past year. Curriculum materials was the most common assistance offered, but equipment, guest speakers, travel stipends for professional meetings, and teacher awards or scholarships were also listed.

On the survey a list was offered to the teachers which included factors that might affect physical science instruction in their school. The teachers were asked to indicate which areas they perceived to be problems in their school. The most serious problems appear to have been inadequate access to computers, inadequate student reading abilities, student absences, and lack of student interest in science. Student absences may be linked to lack of student interest. For the most part, these problems focus on student attitudes and prior experiences. Clearly, the students were not adequately prepared in reading, but it may also be the case that they were not appropriately prepared in science resulting in poor student attitudes toward science. These results support the premise that students least interested in science enroll in physical science to fulfill their science requirement, but they also suggest that reading and science instruction prior to the ninth grade may not be responding to the needs of these students.

Teachers also described the belief that physical science is less important than other science subjects, along with problems of inadequate facilities, insufficient funds for purchasing equipment and supplies, lack of materials for individualizing instruction, and lack of teacher planning time. Most of these problems relate to funding deficiencies in the area of science education. This is an area that may only be effected by increasing the amount of money available to schools and by shifting the budget allocations of the schools. The indication that physical science is seen as less important than other science subjects in many schools may result from student and teacher assignment patterns, i.e., directing students uninterested in science into these classes and assigning teachers unprepared in the physical sciences to teach the course. The majority of the respondents, however, said that neither inadequate preparation of teachers to teach science nor lack of teacher interest in science are significant problems. We should remember, though, that teachers completing the survey are voluntary participants of a summer inservice program designed to improve their physical science teaching, so their interest in science may well be above average.

It is interesting to note that two areas commonly believed to be problematic for physical science teachers, the quality of textbooks and the maintenance of discipline, were not perceived to be problems by the teachers responding to this survey.

Physical Science Teaching in a Particular Class

For this section, teachers were asked to choose a representative physical science class to use in answering the questions. From their responses an average physical science class can be described. This class has 23 students: 12 boys and 10 girls. There are 11 white students, 2 blacks, 8 Hispanics, and 1 Asian. The students are of widely differing abilities, but the majority are of average ability. The teacher requires about 18 minutes of homework a day from the students. They probably use the textbook Bacher-Prentice Hall Physical Science published in 1981 (although Merrill, Macmillan, and Holt are also popular) and cover between 50-90% of the text through the course of the year. This class uses calculators to check answers, do computations, solve problems, and take tests. They probably do not have access to a computer, but if they do it is used mostly for drill and practice and learning science content. The teacher would ideally like to use it more as a laboratory tool or for doing graphics. Students who have the opportunity to use the computer only spend 1-14 minutes on it during a typical week. Finally, the science magazines that the teacher is most likely to read to provide support for his/ her teaching are The Science Teacher, Scientific American, Smithsonian, Current Science, Science World, and Texas Parks and Wildlife.

This section also asked about the textbooks being used in a typical physical science class. A group of teachers from the school or the physical science teacher usually chose the text for the class. That may help explain why respondents were generally quite positive about the quality of their textbooks. They indicated that the textbooks were written at an appropriate reading level for most of the students, were clear and organized, explained concepts clearly, and provided good suggestions for activities and assignments. However, most respondents suggested that the textbooks did not adequately help in the development of problem-solving skills.

The teachers' objectives for their typical physical science class did not offer many surprises. Teachers gave maximum emphasis to learning basic physical science concepts, becoming aware of the importance of physical science in their daily life, becoming interested in physical science, preparing students for further study in physics and/or chemistry, developing a systematic approach to solving problems, learning to effectively communicate ideas in science, developing awareness of safety issues in lab, and developing skill in lab techniques (in approximate order of popularity).

A Recent Physical Science Lesson in this Class

Two thirds of the fifteen respondents for this section discussed a lesson that was designed to be completed in one 55-minute period. The other third had lesson times ranging from 110 minutes to 500 minutes. Thus, the averages did not add up to a normal 55-minute lesson. Nevertheless, the average times for various activities still illuminated the teachers' priorities. The average lesson time was 125 minutes and was composed of 14 minutes for daily routines and interruptions, 43 minutes for lecture, 26 minutes for hands-on or laboratory activities, 10 minutes for reading about science, 13 minutes for a test or quiz, and 18 minutes for other instructional activities. All 15 respondents included a lecture and a discussion period in their lesson. Lecture seemed to be the most popular way for physical science teachers to teach. Thirteen teachers allotted time for students to use hands-on or laboratory materials and to work in small groups and 12 included time for teacher demonstration. These numbers suggest, though, that teachers are not avoiding the scientific nature of this class and are allowing students to explore, to some extent, materials and concepts themselves.

Teacher Preparation

All 23 of the participants had received a bachelor's degree. Their major fields, however, were quite diverse. The most popular degree by far was biology (including the environmental and life sciences) which was held by twelve of the teachers. Three other individuals held a bachelors in science education and two had a secondary school education major. The rest of the degrees varied from mathematics education to history. Nine of the respondents had also received a masters degree. Again, their areas varied considerably but most were in fields of education or science. None of the teachers held a doctorate or specialist degree.

The number of college courses taken by these teachers in education and the life sciences fits well with the information on degrees. Twenty-one respondents had taken at least one course in the general methods of teaching and in psychology and human development Eighteen had taken one or more courses in methods of teaching secondary school science, had supervised student teaching, and had completed at least introductory level biology. Seventeen completed courses in botany and genetics and/or evolution. As would be expected from the previous data on their majors, these teachers had completed, on average, many more courses in the life sciences and education than in any other field, including chemistry and physics.

Though the number of these present or future physical science teachers who completed an introductory level course in chemistry and physics was high (22 had taken general chemistry and 17 had taken general physics), these numbers dropped rapidly with more advanced coursework in these disciplines. Thirteen teachers completed organic chemistry, 9 biochemistry, 7 analytical chemistry, and only 4 completed physical chemistry. The figures in physics were even worse. Of the 23 respondents only 4 had completed a class in electricity and magnetism, 3 studied mechanics, 1 had taken heat and thermodynamics, 1 had modern or nuclear physics, and none had completed a course in optics. In sum, these teachers completed an average of 6 (std error: 0.6) undergraduate or graduate courses in biology, yet only 2 (std error: 0.5) classes in physics or physical science, and 4 (std error: 0.6) courses in chemistry.

With this information in hand, it was not surprising to see that only 6 of the respondents actually held certification in physical science. This result seems to contradict the data collected from section B, namely that none of the teachers were presently teaching physical science without certification. However, 9 of the participants held a composite science certification which allows them to teach any science subject in secondary school, including physical science. Thus, the combination of teachers with a specific certification in physical science and the teachers with a composite certification accounts for all of the teachers assigned to teach physical science.

Though it is comforting to note that teachers are not teaching out of their area of certification, this information does not detract from the fact that most of these teachers had completed little, if any, advanced college course work in chemistry, physics, or physical science.

Their lack of college training, however, did not seem to effect the teachers' confidence about their ability to cover the topics offered in the physical science course. Perhaps, teachers perceive the problems related to the teaching of physical science related less to their understanding of physical science, physics, or chemistry and more to students' lack of motivation, interest, or responsibility. Additional information is needed before any conclusions can be reached.

Inservice Education in Science

Teachers were asked about the time they had spent on inservice education in science or the teaching of science in the last twelve months. Five teachers had no inservice education during the time period specifically related to science or science teaching. Eighteen teachers had completed six or more hours of inservice education in science during the past twelve months, mostly between 6 and 15 hours. One teacher had completed more than 35 hours of inservice education in science or the teaching of science.

Professional growth credits are by far the most frequently used form of support for inservice education. Eleven teachers had received professional growth credit, but some science teachers received released time (8 teachers), travel and/or per diem expenses (7 teachers), or stipends (2 teachers). Results from the survey indicated that summers and teacher work days are the most preferred time for attending inservice programs (19 and 16 responses respectively). Teachers reported that they least like to attend inservice program held in the evenings (12 mentions) and after school (10 mentions). Saturdays received a "somewhat likely" response regarding teachers willingness to attend an inservice program.

Teachers reported that topics, students, and computers represent a problem for them of major concern. Included among the topics difficult to teach were electricity and magnetism, computer chip technology, electromagnetic induction, heat, waves, and topics in mechanics. By far the most frequently mentioned need that teachers expressed was the need to learn more about these basic concepts, rather than applications of the concepts or instructional materials to use when teaching the concepts to students. Moreover, teachers reported that they are either totally or somewhat unprepared to teach science to students who are either physically handicapped, mentally retarded, or learning disabled. According to teachers they have been adequately, well, or very well prepared to teach science to low, average, or high ability students. Sixteen teacher reported that they are either somewhat (7 mentions) or totally (9 mentions) unprepared to use computers as an instruction tool with their physical science classes. Training for teachers in the instructional uses of computers was reported to have taken the form of self-instruction (10 mentions), college coursework (8 mentions), and inservice education (7 mentions of less than 3 days and 2 mentions of more than three days). Six teachers had received no training in the instructional uses of computers.

Several teachers reported that they hold membership in professional organizations solely interested in the promotion of science education. Two teachers are members of the National Earth Science Teachers Association, eight teachers are members of the National Science Teachers Association, and six teachers are member of the Science Teachers Association of Texas. Eleven teachers reported membership in either the National Education Association (4 mentions) or "other" organizations included on the survey (7 mentions).

Research in Science Education

The survey listed the 23 areas of research in science education that were identified by Gabel's study (1986) and asked teachers to give their opinion about the research priority of each topic. A scale of one representing a high priority to five for a low priority was used. All of the topics received scores below three, suggesting that teachers understand the need for greater research in all of the domains of science education. Seven of the topics were given greatest priority, receiving an average score between one and two. These seven include research on motivational techniques that relate to learning and continued involvement in science (1.5); research on the effectiveness on laboratory experiences in the science classroom(1.7); research on problem solving(1.9); research on the effects of teaching science in the interdisciplinary dimension as it relates to areas such as mathematics, social studies, and reading (2); research on the influence of public school science experiences on success in college science classes (2); research on the influence of teacher characteristics on pupil learning and attitudes (2); and research on ways to move instruction from rote learning toward more meaningful learning (2). Despite their desire for more research, however, only 3 of the respondents had ever heard of NSTA's publication series "What Research Says to the Science Teacher." To find cut about the research being done, most teachers listed other teachers and college courses as their most likely sources of information.

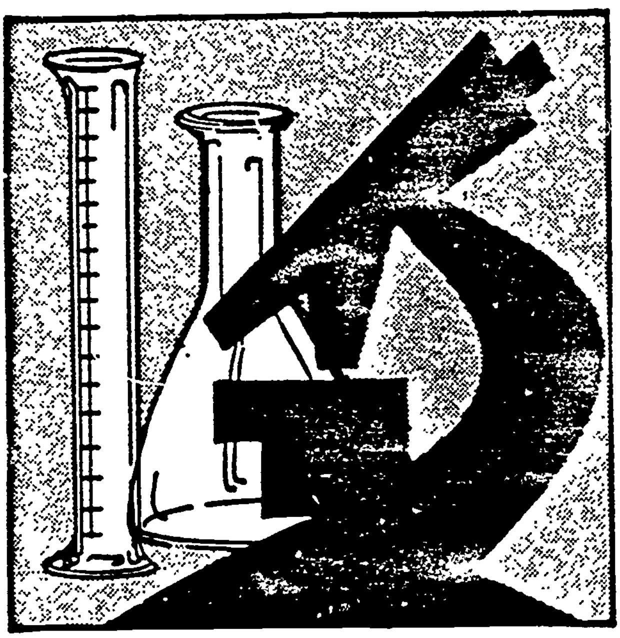
Conclusions

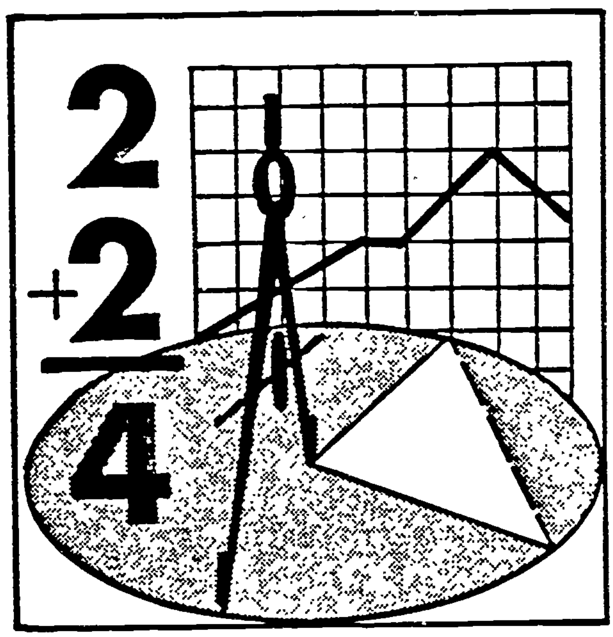
In general, teachers seemed to be most concerned about student attitudes toward science and budgetary constraints, areas in which their control is limited. They were fairly satisfied, on the other hand, with factors over which they did have some control. Many teachers were able to choose their own textbooks, and the data showed positive attitudes towards the texts. Also, those surveyed resoundingly denied that lack of teacher preparation or interest were significant problems in the physical science classroom. Despite their low level of college coursework in chemistry and physics, the respondents felt that they were qualified to teach the topics in the physical science curriculum. Nevertheless, they did express much more interest in an inservice program that mostly stressed advanced physical science concepts than in a program designed to cover either applications of the concepts or techniques and materials useful in teaching the concepts. Finally, they showed quite a bit of interest in research related to science education, though it is unclear whether they would take the time to read those research topics to which they gave such high priority ratings

Further Study

Results of this project will be used to revise the "Physical Science Teacher Questionnaire" for use in a survey of physical science teachers and physical science instruction in Texas. Results of the statewide survey will provide the first comprehensive database on the state of physical science instruction since the course's conception. Information will be collected on physical science teachers, their teaching strategies, and their comments and concerns about physical science instruction. We anticipate using this research to guide the design and implementation of a multi-year summer inservice program to be offered at the University of Texas at Austin. This program will be aimed specifically at updating the content knowledge and teaching skills of teachers certified to teach physical science as well as answer the needs of those teachers who are not fully prepared to teach their assigned physical science classes but are interested in doing the best job they can. The database will also be available to the Texas Education Agency and to the schools participating in the study. We hope that these groups will use the information to assess the extent of the problem with the physical science program in Texas and to judge whether any corrective measures need to be or can be taken.

Physical Science
Teacher Questionnaire





If you have any questions, call Laura Doley 451-7270

We appreciate your taking the time to fill out this survey. We are trying to gather some information on the state of physical science in Texas and the needs of physical science teachers. Please read all of the questions carefully and answer them as accurately as possible. If you are not a physical science teacher and are not intending to be one next year many of these questions will not be applicable to you. However, we are still interested in your opinion so please read all of the questions and answer any that are appropriate to the best of your ability.

Your responses to this questionnaire will help us to develop and refine our survey so that we can obtain useful and relevant information about physical science education in Texas.

Thank you again for your help.

SECTION A: BACKGROUND INFORMATION

1. Indicate your sex:

	(Circle one.)	
Male	1	11
Female	2	11

2. Are you:

	(circle one.)	
White (not of Hispanic origin)	1	19
Black (not of Hispanic origin)	2	1
Hispanic	3	1
American Indian or Alaskan Native	4	0
Asian or Pacific Islander	5	1
Other (*please specify* ________)	6	1 (Middle Easterner)

3. How old are you? 39 (1.3)

4. Which of the following designations best describes the location of the school in which you taught this past school year?

	(Circle one.)	
Major Urban (pop ≥450,000)	1	3
Major Suburban	2	2
Other Central City (pop. 100,000-450,000)	3	1
Other Central City Suburban	4	1
Independent Town (pop. 25,000-100,000)	5	7
Other	6	8

5. What is the approximate enrollment in this school? 766 (std error: 122)

6. Indicate the number of years you have taught each of the following in any grades 7-12, including this past school year.
If none, check here ___ and go on to Question 8.

Science, grades 7-12 8 (std error: .79)
Physical Science 4 (std error: .95)

7. Which of the following subjects have you taught in the last three years?
If you have not taught science in the last three years, check here ___ and go on to Question 8.

	(circle all that apply.)	
General science	1	2
Biology, environmental, life sciences	2	14
Chemistry	3	5
Physics	4	5
Physical science	5	12
Earth/space sciences	6	9

SECTION B: SCIENCE INSTRUCTION IN YOUR SCHOOL

8. Do you teach subjects other than physical science in the same classroom?

(Circle one.)

Yes	1	9
No	2	11

9. We are interested in knowing how much time you spend teaching various subjects, including science. In a typical week, how many days do you have lessons on each of the following subjects, and how many minutes long is an average lesson? (Please write "0" if you do not teach a particular subject.)

Science Subjects	Number of Days per Week	Approx. Number of Minutes per Day
1. General science	2	
2. Biology, environmental, life sciences	9	110
3. Chemistry	4	55
4. Physics	2	55
5. Physical science	10	233
6. Earth/space sciences	7	
Non-Science Subjects		
1. Mathematics	2	
2. Computer Science		
3. Social Studies/History		
4. Health/Physical Education	1	
5. English/Language Arts/Reading	1	
6. Business/Vocational Education		
7. Foreign Languages		
8. Other (*please specify* ______)		

Note: The first collumn figures correspond to the total number of respondents who indicated that they taught that course. However, the second collumn refers only to minutes taught by physical science teachers.

10. For each Physical science class you taught this past semester, indicate the enrollment by grade.

Class	Number of Students in Class by Grade: 7	8	9	10	11	12	Total
1							
2							
3							
Averages:	0	0	25	17	8	6	21

11. Are you currently teaching any course(s) that are outside your major area of certification?

(Circle one.)

Yes	1	3
No	2	17

Course Code No.

a. One in Math. Gr. 7
b. Two in Earth Science
c. ______

12. a. During the past year, did you receive any assistance (e.g., curriculum materials, guest speakers, support to attend workshops, etc.) from private industry?

(Circle one.)

Yes	1	7
No	2	15
Not sure	3	0

b. Indicate the type(s) of assistance you received.

(Circle all that apply.)

Curriculum materials	1	6
Equipment	2	3
Guest Speakers	3	2
Travel/stipends to attend professional meetings	4	2
Teacher awards/scholarships	5	1
Teacher summer employment	6	0
Other (*please specify* ______)	7	0

13. The following factors may affect physical science instruction <u>in your school as a whole</u>. In your opinion, how great a problem is caused by each of the following?

(Circle one on each line.)

		** Serious Problem	* Somewhat of a Problem	Not a Significant Problem
	a. Belief that science is less important than other subjects	1	2	3
*	b. Belief that physical science is less important than other science subjects	1	2	3
	c. Compliance with the essential elements	1	2	3
*	d. Inadequate facilities	1	2	3
*	e. Insufficient funds for purchasing equipment and supplies	1	2	3
*	f. Lack of materials for individualizing instruction	1	2	3
	g. Insufficient numbers of textbooks	1	2	3
	h. Poor quality of textbooks	1	2	3
**	i. Inadequate access to computers	1	2	3
**	j. Lack of student interest in science	1	2	3
**	k. Inadequate student reading abilities	1	2	3
	l. Lack of teacher interest in science	1	2	3
	m. Teachers inadequately prepared to teach science	1	2	3
**	n. Student absences	1	2	3
*	o. Lack of teacher planning time	1	2	3
	p. Not enough time to teach science	1	2	3
	q. Class sizes too large	1	2	3
	r. Difficulty in maintaining discipline	1	2	3
	s. Inadequate articulation of science instruction across grade levels	1	2	3
	t. Inadequate diversity of science electives	1	2	3
	u. Low enrollments in science courses	1	2	3
	v. Lack of support from guidance counselors	1	2	3

SECTION C: YOUR SCIENCE TEACHING IN A PARTICULAR CLASS

The questions in sections C and D relate to your physical science teaching in a particular class. Select a typical class, one that is representative of the physical science classes you teach. Refer to this class as you answer the questions in sections C and D.

14. a. How many students were there in this class? 23 (.93)

b. Please indicate the number of students in this class in each race/sex category:

	Male	Female
White (not of Hispanic origin)	6	5
Black (not of Hispanic origin)	1	1
Hispanic	5	3
American Indian or Alaskan Native	0	0
Asian or Pacific Islander	0	1
Other	0	0
Total	12	10

15. Which of the following best describes the ability makeup of this class? (Comparison should be with the average student in the grade.)

	(Circle one.)	
Primarily high ability students	1	2
Primarily low ability students	2	2
Primarily average ability students	3	5
Students of widely differing ability levels	4	6

16. On the average, how many minutes of physical science homework did you require the typical student in this class to complete each day?

18 (2.3) minutes/day

17. Were you using one or more published textbooks or programs for teaching physical science to this class?

	(Circle one.)	
Yes	1	15
No	2	0

18. Why did you choose not to use a textbook?

	(Circle all that apply.)
I prefer to teach without a textbook	1
I did not like the textbook assigned to this class	2
Available textbooks were not appropriate for this class	3
There were insufficient funds to purchase textbooks	4
Other	5

19. Indicate the one state-adopted physical science textbook used most often by the students in this class.

	(Circle one.)	
Addison-Wesley: Johnson's Physical Science	1	1
D. C. Heath: Nolan Heath Physical Science	2	0
Holt: Ramsey-Holt Physical Science	3	2
Macmillan: Eby Macmillan's Physical Science	4	2
Merrill: Heimler's Focus on Physical Science	5	2
Prentice Hall: Bacher-Prentice Hall Physical Science	6	5
Silver Burdett: Alexander Silver Physical Science	7	0

20. Indicate the most recent copyright date of this textbook.

copyright date: **mode: 1981**

21. Approximately what percentage of the textbook did you "cover" this past year in this class?

	(circle one.)	
Less than 25%	1	0
25-49%	2	3
50-74%	3	5
75-90%	4	5
More than 90%	5	3

22. Please give us your opinion about each of the following statements related to the textbook you used most often in this class.

(Circle one on each line.)

	This textbook:	(**) Strongly Agree	(*) Agree	No Opinion	(+) Disagree	(++) Strongly Disagree
*	a. Is at an appropriate reading level for most of my students	1	2	3	4	5
+	b. Is not very interesting to my students	1	2	3	4	5
+	c. Is unclear and disorganized	1	2	3	4	5
+	d. Helps develop problem-solving skills	1	2	3	4	5
	e. Needs more examples to reinforce concepts	1	2	3	4	5
*	f. Explains concepts clearly	1	2	3	4	5
*	g. Provides good suggestions for activities and assignments	1	2	3	4	5
	h. Lacks examples of the practical use of science in daily life	1	2	3	4	5
	i. Lacks examples of the technological use of science in the world	1	2	3	4	5
	j. Has high quality supplementary materials	1	2	3	4	5

23. **Indicate the persons or groups who helped determine that you would use this particular textbook in this physical science class.**

	(Circle all that apply.)	
I did	1	6
The principal	2	2
A group of teachers from this school	3	8
A district-wide textbook adoption committee	4	4
A state-wide textbook adoption committee	5	2
Other (*please specify* ____________)	6	3

24. **If you were using any materials instead of, or in addition to, a published textbook or program, briefly describe below.**

Lab Mauals, Work Sheets, CRC handbook, Magazines and Newspapers, "Learning Cycle," 1987 Resource Guide, Computerized Tutorial

25. **Did you use calculators in this physical science class?**

	(Circle one.)	
Yes	1	13
No	2	2

26. **How were calculators used in this physical science class?**

	(Circle all that apply.)	
Checking answers	1	10
Doing computations	2	13
Solving Problems	3	10
Taking tests	4	10

27. **Which best describes the availability of computers (microcomputers or terminals to mini/mainframe) for use with this physical science class?**

	(Circle one.)	
Not available	1	8
Available but quite difficult to access	2	3
Available but somewhat difficult to access	3	2
Readily available	4	3

28. **How did this physical science class actually use computers? How would you ideally like to use computers?**

If not used, check here ___ and skip to Question 30.

(Circle all that apply.)

		Actual use (*)	Ideal use(+)
	Teacher demonstrating computer use	1	1
	Writing programs	2	2
*	Learning science content	3	3
+	Laboratory tool	4	4
*	Drill and Practice	5	5
	Using simulations	6	6
	Problem solving	7	7
+	Using computer graphics	8	8
	Games	9	9
	Testing and evaluation	10	10
	Other (*please specify* ____________)	11	11

29. **Think about instruction in this physical science class during a typical week, prior to the end of the spring semester. Three weeks before the semester ended, describe instruction that occurred that week. How many minutes did a typical student spend working with computers as part of this physical science class?**

	(Circle one.)	
None	1	1
1-14 minutes	2	4
15-29 minutes	3	0
30-44 minutes	4	0
45-60 minutes	5	0
More than 60 minutes	6	0

30. **Think about your goals for this physical science class for the entire course. How much emphasis did each of the following objectives receive?**

(Circle one on each line.)

		None		Minimal Emphasis		Moderate Emphasis		Very Heavy Emphasis
5	a. Become interested in physical science	1	2	3	4	5	6
5	b. Learn basic physical science concepts	1	2	3	4	5	6
5	c. Prepare for further study in physics and/or chemistry	1	2	3	4	5	6
4	d. Develop inquiry skills	1	2	3	4	5	6
5	e. Develop a systematic approach to solving problems	1	2	3	4	5	6
4	f. Learn to effectively communicate ideas in science	1	2	3	4	5	6
5	g. Become aware of the importance of physical science in daily life	1	2	3	4	5	6
4	h. Learn about applications of physical science in technology	1	2	3	4	5	6
3	i. Learn about the career relevance of physical science	1	2	3	4	5	6
2	j. Learn about the history of science	1	2	3	4	5	6
5	k. Develop awareness of safety issues in lab	1	2	3	4	5	6
5	l. Develop skill in lab techniques	1	2	3	4	5	6

31. **Use the following categories to indicate the professional magazines or journals which you found particularly helpful in teaching physical science to this class.**

a. I have never heard of this journal.
b. I am slightly familiar with this journal, but do not recall reading it.
c. I once used this journal some, but no longer read it.
d. I do not subscribe to this journal, but do read it occasionally.
e. I do not subscribe to this journal, but do read it regularly.
f. I subscribe to this journal, but seldom read much of it.
g. I subscribe to this journal and read it regularly.

1. Current Science √
2. National Geographic
3. Science Digest
4. Science Scope
5. Science World √
6. Smithsonian √
7. Texas Science Teacher
8. The Physics Teacher
9. Journal of Chemical Education
10. Omni
11. Science and Children
12. Science News
13. Science Teacher √+
14. Scientific American
15. Texas Parks and Wildlife √

SECTION D: A RECENT PHYSICAL SCIENCE LESSON IN THIS CLASS

Please answer the following questions specific to a typical and recent physical science lesson prior to the end of the spring semester.

32. a. How many minutes were allocated for that science lesson? 125 (std error: 35)

b. Of these, how many were spent on the following:

Daily routines, interruptions, and other non-instructional activities	14	(3.3)
Lecture	43	(15.9)
Working with hands-on, manipulative, or laboratory materials	26	(6.6)
Reading about science	10	(3.9)
Test or quiz	13	(4.7)
Other science instructional activities	18	(5.6)
Total	125	

33. Indicate the activities that took place during that physical science lesson.

	(Circle all that apply.)	
Lecture	1	15
Discussion	2	15
Teacher demonstration	3	12
Student use of hands-on or laboratory materials	4	13
Student use of calculators	5	8
Student use of computers	6	0
Students working in small groups	7	13
Students doing seatwork assigned from textbook	8	6
Students completing supplemental worksheets	9	8
Assigning homework	10	10

SECTION E: TEACHER PREPARATION

34. Indicate the degrees you hold. Then indicate your major area of study for each degree using the list of code numbers to the right. Space has been provided for you to enter a code number for a second bachelor's or master's degree. Enter more than one code on the same line only if you have a double major.
If no degree, check here ____ and go on to question 35.

Degree	(Circle all that apply.)	Specify Major Area Code No.	
Associate	1		1
Bachelor's	2	12 in Biol., 3 in Sci. Ed.	23
2nd Bachelor's		vary	3
Master's	3	vary	9
2nd Master's			0
Specialist or 6-year certificate	4		0
Doctorate	5		0

MAJOR AREA CODE NUMBERS

EDUCATION
- 11 Elementary education
- 12 Middle school education
- 13 Secondary education
- 14 Mathematics education
- 15 Science education
- 16 Other education

MATHEMATICS
- 21 Mathematics
- 22 Computer Science

SCIENCE
- 31 Biology, environmental, life sciences
- 32 Chemistry
- 33 Physics
- 34 Physical Science
- 35 Earth/space Sciences

OTHER DISCIPLINES
- 41 History, English, foreign language, etc.

35. Indicate the categories in which you have completed one or more college courses.

(Circle all that apply.)

EDUCATION

General methods of teaching	1	21
Methods of teaching elementary school science	2	5
Methods of teaching middle school science	3	4
Methods of teaching secondary school science	4	19
Supervised student teaching	5	18
Instructional uses of computers	6	3
Psychology, human development	7	22

MATHEMATICS/COMPUTER SCIENCE

College algebra, trigonometry, elementary functions	8	22
Calculus	9	9
Differential equations	10	4
Probability and Statistics	11	8
Computer programming	12	8

LIFE SCIENCES

Introductory biology	13	18
Botany, plant physiology, etc.	14	17
Cell biology	15	9
Ecology, environmental science	16	12
Genetics, evolution	17	17
Microbiology	18	13
Physiology	19	11
Zoology, animal behavior, etc.	20	14

CHEMISTRY

General chemistry	21	22
Analytical chemistry	22	7
Organic chemistry	23	13
Physical chemistry	24	4
Biochemistry	25	9

PHYSICS

General physics	26	17
Electricity and magnetism	27	4
Heat and thermodynamics	28	1
Mechanics	29	3
Modern or nuclear physics	30	1
Optics	31	0

EARTH/SPACE SCIENCES

Astronomy	32	10
Geology	33	12
Meteorology	34	6
Oceanography	35	6
Physical geography	36	1

OTHER

History of science	37	1
Science and society	38	1
Engineering	39	2

36. For each of the following subject areas, indicate the number of courses you have completed. Count each course you have taken, regardless of whether it was a semester hour, quarter hour, graduate, or undergraduate course. If your transcripts are not available provide your best estimates.

Subject Area	Circle the number of courses you have completed		
Life sciences	0—1—2—3—4—5—6—7—≥8	6	(.6)
Chemistry	0—1—2—3—4—5—6—7—≥8	4	(.5)
Physics/physical science	0—1—2—3—4—5—6—7—≥8	2	(.4)
Earth/space sciences	0—1—2—3—4—5—6—7—≥8	2	(.5)
Calculus	0—1—2—3—4—5—6—7—≥8	1	(.3)
Computer science	0—1—2—3—4—5—6—7—≥8	1	(.3)

37. What type of state teaching certification do you have?

(Circle one.)

Not certified	1	0
Provisional (lacking some requirements)	2	1
Regular, lifetime, or other certification	3	2?

38. In what subject areas do you have state teaching certification?

(Circle all that apply.)

Elementary education	1	2
Middle school education	2	1
Secondary school education		
Two single subject fields	3	9
Composite field	4	9
General science	5	3
Biology, environmental, life sciences	6	17
Earth/space sciences	7	7
Physical sciences	8	6
Chemistry	9	7
Physics	10	5
Mathematics	11	1
Computer science	12	0
Business	13	0
English, language arts, reading	14	2
Physical education, health	15	4
Social studies, history	16	1
Foreign language	17	1
Other (*please specify* ________________)	18	3

39. Read each of the following topics included in the physical science course, introduction to chemistry and introduction to physics. Indicate the extent to which you feel adequately qualified to teach about each topic.

(Circle one on each line.)

		Not Qualified (*)	Somewhat Qualified (+)	Well Qualified (++)
	Chemistry			
++	Atomic structure	1	2	3
++	Chemical nature of matter	1	2	3
+	Nuclear chemistry	1	2	3

Physics

++	Matter	1	2	3
+	Electricity	1	2	3
+	Magnetism	1	2	3
+	Heat energy	1	2	3
+	Motion	1	2	3
+	Work and energy	1	2	3
+	Waves	1	2	3
+	Sound	1	2	3
+	Electromagnetic energy	1	2	3

SECTION F: IN-SERVICE EDUCATION IN SCIENCE

40. **During the last twelve months, what is the total amount of time you have spent on inservice education in science or the teaching of science? (Include attendance at professional meetings, workshops, and conferences, but do not include formal courses for which you received college credit.)**

	(Circle one.)	
None	1	5
Less than 6 hours	2	4
6-15 hours	3	7
16-35 hours	4	6
More than 35	5	1

41. **What type(s) of support have you received?**

	(Circle all that apply.)	
None	1	3
Released time from teaching	2	8
Travel and/or per diem expenses	3	7
Stipends	4	2
Professional growth credits	5	11
Other (please specify ____________)	6	2

42. **If an in-service program that interested you were available, how likely would you be to attend if it were offered at the following times?**

(Circle one on each line.)

		Not Likely (*)	Somewhat Likely (+)	Very Likely (++)
+	a. After school	1	2	3
*	b. Evenings	1	2	3
+	c. Saturdays	1	2	3
++	d. Summers	1	2	3
++	e. Teacher work days	1	2	3

43. **In what year did you last take a course for college credit in science or in the teaching of science?**

most have had a course in the last two years

44. Think about a specific physical science topic that you would find difficult to teach. Which would be the most useful in helping you teach that topic?

(Circle one.)

Learning more about the basic concepts	1	13
Learning more about applications of those concepts in daily life, technology, and careers	2	2
Learning more about instructional materials/techniques	3	7

45. How adequately prepared do you feel to teach science in a class that includes the following types of children with special needs?

(Circle one on each line.)

	Totally(**) Unprepared	Somewhat (*) Unprepared	Prepared	Well (+) Prepared	Very well(++) Prepared
* a. Physically handicapped	1	2	3	4	5
** b. Mentally retarded	1	2	3	4	5
* c. Learning disabled	1	2	3	4	5
d. Low ability	1	2	3	4	5
+ e. Average ability	1	2	3	4	5
+ f. High ability	1	2	3	4	5

46. How adequately prepared do you feel to use computers as an instructional tool with your physical science classes?

(Circle one.)

Totally unprepared	1	9
Somewhat unprepared	2	7
Adequately prepared	3	4
Well prepared	4	2
Very well prepared	5	1

47. What training have you received in the <u>instructional uses</u> of computers?

(Circle all that apply.)

None	1	6
College coursework	2	8
Less than three days in-service education	3	7
Three or more days in-service education	4	2
Self-taught	5	10
Other (*please specify* ________________)	6	1

48. To which of the following professional organizations do you currently belong? If none, check here ___ and go on to Question 49.

(Circle all that apply.)

American Association of Physics Teachers	1	0
American Chemical Society	2	0
National Association of Biology Teachers	3	0
National Association of Geology Teachers	4	0
National Earth Science Teachers Association	5	2
National Science Teachers Association	6	8
School Science and Mathematics Association	7	0
Science Teachers Association of Texas	8	6
American Federation of Teachers	9	0
National Education Association	10	4
Other (please specify ________________)	11	7

49. Please give us your opinion about each of the following statements.
(Circle one on each line.)

			Strongly Agree (**)		No Opinion		Strongly Disagree (++)
+	a.	Science is a difficult subject for children to learn	1	2	3	4	5
+	b.	Physical science is a difficult subject for children to learn	1	2	3	4	5
++	c.	Hands-on science experiences aren't worth the time and expense	1	2	3	4	5
	d.	My principal really does not understand the problems of teaching physical science	1	2	3	4	5
**	e.	I enjoy teaching physical science	1	2	3	4	5
**	f.	Laboratory-based science classes are more effective than non-laboratory classes	1	2	3	4	5
	g.	Counselors encourage all students to enroll in physical science	1	2	3	4	5
	h.	I consider myself a "master" science teacher	1	2	3	4	5

SECTION G: RESEARCH IN SCIENCE EDUCATION

In a national survey secondary science teachers identified research needs in science education. We asked the teachers to rate these research areas on a scale of 1 to 5 with 1 being the highest priority and 5 being the lowest. All of the areas received average scores below 3 suggesting that teachers do recognize the need for more research in a the various domains of education.

The following received average scores at or below 2. They are listed in order of priority.

Research on motivational techniques that relate to learning and continued involvement in science. 1.5

Examples might include:

a. Research related to promising practices in teaching science to reluctant learners
b. Techniques which generate enthusiasm in all students
c. Ways of encouraging more students to take upper level courses

Research on the effectiveness of laboratory experiences in the science classroom. 1.7

Examples might include:

a. The effect of traditional lab experience versus those involving inquiry
b. Detailed look at benefits of laboratory science
c. Use of safe practices in laboratory experience

Research on problem solving. 1.9

Examples might include:

a. Variables that influence rote versus meaningful problem solving
b. Strategies and variables that lead to success in problem solving
c. Differences in strategies between the way experts and beginners solve problems

Research on the effects of teaching science in the interdisciplinary dimension as it relates to areas such as mathematics, social studies, and reading. 2

Examples might include:

a. The relationship between using calculators in science class and an improvement in mathematical ability
b. Relationship between math skills and science achievement
c. Improving reading and language skills while teaching science
d. The most effective methods to approach social issues in science

Research on the influence of public school science experiences on success in college science classes. 2

Examples might include:

a. The retention of scientific facts from high school to college
b. Various learning systems versus student success in college science courses
c. Research which analyzes the forms of science education and correlates them to the success of the students in college

Research on the influence of teacher characteristics on pupil learning and attitudes. 2

Examples might include:

a. How the teacher's personality affects classroom learning
b. Correlations between teachers' attitudes toward science

Research on ways to move instruction from rote learning toward more meaningful learning. 2

Examples might include:

a. Value of various kinds of "advance organizers" to facilitate meaningful learning
b. Concept mapping as a strategy to encourage meaningful learning
c. Instructional strategies that encourage meaningful learning

73. Are you familiar with NSTA's publication series entitled "What research says to the Science Teacher"?

(Circle one.)

Yes------1 3
No------2 20

74. How many of these books have you read? 1

75. Suppose you wanted to find out about the research related to a topic (e.g., discovery learning, science anxiety, or sex differences in learning). How likely would you be to use each of the following sources of information?

(Circle one on each line.)

			Not Likely(*)	Somewhat Likely(+)	Very Likely(++)
++	a.	Other teacher(s)	1	2	3
*	b.	Principals	1	2	3
+	c.	Local science specialists	1	2	3
*	d.	State department personnel	1	2	3
*	e.	Consultants	1	2	3
++	f.	College courses	1	2	3
+	g.	In-service programs	1	2	3
+	h.	Meetings of professional org.	1	2	3
+	i.	Journals	1	2	3
+	j.	Research reviews	1	2	3
+	k.	Newspapers/magazines	1	2	3
+	l.	Television/radio	1	2	3
*	m.	Publishers and sales rep.s	1	2	3