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ABSTRACT

A survey of all Kansas physical sciences (chemistry, general science, physical science, and physics) teachers (36 percent return rate) in the Spring of 1991 provided elements of a profile of physical sciences teachers and teaching. Findings are presented concerning teaching assignments, course enrollments, school demographics, teacher background and preparation, computers and their role in the science classroom, textbook adoptions, inclusion of field trips, laboratory safety, the "approach" to science teaching, inclusion of environmental education topics, perceptions of "academic responsibility," and background levels of confidence by teaching assignments in chemistry, physics, and physical/general science. The survey questionnaire and respondent data are appended. (Author)

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TITLE: Secondary-Level Physical Sciences Teachers and Teaching in Kansas: Survey Results from the Early 1990s

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Secondary-Level Physical Sciences Teachers and Teaching in Kansas: Survey Results from the Early 1990s

Introduction

In the spring, 1991 questionnaires were sent to Kansas science and mathematics teachers to address the following objectives: (1) to establish a profile of selected characteristics that indicate the current status of science and mathematics teachers and teaching in the State of Kansas; (2) to obtain information prior to the development of proposals which might address identified needs; and (3) to provide information to compare with similar surveys, Kansas and national, where possible.

Questionnaires were sent to all secondary-level certified biology, chemistry, earth science, general science, mathematics, physical science, and physics teachers reported by Kansas school principals to the Kansas State Department of Education. [See Appendix I for the questionnaire sent to "physical sciences" (chemistry, physics, physical and general science) teachers.] Different but parallel questionnaires were sent to a sample of grade-levels two and five elementary teachers to obtain information concerning elementary mathematics and science. Compilations and reportings have been made of the biological science (Schrock, 1992) and earth science (Yates, Thompson, and Backhus, 1994) findings. This document reports data (see Appendix II) and findings/conclusions for physical sciences (chemistry, physics, physical and general science) teachers.

The questionnaire (see Appendix I) solicited the following information concerning physical sciences teachers and/or science teaching:

- Respondent teaching assignment by period of the day, course title, and enrollment
- School demographics, e.g., size, school organization, etc.
- Teacher-respondent background information, e.g., educational background, teaching experience, teaching field certifications, etc.
- Computers in the classroom, attitudes toward and perceptions of
- Textbook adoptions
- Use of field trips, attitudes and opinions of
- Laboratory safety
- "Approach" to science teaching
- Environmental education
- "Academic responsibility" regarding teaching and learning "controversial" topics and
- Teacher levels of confidence in dealing with various content topics by teaching assignments in chemistry, physics, physical science, and/or general science.

Questionnaires were sent to 529 "physical sciences" teachers; 191 were returned for a 36 percent response/return rate (see Table 1, Appendix II). Because of the rural demographics of the State of Kansas, multiple teaching field certifications are normative and, indeed, essential in all but a few urban attendance centers. Consequently, data in Table 2, Appendix II are crucial to understanding the circumstances of Kansas science teachers and science teaching in the State. Of the 191 returned questionnaires from "physical sciences" teachers, 441 certifications including chemistry, earth science, general science, physical science, and/or physics were reported. This averages 2.3 (two to three) science certifications per respondent. Moreover, finding/conclusion ten (10) indicates that the average "physical sciences" teacher will have 3.6 (three to four) certifications. Thus, in addition to physical sciences certifications, certifications are often common in biology, mathematics, and disciplines outside of the sciences and mathematics. This is, perhaps, the outstanding finding which will --or should--influence reform efforts in Kansas or any rural state.

Data reflected by Table 3, Appendix II, is also germane to the representativeness of the data, and subsequent implications for a rural state. The response/return rate for teachers from small attendance centers was less than that expected based on the number of those attendance centers; conversely, the number returned from teachers at the largest schools is greater than expected. Consequently, one may infer that teachers from small high schools are less represented based on the distribution of schools by size, and the biology teacher in these small schools is typically the only high school science teacher who has been "drafted" to teach the physical sciences. (See note 2, Table 3).

Limitations inhere to any survey research. Two shortcomings became apparent following the solicitation and during the data analyses. Specifically, the questionnaire failed to solicit certain demographic information (e.g., age, gender, race/ethnicity) to compare with national surveys, or previous, similar surveys; and it was difficult to interpret data for specific disciplines and/or teaching field certifications of the physical sciences. The latter was anticipated; the former was not.

Following are salient findings/conclusions based upon the survey results from the "physical sciences" teacher-respondents.

Findings and Conclusions

1 **Teachers average 5.2, i.e. five (5) to six (6), class periods of instruction per day.**

Multiple sections of the same course may be taught for two or more class periods. However, the typical teacher of the physical sciences in Kansas will teach three (3) or more different subjects. (See finding/conclusion 11.) In addition to five (5) or six (6) different class periods, most respondents indicated a planning period and/or some other nonteaching commitment during a day's available class periods. (Most Kansas secondary schools have a six (6) or seven (7) period day See Appendix II, Table 4.) Implicit in the data are evidence of part-time teachers of one or more sciences only, schools which alternate chemistry and physics, and teachers who teach at more than one school (i.e., more than one attendance center within a district).

2 **Teachers contact 71 students per day, or 13 to 14 students per class.**

As might be expected in a state with rural demographics, the range of numbers of students contacted is large. About seven (7) percent of respondents reported contacting 20 or fewer students per day; see Appendix II, Table 5.

3 **The average class period is 51 to 52 minutes long.**

However, as may be noted by Table 6 data, appended (II), the range of reported class duration is large: 43 to 60 minutes, with 55 minutes characterizing the response of greatest frequency.

4 **The school's organizational configuration is most likely grades 9-12 (~65%), or grades 7-12 (~15%).**

See Appendix II, Table 7, for variations.

5 **Two sciences will most likely be "required" as interpreted by the teacher-respondents: biology and a physical science.**

The State of Kansas science requirement in the early 1990s for graduation from high school is "two units of credit, one of which is a laboratory course." The "unit" is the Carnegie unit, defined as 120 hours of instruction. There is no explicit specification of biological or physical science to meet this requirement (Vern Smith, Kansas State Department of Education, personal communication, March, 1993). See Table 8, Appendix II.

6 **Typically earth/general/or physical science will be offered for 9th graders, biology for 10th graders, chemistry for 11th graders, and physics for 12th graders.**

There is evidence (Appendix II, Table 9) that at least ten percent of the schools may not offer physics, and some schools alternate chemistry and physics offerings. These are consistent with national findings, although the percentage of schools and, hence, the proportion of the student population affected may be smaller on the national level than is the case for Kansas' schools and students (Marasco, 1992; Neuschatz and Covalt, 1988; and Neuschatz, 1992).

7 **If students are "grouped," it will most likely be for college-preparatory or learning-disability purposes (~30% each).**

Appendix II, Table 10 presents the tabulated teacher-respondent data.

8 **The most frequent highest degree possessed by a physical sciences teacher will be a masters degree.**

About 45 percent will have a bachelors degree as the highest degree, and slightly over half will have a masters degree. The balance will have a "specialist" or doctorate. Because of credentialing requirements for teaching, it is presumed that the bachelors degree is in education. The masters degree may be in a discipline taught, or may be in education with a cognate of supporting courses from the science disciplines taught. See Appendix II, Table 11 for respondent data. Baker and Brooks (1957), based on mid-1950s data, found that about one-third of Kansas science teachers possessed masters degrees, however, they noted "that more than half of these degrees were in education rather than science" (p.9). The composite percentage of Kansas physical sciences teachers with a masters degree (~50 percent) exceeds the national average, about 30 percent, for chemistry teachers (Marasco, 1992).

9 **The typical physical sciences teacher will have more than 12 years of teaching experience (~55%).**

The greatest frequency of response was some number of years of teaching greater than 12. An aging of faculty has been discerned (Neuschatz and Covalt, 1988); unfortunately the choices of response intervals were not sufficiently large to obtain a more precise indication of the number of years of teaching experience for Kansas respondents, and the corollary of an aging of teachers at the secondary level. However, the second most frequent response category, 15 percent for 1-3 years of teaching, suggests new entrants most likely due to retirements; see Table 12, Appendix II. Positions created by retirees is posited based on a knowledge of few new positions being created, and minimal position creation due to existing teachers leaving the profession.

A posited, current cohort of "senior" physical sciences teachers contrasts with mid-1950s circumstances for Kansas science teachers:

> The teachers of science [1955-1956] are a comparatively young group with relatively few years of experience.

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Almost half of them, or 49 percent, were under 35, while only 25 percent were above 50. As might be expected from the foregoing figures, more than half of the teachers, or 53 percent, had less than nine years of teaching experience; almost a third, or 32 percent, had less than five years (p.9).

10 **The average physical sciences teacher will have 3.6 certifications, i.e., will be certified to teach three (3) to four (4) of the science fields or possibly some other nonscience field.**

As indicated by data in Table 13, the Kansas "physical sciences" teacher survey respondents were most likely to possess credentials for teaching chemistry (167 of 191 or 87% respondents), followed by biology (119/191 or 62%), physics (117/191 or 61%), general science (54/191 or 28%), physical science (54/191 or 28%), and earth science (27/191 or 14%). It should be noted that biological science and earth science survey data were analyzed separately; yet the second most frequent field reported by "physical science" teacher-respondents was biology. This data corroborates the fact that the many smaller rural Kansas schools have only one "science" teacher. Mathematics was also a common nonscience teaching field, with credentials possessed by 56 of the 191 respondents. Others may be noted in Appendix II, Table 13. Multiple field teaching combinations in Kansas, including nonscience fields, is a circumstance that has been noted by science education researchers since the 1950s (Breukelman and Andrews, 1953; Breukelman and Andrews, 1956; and Baker and Brooks, 1957). The following conclusion, November 11, amplifies certification fields of survey respondents.

11 **Teaching three different subjects will be normative, including biology or mathematics.**

The typical respondent indicated three (3) to four (4) full fields of certification; the mean value was 3.6. Fewer than 13 percent reported one (1) or two (2) fields of certification. See Appendix II, Table 14. This data corroborates other indicators for multiple, related certifications which characterize the rural demographics of Kansas and its physical science teachers. One cluster of physical science teachers has biology as a teacning field, another cluster has mathematics teaching credentials. A tentative assertion is that many teachers had credentials first in biology, but then found it necessary to obtain credentials for a broader teaching assignment. Similarly, one with mathematics credentials may have been encouraged to obtain teaching credentials for physics to "help" a school provide a physics offering. These persons obtaining "second" field credentials are dubbed "draftees" by Marasco (1992). In her lexicon few teachers are science subject field "specialists," those with an earned degree in the discipline, or who started teaching a subject field as a specialty, and who have taught that field for a sustained period in their teaching careers (p.4). A sustained history of this circumstance in Kansas is corroborated by the citations noted in the discussion of the previous finding, and in Breukelman (1964).

Further evidence of a "science" teacher, rather than a physics, chemistry, or even a "physical science" teacher, is provided in Table 15, Appendix II. When data for 172 physical sciences teacher-respondents were analyzed to determine subject field combinations of teachers, 37 different combinations existed among the respondents! Within this reality, it is difficult to summon teachers by a teaching specialty to respond to reform initiatives. This reality also mitigates against reform efforts to prepare subject field specialists with only one teaching field unless the assignment (employment) is at a larger school in the State of Kansas. Such opportunities are generally available only for experienced teachers, not as a first-employment opportunity.

12 **Regarding inservice courses/workshops, the expressed preference is for a science course scheduled in the summer with face-to-face instruction.**

Respondents indicated the following preferences for inservice opportunities (Table 16, Appendix II): science (rather than non-science or education) courses (80%), summer courses (67%), and a "face-to-face" mode of delivery or instructional setting (23%). About 10 percent indicated a preference for each of long-distance delivery (Telenet/TV), or correspondence-formatted courses. Even though these preferences were expressed, considerable other obligations and distractions faced by teachers may mitigate against this expressed "ideal."

13 **Over 80% of physical science teachers will have had a workshop/inservice course considered "useful" within the past three (3) years.**

Over 80 percent (Table 17, Appendix II) reported that they had attended a "useful" science course or workshop within the past four years. Depending upon the nature of the course or workshop, this may indicate a robust level of "physical sciences" teacher renewal and commitment, assuming a representative reporting "sample." Or, respondents may recognize a lack of preparation or deficiences and thus update or increase their background knowledge base.

Respondents were queried for the availability and use of computers in their science classrooms. Findings 14 through 18 are based on the computer-related questions. The questionnaire section from which findings 14-18 were developed concerned computers in the classroom: their availability, uses (see Table 18, Appendix II), previous instructional activity displaced (Table 19), and budget source(s) for computer hardware (Table 20) and software (Table 21), teacher-respondent perceptions of role of computers in science classes (Table 22), and computer nameplates available (Table 23).

14 **Over 85% of physical sciences teachers have computers available which are used most frequently for individual student remediation (80%), word-processing (40%), and/or simulations (40%).**

15 **Time for computer use has more generally displaced lecture (~43%) rather than laboratory (~30%) time or perhaps "homework" time.**

16 **Budgets for purchase of computer hardware have generally been external to the science budget, but software is more frequently purchased from the science budget.**

17 **Teachers perceive computers as "another tool" for accomplishing instructional objectives.**

It may be noted in Table 22 (Appendix II) that the majority of respondents consider computers to be another "tool" or "instructional strategy" (see Table notes). However, some respondents offered a range of additional perspectives: a lack of computer familiarity, a means (computers) to supplant all else in science instruction, a motivational device or tutorial aid, a fear that it might supplant laboratory activity, or a ruse for an incompetent teacher. Responses suggest that computer hardware and software are generally viewed as an instructional technology--an alternative strategy--that may effectively augment science teaching when used judiciously.

18 **Ninety-five (95) percent of the schools possessing computers have computers with an Apple nameplate; 25% have IBM or IBM-compatible.**

19 **Holt Rinehart & Winston or Merrill have the majority of the textbook market: chemistry (43 and 22%), physics (32 and 39%), physical science (35 and 20%), general science (39 and 15%), and earth science (42 and 17%).**

Respondents were asked to list the textbooks used in their various courses. Chemistry texts used are indicated in Table 24 (Appendix II); physics, Table 25; physical science, Table 26; general science, Table 27; and earth science, Table 28.

20 **Fewer than 40% of physical sciences teachers take all of the field trips considered necessary. Administrative "red tape" is considered the major impediment.**

A questionnaire section concerned field trips (see Appendix I). Table 29 (Appendix II) presents responses concerning attitudes toward, need for, duration, and reasons for reducing the number and duration of field trips. Several significant impediments to field trips--their perceived value, administrative hassles, cost, alternatives to, etc.--seemingly curtail the use of field trips as a supplement to classroom and laboratory instruction. Table 30 suggests that more field trips would be utilized if administrative support and adequate budgets existed.

21 **Laboratory safety is a concern for which instructional time is spent; teachers plan for it as their responsibility, 50% have purchased liability insurance, and nearly 50% have students sign a document regarding laboratory and safety procedures.**

Table 31, Appendix II, amplifies findings/conclusions regarding laboratory safety. With increased emphasis on laboratory safety, a propensity to litigate in the present social context, and concerns for appropriate disposal of chemical substances, one can understand that science teacher anxiety has increased concerning these matters. A most serious consequence might be the reduction of laboratory-based instruction in the physical sciences.

22 **About 45% of physical sciences teachers describe their approach to science teaching as "doing occasional experiments and reading from text(s)," and another 45% describe their approach as "experimenting regularly with supplemental reading."**

23 **In most instances (~67%) the laboratory is a verification exercise; for the other one-third it is an introduction to a concept or topic.**

24 **The greatest impediments to laboratory-based instruction appear to be insufficient budgets for equipment and supplies, perceived time constraints, laboratory space, and assistance with laboratory preparations.**

Table 32, Appendix II, presents teacher responses supporting findings/conclusions 22, 23, and 24 regarding approach to science teaching.

Nearly half of the respondents "do occasional experiments and read from text(s)," virtually a like number "experiment regularly with supplemental reading." The current state of science teaching may be characterized by pedagogical strategies of "read and recitation." Emphasis on hands-on, inquiry-oriented and laboratory-based instruction extolled in the post-Sputnik decades (following the late 1950s) apparently has lapsed to the more traditional modes of instruction endemic to the pre-1960s. Perhaps the generation of teachers influenced by curricula and inservice teacher implementation workshops in the late 1950s and early 1960s are completing or have completed their teaching careers. Perhaps the other "distractions" of teaching, inadequate budgets, shortcomings of preservice teacher preparation, and an external social context somewhat "indifferent" to education (in spite of bludgeoning criticism) have contributed to the present circumstance. These Kansas findings are similar to national findings for high school chemistry and physics teachers (Marasco, 1992; Neuschatz, 1992; and Neuschatz and Covalt, 1988).

Evidence contributing to finding/conclusion 23 (i.e., experiments "illustrate concept[s] or topic[s] previously presented" versus experiments "conduct[ed] as an introduction") suggests that, when conducted, experiments are utilized more for "verification" of the previously "learned" rather than the "grist" for inquiry.

25 **More than half of physical sciences teachers devote one or more class periods to "environmental education" topics such as alternate energy sources, ozone depletion/global warming, water pollution, acid rain, nuclear waste, and air pollution (in descending order of time devoted to).**

The environmental topics noted in finding 25 elicited a "yes" response from greater than 50 percent of respondents. Four other topical choices, including "a conservation ethic," registered less than 50 percent from respondents (see Table 33, Appendix II).

26 **Nearly 70% of physical sciences teachers believe they "have the freedom to teach any ideas I choose."**

Regarding "academic responsibility," seven of ten teachers feel they may use their professional judgement to include any topics legitimately within the domain of the physical sciences; three of ten believe that "students have a legal right to 'opt out' of any classes in which there are family religious objections." Even in a state where public schooling is normative, 30 percent of physical sciences teachers may "lose" students where physical science perspectives are germane to the topic under consideration.

27 **Chemistry teachers (~90%) expressed greatest confidence with "topics" such as balancing equations, the gas laws, atomic theory, stoichiometry, the periodic law, and nomenclature, but the least confidence with nuclear chemistry, kinetics, molecular spatial geometry, and buffers.**

28 **Physics teachers (~90%) expressed greatest confidence with traditional kinematics (velocity, acceleration) and mechanics**

topics (Newton's laws), but the least confidence with relativity, magnetism and magnetic fields, and specifics of thermodynamics.

29 **Physical/general science teachers (~90%) expressed greatest confidence with topics from basic chemistry (e.g., chemical equations, states of matter, atomic model of matter), but the least confidence with earth/space science topics (e.g., stars and stellar evolution, air masses, fronts, and storms, and specific geologic processes).**

Tables 35 through 37, Appendix II, present reported levels of confidence for chemistry, physics, and physical/general science teacher survey respondents. Highest confidence seems to be with factual, basic topics of the disciplines, and least confidence with topics requiring higher order thinking and understanding (e.g., syntheses of, and extensions from, foundations of the discipline). Further, this finding may be a consequence of a minimal academic preparation of physical sciences teachers. Other conclusions might be generalized from these findings, however, inclusion of these items on the survev regarding teacher confidence was intended to meet one of the survey objectives: to determine information which might guide proposal development and inservice workshop planning to meet perceived statewide (Kansas) needs.

Following are Appendix I with the survey questionnaire, Appendix II which contains the raw data and notes from each survey item, a bibliography of citations, and acknowledgments.

APPENDIX I

Survey Questionnaire for Physical Sciences Teachers, Spring 1991

NOTE: The actual survey questionnaire was printed on both sides of 8.5 x 14-inch paper, and folded once to produce a four-page-format questionnaire with 7 x 8.5-inch dimensions.

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CHEMISTRY/PHYSICS/PHYSICAL SCIENCE/GENERAL SCIENCE

1a. I teach the following classes:

Period	Course	No. of Students
1	____________________	______
2	____________________	______
3	____________________	______
4	____________________	______
5	____________________	______
6	____________________	______
7	____________________	______
8	____________________	______

1b. The total number of students in my school is: (circle one)

0-49	100-199	400-499
50-74	200-299	500-999
75-99	300-399	1000+

1c. How many minutes in an average class period? _____ min

1d. My school includes grades (circle)

K 1 2 3 4 5 6 7 8 9 10 11 12

1e. At my school a student must take (circle those that apply):

Earth Science Physical Science Chemistry
Physics General Science

1f. Most of the students in my school take the following courses during which year of school?

Biology	(9)	(10)	(11)	(12)
Chemistry	(9)	(10)	(11)	(12)
Physics	(9)	(10)	(11)	(12)
Earth Science	(9)	(10)	(11)	(12)
Physical Science	(9)	(10)	(11)	(12)
General Science	(9)	(10)	(11)	(12)

1g. My school's science program makes provisions for grouping students into the following categories: (circle all that apply)

Vo-Tech College-Prep Gifted Learning-Disabled
Physically-handicapped

2a. My highest degree is: BA/BS/BSE ( ), MS/MA ( ), EdS ( ), PhD/EdD ( ).

2b. My years of teaching experience including this year (circle)

1-3   4-6   7-9   10-12   12+ years

2c. I am fully certified to teach: ______________, ______________, ______________

2d. I am provisionally certified to teach: ______________, ______________

2e. Institution where I took my last college science course: ______________________

2f. For inservice courses to update my professional knowledge, I prefer: (mark all that apply)

Science courses .... ( )
Non-college workshops .... ( )
TELENET-TV .... ( )
Summer courses .... ( )
Late afternoon courses .... ( )
Education courses .... ( )
Weekend courses .... ( )
Face-to-face coursework .... ( )
Correspondence courses .... ( )

2g. How long has it been since you participated in a science course or science inservice workshop that you believe improved your competence and confidence in teaching: (circle)

1 year   2-4 years   5-7 years   7+ years   never

3. **Computers in the Science Classroom:** (mark all that apply)

3a. I do not have, and my school does not provide, computers for teacher or student use (go to 4) .... ( )

3b. Computers are available for my students (go to 3c-h) ... ( )

3c. I utilize student-accessed computers for:
Drill-and-practice in day-to-day lessons .... ( )
Individual remediation .... ( )
Data management .... ( )
Independent advanced projects for students .... ( )
Simulations .... ( )
On-line access to outside resources .... ( )
Word-processing for report writing .... ( )
Interface with experiments to analyze real data .... ( )
Other ____

3d. Additional computer use must come out of **some** time allotment. I perceive student computer use as replacing:

Lecture Time ( )   Laboratory ( )   Other ___________

3e. Money to buy computers, printers (hardware):
Was subtracted from the budget for lab equipment .... ( )
Was external to the science budget .... ( )
Other ____

3f. Money to buy programs, etc. (software):
Was subtracted from the budget for lab equipment .... ( )
Was external to the science budget .... ( )
Other ____

3g. I perceive student computer use in science classes as:
A major improvement over lectures, labs, discussion .... ( )
Just another tool like a typewriter, calculator, etc. .. ( )
A serious threat to real labs, field trips, etc. .... ( )
Other ____

3h. Our school science computers are (mark all that apply)
TRS 80 ( ) Apple IIc/e ( ) MacIntosh ( )
IBM PC/PS/XT/AT ( ) Commodore ( )
Other ______________

4. **Textbooks:** I use the following textbook(s) in my science course(s):

5. **Field Trips:** (mark all that apply)

5a. I have never taken nor need to take field trips .... ( )

5b. My field trips never go beyond one class period .... ( )

5c. I take all of the trips that I feel are necessary ...... ( )

5d. I have reduced numbers and lengths of trips due to:
They are not as valuable as other classwork .... ( )
Administrative "read tape", insurance, etc. .... ( )
Cost of trips has become too high .... ( )
Use of VCR and other media replace need for trips ...... ( )
Other ____

5e. I feel confident that I have sufficient experience in the field to conduct trips with my students .... ( )

5f. I am not aware of anything in my local area to take my classes to study .... ( )

5g. I would take more field trips if:
The administration supported and encouraged it .... ( )
More money were available .... ( )
Other ____

6. **Lab Safety:** (mark all that apply)

6a. I do not conduct labs (go to 7) .... ( )

6b. Safety rests solely in my planning and care .... ( )

6c. I spend substantial time instructing on lab safety ..... ( )

6d. I require students to sign a statement that they have read and understand lab safety procedures in class ..... ( )

6e. I carry liability insurance to cover myself in class ... ( )

7. **Approach to Science:** Which of the following best describes your approach to teaching science? (mark one)
We read one science text .... ( )
We read from multiple textbooks .... ( )
Do occasional experiments and read from text(s) .... ( )
We experiment regularly with supplemental reading ...... ( )

7a. The following best describes the way MOST "experiments" are done in my classes: (mark one)

As teacher demonstrations .... ( )
Students conduct experiments that illustrate a concept or process that has already been presented .... ( )
Students conduct experiments as an introduction and/or predominant part of most units .... ( )
We don't perform experiments .... ( )
Other ____

7b. I would do more lab experiments if:

The administration supported and encouraged .... ( )
More space were available .... ( )
Money to purchase equipment and supplies .... ( )
Other ____

8. **Environmental Education:**

I spend one class period or more on: (mark all that apply)

Acid rain ( ), Soil erosion ( ), Ozone/global warming ( ), Water pollution ( ), Solid waste recycling ( ), Air pollution ( ), Sewage disposal ( ), Nuclear waste ( ), A conservation ethic ( ), Alternate energy sources ( ).

9. **Academic Responsibility:** (mark one)

I believe students have a legal right to "opt out" of any class in which there are family religious objections .... ( )
I can only teach concepts presented in approved texts .. ( )
I have the freedom to teach any ideas I choose to ...... ( )

If you teach Chemistry, continue to #10. If you teach Physics go to #11. If you teach a course in Physical Science and/or General Science, go to #12. If you teach General Science with biological sciences topics, continue to #13.

10. **Chemistry:** Please indicate with a number (5-1) your level of confidence in dealing with each of the following topics in the classroom.
(5) highly confident............total lack of confidence (1)
Atomic theory .... ( )
Chemical equilibrium .... ( )
Oxidation and reduction .... ( )
Entropy .... ( )
Stoichiometry .... ( )
Acid-based titration and pH .... ( )
Consumer chemistry .... ( )
Lewis structures .... ( )
Equations, molecular, ionic, balancing .... ( )
Phase change and energy involved .... ( )
Chemical bonding .... ( )
Periodic Law .... ( )
Gas laws .... ( )
Nomenclature .... ( )
Reaction types .... ( )
Buffers .... ( )
Organic chemistry .... ( )
Kinetics .... ( )
Spatial geometry (shapes of molecules) .... ( )
Nuclear and subnuclear particles .... ( )

11. **Physics:** Please indicate with a number (5-1) your level of confidence in dealing with each of the following topics in the classroom.
(5) highly confident............total lack of confidence (1)
Graphing .... ( )
Acceleration and velocity .... ( )
Moving coordinate systems .... ( )
Circular motion .... ( )
Forces, and analysis of .... ( )
Relativistic kinetic energy .... ( )
Conservation of momentum .... ( )
Wave phenomena .... ( )
Angular momentum .... ( )
Torque .... ( )

The laws of thermodynamics .... ( )
The nature of light .... ( )
Quantum theory .... ( )
Heats of fusion, vaporization and sublimation ...... ( )
Vectors .... ( )
Newton's Laws .... ( )
The dot product .... ( )
Harmonic motion .... ( )
Work/energy theorem .... ( )
Energy and forms of .... ( )
Kepler's Laws .... ( )
Impulse .... ( )
Gas laws .... ( )
Entropy .... ( )
Carnot's Theorems .... ( )
Magnetic fields .... ( )
Relativity .... ( )
Electrical currents and circuits .... ( )

12. **Physical Science/General Science:** Please indicate with a number (5-1) your level of confidence in dealing with each of the following topics in the classroom:
(5) highly confident............total lack of confidence (1)
Planets and planetary motion .... ( )
Atomic model of matter .... ( )
Molecular motion and temperature .... ( )
Density and pressure of a gas .... ( )
Evolution of stars .... ( )
Humidity and clouds .... ( )
Currents and conductors .... ( )
Air masses, fronts and storms .... ( )
Chemical equations .... ( )
Weather and climate .... ( )
Physical and chemical properties and change .... ( )
Geologic processes-agents or erosion, weathering, etc. .... ( )
States of matter .... ( )
Relativity .... ( )
Energy, forms of .... ( )
Magnetism .... ( )
Electrostatics .... ( )
Weather maps .... ( )
Nuclear energy .... ( )
Light .... ( )
Wave phenomena .... ( )
Weather maps .... ( )

13. **General Science:** If you do **not** teach General Science, please skip to #14; otherwise complete the following:

My general science classes include (mark one):
- Only physical science topics .... ( )
- Only biological science topics .... ( )
- Both physical and biological science topics .... ( )

Check any of the topics listed below in which you DO NOT feel confident teaching:
- The "scientific method" .... ( )
- The five kingdoms .... ( )
- Survey of plants .... ( )
- Survey of animals .... ( )
- Human reproduction .... ( )
- Human diseases .... ( )
- Heredity and genetics .... ( )
- Cells .... ( )
- Evolution .... ( )
- Human body systems .... ( )
- Alcohol/drug abuse .... ( )
- Classification/identification .... ( )

14. Are there any other topics that were not mentioned here that you feel somewhat inadequate covering in your classes?

APPENDIX II

Data From Spring 1991 Survey of Kansas
Physical Sciences Teachers

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TABLE 1

Spring 1991 Science and Mathematics Teacher Components

Teacher Category	Surveys Sent	Number Returned	Percent Return
Elementary Science Grades 2 & 5	1356	570	42.0
General Science/Earth Science/ Junior High Science	1305	375	28.7
Biology, Grades 7-12	785	296	37.7
Chemistry/Physics/Physical and General Science	529	191	36.1

NOTE: Survey conducted by Emporia State University Science and Mathematics Education Center, Spring 1991.

TABLE 2

Kansas Certification Data(2)/Survey Comparisons

Subject Certification	Number Certifications(2)	Returned Certifications(3)	Percent Return
Chemistry	418	167	39.9
Earth Science	103	27(4)	26.2
General Science	726	76(5)	10.5
Physical Science	158	54	34.2
Physics	292	117	40.1

NOTES:

(1) N=1697.

(2) 1990-1991 school year data as reported by the Kansas State Board of Education; total number of certifications [1697] exceeds total number of individuals based on multiple certifications by each individual.

(3) Inferred from survey respondent data; total returned certifications exceeds N=191 returned surveys based on multiple certifications by individual teachers.

(4) Earth science data tabulated separately.

(5) Inferred that majority of general science teachers among General Science/Earth Science/Junior High Science teacher-respondent data analyzed separately from this report of findings.

TABLE 3

Teacher-Respondent School Size Compared to State Data for School Size

School Enrollment (Number Students)	Number Survey Respondents	Percent Survey Respondents	KSHSAA Data (1) Number High Schools	Percent High Schools
0- 49	4	2.1	57	15.7
50- 74	11	5.8	52	14.3
75- 99	22	11.6	40	11.0
100-199	48	25.4	99	27.3
200-299	23	12.2	32	8.8
300-399	24	12.7	14	3.9
400-499	6	3.2	13	3.6
500-999	21	11.1	37	10.2
>1000	30	15.9	19	5.2
	N=189		N=363	

NOTES:

(1) Data for 1992-93 academic year, enrollments based on grades 10-11-12, from Kansas State High School Activities Association, 1993.

(2) Infer that teachers from small high schools less represented because teacher of biology typically only high school science teacher who also teaches chemistry, physics, etc. From data for 296 biology teachers, other sciences taught included chemistry [67], physical science [46], general science [43], and physics [24]. See Schrock, 1992.

(3) Survey data obtained from survey (questionnaire) item 1b.

TABLE 4

Survey Item 1a. Number of Class Periods Taught (excluding study halls, planning periods, etc.)

Number Teaching Periods	Number Respondents	Percent Respondents
1	6	3.2
2	4	2.2
3	5	2.7
4	11	5.9
5	71	38.4
6	81	43.8
7	7	3.8

NOTES:

(1) N=185.

(2) Some teachers teach part-time: reflected by 1-3 periods.

(3) Some schools alternate chemistry and physics.

(4) Several teachers teaching at two schools.

TABLE 5

Survey Item 1a. Total Number Students Per Teacher-Respondent

Number Students	Number Teachers Reporting	Percent Teachers Reporting
<10	5	2.7
11-20	8	4.3
21-30	5	2.7
31-40	5	2.7
41-50	17	9.1
51-60	27	14.4
61-70	16	8.6
71-80	31	16.6
81-90	20	10.7
91-100	26	13.9
>100	27	14.4

N=187

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TABLE 6

Survey Item 1c. Number Minutes in Average Class Period

Number Minutes	Number Respondents	Percent Respondents
≤49 (2)	38	20.0
50	47	24.7
51-54	37	19.5
55	58	30.5
≥56 (3)	10	5.3

NOTES:

(1) N=190.

(2) Range 43 to 49.

(3) Range up to 60.

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TABLE 7

Survey Item 1d. Grades in School/School Organization

Grades	Number Responses	Percent Responses
6-8	2	1.1
K-12	14	7.4
5-12	1	0.5
7-12	31	16.5
8-12	2	1.1
9-12	119	63.3
10-12	19	10.1

N=188

TABLE 8

Survey Item 1e. Sciences Required at School

Subject	Percent Yes	Percent No
Earth Science	20.1	79.9
Physical Science	36.5	63.5
Chemistry	7.9	92.1
Physics	5.8	94.2
General Science	23.7	76.3

NOTES:

(1) N=189.

(2) Conclude a poorly written question.

(3) On a parallel biology questionnaire, 62% of respondents indicated "yes" to biology.

(4) Inference that 1 or 2 sciences required for graduation. Biology generally taken with choice of some other science offered which may be one of the above; a "physical science" most likely specified as one if two sciences are required.

TABLE 9

Survey Item 1f. Grade Level Various Course Offerings

Course	Grade Level ("Yes" responses) 9	10	11	12	N
Biology	12.8	86.2	0.5	0.0	188
Chemistry	0.0	3.8	81.0	15.1	185
Physics	0.0	1.4	16.2	82.4	169(1)
Earth Science	61.6	24.2	10.4	4.1	65(2)
Physical Science	81.7	12.8	4.5	2.3	114(3)
General Science	86.4	11.7	1.6	0.3	75(3)

NOTES:

(1) Infer that about 11.5% of schools responding may not offer physics.

(2) Infer that about 66.0% of schools may not offer earth science.

(3) Schools may use course names "general" and "physical" science interchangeably.

(4) Conclude rather standard offering of earth/physical/general science at grade 9, biology at grade 10, chemistry at grade 11, and physics at grade 12. Evidence of schools with alternate year offerings of chemistry and physics.

TABLE 10

Survey Item 1g. Students grouped/tracked by

Grouping	Percent "Yes"
Vocational-technical	9.0
College-preparatory	31.4
Gifted	17.0
Learning-disabled	27.7

N=188

TABLE 11

Survey Item 2a. Highest Degree of Respondent

Degree	Number	Percent
Bachelors	82	44.3
Masters	97	52.4
Specialist	2	1.1
Doctorate	4	2.2

N=185

TABLE 12

Survey Item 2b. Years of Teaching Experience

Years	Number	Percent
1-3	28	15.3
4-6	20	10.9
7-9	15	8.2
10-12	16	8.7
>12	104	56.8

NOTES:

(1) N=183.

(2) Poor intervals of choice; too little opportunity to distinguish at higher values.

(3) "Aging" of faculty conjecture impossible to discern unequivocally.

TABLE 13

Survey Item 2c/d. Subject Matter Certifications

	Subject Area (Number Certifications)					
	BI	CH	PH	ES	PS	GS
Full	119	167	117	27	54	76
Provisional	4	5	6	5	2	3

NOTES:

(1) N=191.

(2) BI=biology, CH=chemistry, PH=physics, ES=earth science, PS=physical science, and GS=general science.

(3) Other Certifications:

Full: Mathematics [56], Computer science [19], Psychology [9], Physical education [7], Counseling [2], Social sciences [2], and Business, Music, Speech, English, Administration, Aeronautics, Photography, Gifted, Journalism, Health, Spanish, Driver education, and Agriculture one [1] each.

Provisional: Computer science, Technology, Photography, and Mathematics, one [1] each.

TABLE 14

Frequency Distribution of Number Full Certifications

	Full Certifications (Number)				
	1	2	3	4	5
Number respondents	1	19	65	34	39
Percent respondents	<1	12.0	41.9	21.5	24.7

NOTES:

(1) N=158.

(2) Typical "physical sciences" teacher possesses 3 to 4 subject matter certifications. (The mean value is 3.6.)

(3) Conclude multiple, related certifications essential to rural demographics of Kansas.

TABLE 15

Science Teaching Combinations--Frequency >2

Subject(s)	Number	Subjects	Number
BI only	3	BI-CH-ES	6
CH only	17(3)	BI-PH-PS	3
PH only	6(5)	CH-ES-PH	2
CH-BI	17	CH-GS-PH	7
CH-PH	17	CH-PH-PS	12
CH-PS	7	PH-ES-PS	2
GS-PH	2	PH-CH-MA	4
PH-PS	4	PH-PS-MA	2
CH-MA	3	CH-BI-ES-PH	2
PH-MA	9	CH-BI-ES-GS	3
BI-CH-PH	10	CH-ES-PH-PS	3
BI-CH-PS	8	CH-BI-PH-PS/GS	8
BI-CH-GS	15		

NOTES:

(1) BI=biology, CH=chemistry, ES=earth science, GS=general science, PH=physics, PS=physical science, MA=Mathematics.

(2) N=190 for this response item. The total tabulated above is 172.

(3) A variation in the nature of chemistry courses taught was reported.

(4) Two [2] respondents were teaching only one [1] class/day; a part-time teacher is inferred.

(5) Three [3] respondents of the six [6] reporting teaching PH only were teaching only 1 physics class/day; again the inference is of a part-time teacher.

(6) Thirty-seven [37] combinations of subjects were reported!

(7) Other subjects combined with sciences in addition to mathematics included "technology" [8], computer science [7], photography [3], physical education [2], "environmental" science [2], and business [1].

TABLE 16

Survey Item 2f. Respondent Preferences Regarding Inservice Courses

Factor/Characteristic	"Yes"
Science Courses	79.5
Summer Courses	67.4
Weekend Courses	24.7
Face-to-face Instruction	23.2
Education Courses	17.4
Non-college Workshops	15.3
Late-afternoon Courses	11.1
Telenet/TV	10.5
Correspondence Courses	9.5

NOTES:

(1) N=190.

(2) Conclude preference for summer science course taught in conventional classroom mode.

TABLE 17

Survey Item 2g. Time Since Last "Useful" Science Course or Inservice Workshop

Time [year(s)]	Number	Percent
1	101	53.7
2-4	54	28.7
5-7	14	7.4
>7	14	7.4
Never	5	2.7

N=188

Computers in the Science Classroom

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TABLE 18

Computers in the Science Classroom (Survey Items 3a-c)

		Percent "Yes"
3a.	Do <u>not</u> have computer(s), n=23	12.1
b.	Computers are available, n=167	87.9
c.	Utilize student-accessed computers for:	
	Drill-and-practice	7.9
	Individual remediation	79.6
	Data management	23.2
	Independent advanced projects	20.5
	Simulations	39.5
	On-line access to external resources	31.6
	Word-processing for report writing	40.0
	Interfacing to analyze data	7.9

NOTES:

(1) N=190.

(2) Other reported uses: Students use during free time; teacher uses, not students; use determined by student interest; used by high achievers; plan more use in future; interface with laser disc; use for student records; computers available but not in science classroom.

TABLE 19

Survey Item 3d. Computer Use Displaced

	Percent "Yes"
Lecture time, n=80	42.6
Laboratory time, n=57	30.3

NOTES:

(1) N=188.

(2) Other: Drill and exercise/homework time [8]; some of both lecture and laboratory time [3]; before/after school; "free time."

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TABLE 20

Survey Item 3e. Computer Hardware Budget Source

	Percent "Yes"
Subtracted from laboratory budget	6.4
External to science budget	73.4

NOTES:

(1) N=188.

(2) Other: Both above; computers "loaned" from elsewhere in school; grants; computer lab discard; discard from elsewhere; special fund-raising project(s).

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TABLE 21

Survey Item 3f. Computer Software Budget Source

	Percent "Yes"
Subtracted from laboratory budget	47.9
External to science budget	35.6

NOTES:

(1) N=188.

(2) Other: Library budget; have limited software.

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TABLE 22

Survey Item 3g. Perceptions of Student-computer-use in Science Classes

	Percent "Yes"
A major improvement over lectures, labs, discussion	18.0
Another tool like calculators, typewriters, etc.	63.0

NOTES:

(1) N=189.

(2) Other: Another method of instruction or teaching tool [3], a major supplement [3], something integrated into what trying to do [2], lack of usable software [2], unfamiliar with what is available, future generations could use to replace all else, motivator for students to answer own questions, a tutorial aid, should not replace hands-on investigation, an "out" for incompetent teachers, an opportunity for individual student advancement.

TABLE 23

Survey Item 3h. School's Science Computer Nameplates

Brand/Model Name	Percent "Yes"
TRS 80 (i.e., Radio Shack)	5.8
Apple II c/e	72.0
MacIntosh (Apple)	23.3
IBM PC/PS/XT/AT	24.3

NOTES:

(1) N=189.

(2) Instructions were to "mark all that apply."

(3) Other: Apple II GS [8], Tandy [2].

Textbooks

TABLE 24

Textbooks Used in Chemistry Courses
(Survey Item 4)

	Number	Percent
Holt Rinehart & Winston Modern Chemistry	58	43.0
Merrill Chemistry: A Modern Course	29	21.5
Heath Chemistry: Experiments and Principles	16	11.9
ACS Chem Com	9	6.7
Prentice-Hall Chemistry: The Study of Matter	9	6.7
Addison-Wesley Chemistry	8	5.9
Totals	129	95.5

NOTES:

(1) N=135.

(2) Five [5] others mentioned by remaining 6 respondents.

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TABLE 25

Textbooks Used in *Physics* Courses
(Survey Item 4)

	Number	Percent
Merrill *Physics*: *Principles & Problems*	32	39.0
Holt Rinehart & Winston *Modern Physics*	26	31.7
Addison-Wesley *Physics*: *Methods & Meanings*	8	9.8
Allyn & Bacon *Physics*: *Methods & Meanings*	3	3.7
Harcourt Brace & Jovanovich *Physics*	3	3.7
Prentice-Hall *Physics*	3	3.7
Totals	75	91.5

NOTES:

(1) N=82.

(2) Six [6] others mentioned by remaining 7 respondents.

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TABLE 26

Textbooks Used in Physical Science Courses
(Survey Item 4)

	Number	Percent
Holt Rinehart & Winston *Modern Physical Science*	14	35.0
Merrill *Focus on Physical Science*	8	20.0
Prentice-Hall *Science*	5	12.5
IPS	3	7.5
Scott Foresman *Physical Science*	3	7.5
Totals	33	82.5

NOTES:

(1) N=40.

(2) Four [4] others mentioned by remaining 7 respondents.

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TABLE 27

Textbooks Used in General Science Courses
(Survey Item 4)

	Number	Percent
Holt Rinehart & Winston General Science	10	38.5
Harcourt Brace & Jovanovich Physical Science	6	23.1
Merrill General Science	4	15.4
Totals	20	76.9

NOTES:

(1) N=26.

(2) Four [4] others mentioned by remaining 6 respondents.

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TABLE 28

Textbooks Used in Earth Science Courses
(Survey Item 4)

	Number	Percent
Holt Rinehart & Winston Modern Earth Science	10	41.7
Merrill Focus on Earth Science	4	16.7
Heath Earth Science	3	12.5
Totals	17	70.8

NOTES:

(1) N=24.

(2) Five [5] others mentioned by remaining 7 respondents.

Field Trips

TABLE 29

Survey Items Regarding Field Trips (Items 5a-d)

		Percent "Yes"
a.	Never take nor need to take	11.6
b.	Field trips limited to one class period	12.6
c.	Take all trips considered necessary	37.9
d.	Reduced number or lengths of trips due to:	
	i. Not as valuable as class work	12.6
	ii. Administrative "red tape", insurance, etc.	34.7
	iii. Cost too great	27.4
	iv. Available media replaced need	22.6
	v. Other: Field trip to KC amusement park for physics sponsored by Northwest Kansas Alliance for Science; too many students; students currently miss too many classes; liability concerns; immaturity of students; difficulty covering classes teacher misses; time; lack of cooperation from potential site personnel; limitations imposed on number/distance of trips; causes students to miss other classes; difficult to schedule around other school activities; limited opportunities in area; administrative restrictions because of numerous athletic-based absences; administrative and board politics; use weekends to avoid missing class time; money-raising projects to finance field trips; cost factors. (Those underlined received multiple mentions.)	

N=190

TABLE 30

Survey Item 5g. I would take more field trips *if*:

		Percent "Yes"
a.	The administration supported/encouraged	29.5
b.	More money were available	36.8
c.	Other (based on multiple responses):	
	I were aware of appropriate sites.	
	Students didn't miss classes.	
	Time weren't a constraint.	
	Students were more interested.	
	"Red tape" were decreased.	
	Transportation more easily arranged.	
	More nearby opportunities were available.	

N=190

Laboratory Safety

TABLE 31

Survey Items Regarding Laboratory Safety (Survey Items 6a-e)

		Percent "Yes"
a.	I do not conduct labs (n=3)	1.6
b.	Safety is solely in my planning and care	64.7
c.	Spend time instructing lab safety	72.1
d.	Require students to sign statement that have read and understand lab safety procedures	46.3
e.	Have purchased liability insurance	50.0

N=190

Approach to Science Teaching

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TABLE 32

Survey Items Regarding Approach to Science (Survey Items 7a and b)

	Percent "Yes"
Approach in general:	
Read one science text	27.4
Read multiple texts	11.6
Do occasional experiments and read from text(s)	46.8
Experiment regularly with supplemental reading	44.7
The laboratory in particular:	
a. Most "experiments" are conducted as follows:	
As teacher demonstrations	8.9
Students conduct to illustrate concept or topic previously presented	67.4
Students conduct as an introduction	32.1
Don't perform experiments	1.1
Other: Require formal write-ups on all experiments; do open-ended, even research in biology labs; do very few experiments (physics).	
b. Would do more lab experiments if:	
Administration supported and encouraged	1.6
More space were available	23.7
Additional money to purchase equipment and supplies	42.1
Other: If more time [37]; if lab assistance were available for preparations [4]; if smaller class sizes [2]; if considered seriously by students [3]; if knew more good labs on topics [2]; if weren't so concerned with safety and liability [2]; if more equipment; if laboratory outcomes were more successful; if had science room during planning period; if had more earth science experience (5 sections ES, not certified); if had separate lab room; if did not share time between two schools; if students actually benefitted; if labs improved lecture topics.	

Environmental Education

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TABLE 33

Survey Item 8. Environmental Education

	Percent "Yes"
I spend one or more class periods on:	
Alternate energy sources	58.2
Ozone depletion/global warming	56.3
Water pollution	55.8
Acid rain	54.7
Nuclear Waste	51.1
Air pollution	50.5
A conservation ethic	37.9
Solid waste recycling	34.2
Soil Erosion	32.1
Sewage disposal	25.8

N=190

Academic Responsibility

TABLE 34

Survey Item 9. Academic Responsibility

	Percent "Yes"
I believe students have a legal right to "opt out" of any class in which there are family religious objections	29.1
I can only teach concepts presented in approved texts	12.1
I have the freedom to teach any ideas I choose	69.3

NOTES:

(1) N=189.

(2) Unsolicited comment: "I remind myself and my students that in 'touchy areas' I function as an observer, not as an advocate except in [a] scientific means. I don't think a student should opt out of honest science."

Levels of Confidence With Various Topics

TABLE 35

Chemistry Teacher Level of Confidence With Selected Topics

Rating Scale:
Highly confident 5 4 3 2 1 Total lack of confidence

Per cent of respondents reporting 5 or 4:

Topic	Percent
Equations, molecular/ionic balancing	94.9
Gas laws	91.5
Atomic theory	89.8
Stoichiometry	89.7
Periodic law	88.9
Nomenclature	88.9
Reaction types	84.9
Chemical bonding	81.6
Acid-base titration and pH	78.0
Phase change and energy involved	76.8
Chemical equilibrium	70.9
Oxidation and reduction	67.1
Lewis structures	57.5
Entropy	53.6
Organic chemistry	52.0
Consumer chemistry	51.6
Nuclear and subnuclear structure	48.0
Kinetics	41.3
Spatial geometry (molecular shapes)	38.8
Buffers	33.8

N=155

TABLE 36

Physics Teacher Level of Confidence

Rating Scale:
Highly confident 5 4 3 2 1 Total lack of confidence

Per cent of respondents reporting 5 or 4:

Topic	Percent
Acceleration and velocity	93.6
Newton's laws	91.7
Vectors	91.7
Graphing	89.0
Forces, and analysis of	87.2
Gas laws	87.0
Conservation of momentum	87.0
Energy, and forms of	87.0
Wave phenomena	73.4
Nature of light	71.6
Circular motion	67.0
Work-energy theorem	66.6
Thermodynamic laws	66.4
Entropy	62.9
Electrical currents and circuits	58.7
Quantum theory	55.2
Harmonic motion	54.2
Moving coordinate systems	53.3
Kepler's laws	52.8
Angular momentum	47.3
Relativity	34.2
Magnetism and magnetic fields	33.6
Carnot's theorem	20.6

N=109

TABLE 37

Physical Science/General Science Teacher Level of Confidence With Selected Topics

Rating Scale:
Highly confident 5 4 3 2 1 Total lack of confidence

Per cent of respondents reporting 5 or 4:

Topic	Percent
Chemical equations	96.7
States of matter	95.6
Atomic model of matter	95.1
Molecular motion and temperature	93.4
Density and pressure of a gas	91.2
Physical and chemical properties/ changes	90.1
Energy, forms of	89.0
Current electricity	70.4
Planets and planetary motion	67.8
Light	66.0
Electrostatics	66.0
Weather and climate	65.6
Nuclear energy	65.5
Wave phenomena	63.7
Magnetism	62.7
Humidity and clouds	60.0
Geologic processes--agents of erosion, weathering, etc.	53.6
Weather maps/mapping	53.3
Air masses, fronts, and storms	52.2
Relativity	50.6
Evolution of stars	40.0

N=91

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