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A SURVEY OF THE SCIENCE TEACHING PRACTICES IN
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IN THE UNITED STATES

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ABSTRACT

A SURVEY OF THE SCIENCE TEACHING PRACTICES IN
SELECTED ELEMENTARY CHRISTIAN SCHOOLS
IN THE UNITED STATES

By

Charles A. Joss

A survey of science teaching practices in selected fundamentalist Christian schools of the United States was conducted during early 1981. Sampling procedures undertaken with a population of 5,761 elementary schools in fifty states yielded data from 184 administrators and 334 teachers. The information related to the character of the science programs for approximately 29,550 pupils in grades kindergarten through six. The purpose of this study was to establish a data base of information that is intended to inform decision makers of the changes taking place in programs, facilities, instructional media production, and teacher education.

Over the past thirty years, as the number of Christian schools has grown from about two hundred to more than ten thousand schools, Christian school leaders have deemed the subject matter of science to be critical in their curriculum development efforts. These adherents to

Fundamentalism institute privately supported day schools as extensions of the ministry of local, autonomous churches that support the teachings of Biblical Christianity and aim to develop Christian students "in the image of God." Christian school leaders are demanding increasing quantities of philosophically acceptable high quality instructional materials and properly trained teachers to use them.

In the absence of adequate data to assist decision makers in curriculum development efforts, the writer has organized the findings of science educators, historians, and Christian school leaders to develop a data base of information and a perspective for appraising such findings. The findings included information concerning school organization, facilities, teaching tools and methods, resources, and characteristics of teaching personnel. The writer found many similarities between Christian school and public school science teaching practices, including low science teaching priority, barriers to effective teaching, and dependence upon teacher-centered methods and reliance upon a single textbook. Differences included better prepared public school science teachers and smaller Christian school class sizes. There seemed to be little consistency in science teaching practices among surveyed schools.

Further studies are required to evaluate science goals and learning outcomes.

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Chapter 1

THE PROBLEM

Purposes

The major purpose of this study is to establish a data base of information regarding science instruction in certain elementary Christian schools. It is intended that the information obtained will be used to assist decision makers concerning the changes taking place in programs, instruction, facilities, and teacher education.

A survey of science teaching practices in selected Christian schools of the United States was conducted during February of 1981. Sampling procedures were initiated with a population of 5,761 elementary Christian schools comprising fifty states and the District of Columbia. Usable survey information from 184 school administrators and 334 elementary teachers relates to the character of science curriculum and instruction for approximately 29,550 pupils in grades kindergarten through six.

This study has been conducted by a researcher who is himself avowedly committed to the cause of promoting Christian education, specifically fundamentalist Christian education. Although it is not a purpose of this study to argue for or to defend that cause, one set of purposes will be to explicate the concerns that motivate fundamentalist Christian educators, especially with regard to the teaching of science in the elementary Christian schools, and to inquire into the current practices and materials used in teaching science in those schools.

Rationale

The number of fundamentalist Christian schools is growing every year. The Christian school movement has been termed "the fastest growing educational movement in America" by Paul Kienel, President of the Association of Christian Schools International.[1] He says that each year about 700 new Christian schools are begun. Enrollment in schools holding membership in four major Christian school organizations was reported to have increased from 159,916 in 1971 to 349,679 in 1977 or 118 percent.[2] Declining enrollments in public schools, off 6 to 11 percent on a region-by-region basis during the past ten years, has been surpassed by declines in Catholic school enrollments, which had mounted to 20 percent by 1979.[3] According to an estimate by the Bureau of

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[1] Paul Kienel, Reasons for Sending Your Child to a Christian School (LaHabra, California: P.K. Books, 1978, p.13

[2] Virginia Davis Nordin and William Lloyd Turner, "More Than Segregation Academies: The Growing Protestant Fundamentalist Schools," Phi Delta Kappan, February 1980, pp. 391-394.

[3] Dennis A. Williams, "The Bright Flight," Newsweek, 20 April 1981, p. 66.

the Census, the enrollment in non-Catholic, non-public schools increased 134.4 percent between 1965 and 1975.[4] Although many non-public schools' enrollments had stabilized or had experienced slight declines, fundamentalist Christian schools grew rapidly. Since these independent, private schools have been frequently omitted from standard reporting procedures, the true proportions of the size of the movement can only be estimated and the true nature of the curriculum and instruction practices not clearly defined. However, because of the declining enrollments in the public schools and the recent reports of litigation involving some Christian schools, attention is now focusing on this growing educational development.

The demand for the production of non-secularized curriculum materials and teachers who are prepared to use them is increasing with the growth of the Christian school movement. Private agencies and Christian colleges are responding to requests from Christian schools by producing textual and ancillary materials for incorporation into the programs of these schools. Pre-service programs at Christian colleges are expanding at a time when colleges in the public sector are experiencing declining enrollments in their teacher preparatory programs. The developmental efforts in Christian school curriculum production and pre-service programs must be tuned to the real and perceived

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[4]Ibid., p. 68.

needs of the Christian community. Such efforts to produce uniquely Christian textual materials, responsive to Biblical principles as well as being professionally credible, must be based upon an accurate understanding of the existing programs and the nature of the goals to be attained. Most Christian schools are unable to provide the substance or the leadership for this teacher training and publication at the required level of sophistication.

The kind of representative data base required for developing curriculum materials and pre-service programs for Christian schools does not seem to be available. The lack of such information can be generally attributed to three basic reasons. First, the Christian schools, as a whole, lack financial resources. Second, the schools are not ready to take the time required for evaluation studies. Third, the independent and autonomous organizations within the Christian school movement, in providing for achieving highly individualistic objectives for their constituencies, do not readily communicate and share mutually helpful information. Although very limited information is available concerning the science teaching practices of Christian elementary schools, there is a wealth of accessible information regarding science teaching in the public elementary schools of the United States. However, the application of the findings of surveys of public school science teaching to Christian school science teaching can be held in serious question. Underlying the third reason for this study are certain basic differences between private and public school programs as they may impact science teaching practices in each type of school. Such differences in the fundamentalist Christian schools are recognized to include the following: (a) incorporation of educational priorities that have their basis in a religious philosophy, (b) parental involvement in the process and product of programs of Christian schools, (c) financial limitations that affect facilities, equipment, materials, and personnel, and (d) constituents' general lack of trust in the motivations and methods of scientists and educators that derives from the teaching of what is deemed to be unacceptable values by means of such topics as sex education, abortion, euthenics, and evolution. These factors affect not only what (science) is taught and how it is taught, but _if_ it will be taught.

For the reasons given above, it is believed that a need exists to determine the current status of science teaching in elementary Christian schools of the United States. The elaboration of a data base of information is viewed to be an essential part of the development and articulation of curriculum and instructional practices and pre-service programs in the Christian school movement.

Methodology

Although comparisons among sectarian and non-sectarian school programs may be open to question, the methods by which the information can be obtained are applicable to both types of school systems. Several excellent models of survey research have been adapted for the purpose of this study. These in-depth expositions provided the background of information, the portrayal of trends in science teaching practices, as well as the explication of design for the effective construction of descriptive research.

The questions employed in this study are, for the most part, not unique. They reflect many of the same concerns seen in national studies and include the following major science teaching areas: (1) school organization, (2) facilities, (3) curriculum resources, (4) supplies and equipment, (5) availability and frequency of employment of teaching "tools" and methods, (6) characteristics and qualifications of teaching personnel, and (7) attitudes of school personnel toward science teaching. A rationale for selecting questions, copies of the questionnaires, and specific procedures employed in this study are found in Chapter Three.

Definitions

Much of the terminology of survey studies in education employed in the research will be familiar to the reader. Vocabulary relating to the design of the questionnaires involving the seven areas of concern stated above are most easily defined operationally and appear as part of the discussion in Chapters Two and Three. However, the meaning of the descriptor Christian school must be set forth early in this report.

The term Christian school as it is employed throughout this discussion should be understood to be a privately supported, religiously oriented church or doctrinally related educational institution which subscribes to and supports by its organization and activities the following summary statement of beliefs and purposes taught in the Bible.

> We recognize that God created man in His own image, that this image was marred through disobedience to his Creator, and that God provided for the restoration of His image in man through the Person and work of His Son, Jesus Christ. We affirm that the scriptures are inspired and inerrent and provide the only dependable direction for establishing relationships between God and man and among men on the earth. We believe that the Christian School is an extension of the Christian educational ministries of the home and church, and that its purpose is the development of the student in the image of God.

The statement above is quoted from the Principal's questionnaire employed in this study and has been adapted from <u>The Philosophy of Christian Education</u>, a pamphlet published by the Bob Jones University Press.[5]

In popular periodical literature and news media, Christian schools are frequently referred to by means of the term, "fundamentalist." Although fundamentalists do not often employ this term in conversations in reference to themselves, they recognize the distinctiveness that the term embodies as it is used to describe adherents to Fundamentalism which "is militant orthodoxy set on fire with

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[5] Robert D. Bell et al., <u>The Christian Philosophy of Education</u> (Greenville, S. C.: Bob Jones University Press, 1978), pp. 1-11.

soulwinning zeal."[6] During the World Congress of Fundamentalists held in Edinburgh, Scotland in June, 1976, the descriptor, Fundamentalist, was defined as follows:

> A Fundamentalist is a born-again believer in the Lord Jesus Christ who
> 1. Maintains an immovable allegiance to the inerrant, infallible, and verbally inspired Bible;
> 2. Believes that whatever the Bible says is so;
> 3. Judges all things by the Bible and is judged only by the Bible;
> 4. Affirms the foundational truths of the historic Christian Faith:
>   The doctrine of the Trinity
>   The incarnation, virgin birth, substitutionary atonement, bodily resurrection, ascension into Heaven and Second Coming of the Lord Jesus Christ
>   The new birth through regeneration of the Holy Spirit
>   The resurrection of the saints to life eternal
>   The resurrection of the ungodly to final judgment and eternal death
>   The fellowship of the saints, who are the body of Christ;
> 5. Practices fidelity to that Faith and endeavors to preach it to every creature;
> 6. Exposes and separates from all ecclesiastical denial of that Faith, compromise with error, and apostasy from the Truth; and
> 7. Earnestly contends for the Faith once delivered.[7]

As will be seen from the foregoing description, the schools selected for survey efforts are composed of those whose administrative leadership actually affirmed that the core of their philosophy is the Fundamentalist one given above. Many Baptist organizations will find the statement of purposes for Christian education to be quite acceptable. It is evident, however, that there is no particular

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[6] Elmer L. Rumminger, "Special Report: World Congress of Fundamentalists," F A I T H for the Family, September/October 1976, p. 9.

[7] Ibid.

denominational exclusion required for the establishing of a fundamentalist Christian school. The churches that establish fundamentalist Christian schools are autonomous in nature. Therefore, these schools cannot be accurately classified as either denominational (belonging to an ecclesiastical organization) or parochial (limited to the membership of one particular local church). Throughout the ensuing chapters of this report of a survey of the science teaching practices of selected elementary Christian schools in the United States, the reader should be aware that the term Christian school will be employed as a more compact synonym for fundamentalist Christian school.

Christian schools are designed to assist Christians and those who are interested in becoming Christians to develop "in the image of God." Since the meaning of the term Christian is subject to imprecision and interpretation, the writer has chosen to employ the following definition in the report of his survey. A Christian is one who "has received Jesus Christ as personal Savior and who follows His teachings given in the Bible."[8] A Christian education, then, is "a Bible-based, Christ-centered, teaching-learning process that seeks to guide individuals at all levels of growth through contemporary teaching means toward knowing and experiencing God's purpose and plan . . . in every aspect of living, and to equip them for effective

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[8]Grace Collins and Kenneth Frederick, The Christian Student Dictionary (Greenville, S.C.: Bob Jones University University Press, 1982).

ministry . . ."[9]

Delimitations

The first delimitation of the survey reported in this study is that it deals exclusively with fundamentalist Christian schools and with their science teaching practices in particular. The survey is further delimited in that it can provide little more than the information in the aggregate that has been furnished by participating teachers and principals. The research also focuses on grades one through six in the elementary schools, although there are some data pertinent in describing the status of certain features of Christian schools from kindergarten through grade twelve.

A fourth delimitation of this descriptive study is that the population of Christian schools employed in the sampling procedures comprises the group of schools that has requested to be placed on the mailing list of Bob Jones University, a non-denominational, Fundamentalist, liberal arts university that stresses the Christian religion and is located in Greenville, South Carolina. Finally, the report of this research is delimited in that the comparisons of data provided herein with other survey results must be approached with caution. The generalizability of these findings will also be limited in their application to members of the Christian school community at varied levels.

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[9] Werner C. Graendorf, Introduction to Biblical Christian Education (Chicago: Moody Press, 1981), p. 16.

Conclusion

A survey of science teaching practices in selected elementary Christian schools in the United States was undertaken early in 1981 primarily to provide a source of information concerning the rapidly expanding Christian school movement with respect to its elementary science programs. These data and the implications which may be drawn from them are viewed as an important part of the process of curriculum development in the schools and in the design of teacher pre-service efforts in the university.

More complete discussion of the rationale for this research and the nature of the Christian school movement, as well as an examination of the relevant literature in the field of elementary school science, are the subjects of concern in Chapter Two.

Chapter 2

RELEVANT PRECEDENTS IN THE LITERATURE

In the belief that a need exists to determine the current status of science teaching in elementary Christian schools of the United States, a rationale consisting of four reasons to support this study and an outline of the design features of the survey were set out in the initial chapter. The second chapter focuses upon these two major considerations and the manner in which they have come to be related. It will be seen that the employment of standard survey strategies and data processing offers the best opportunity to ascertain the current status of science teaching practices in the rapidly developing Christian schools of the United States.

The discussion will treat the following three major areas: (1) a description of the Christian school movement, (2) a brief narrative of the history of elementary science in America, and (3) an examination of the procedures involved in and the findings of three major surveys of science teaching practices in public elementary schools since 1960. The chapter concludes with an exposition of the principles and major questions used to guide the development of the author's survey of science teaching practices in Christian schools.

The Christian School Movement

"Christian fundamentalist schools are spreading like kudzu from Atlanta to Anaheim."[1] The recent surge of growth in Christian schools that began in the 1960's is accelerating annually.[2] Exact statistics on such schools are difficult to determine because no official government research has been done and the movement itself is coordinated by a variety of associations and organizations. "By some estimates, there are more than ten thousand Christian schools around the country . . ."[3] The majority of fundamentalist schools belong to one of four major organizations: the National Association of Christian Schools, the American Association of Christian Schools, the Association of Christian Schools International, and Christian Schools International. Enrollment in the schools holding membership in these four organizations has increased from 159,916 in 1971 to 349,679 in 1977, or 118%.[4] Paul Kienel, Executive

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[1]Dennis A. Williams, "Why Public Schools Fail," Newsweek 98 (1981), 62-65.

[2]Paul Kienel, Reasons for Sending Your Child to a Christian School (La Habra, California: P. K. Books, 1978), p. 13.

[3]Dennis A. Williams, "The Bright Flight," Newsweek, 20 April 1981, p. 68.

[4]Virginia Davis Nordin and William Lloyd Turner, "More Than Segregation Academies: The Growing Protestant Fundamentalist Schools," Phi Delta Kappan, February 1980, pp. 391-394.

Director of the Association of Christian Schools International, has estimated the rate of growth of the Christian school movement in America to be about two new schools per day.[5]

When did Christian schools actually begin? The question is not easily answered since the avowed purposes of such education have undergone changes over the years. Certainly the education called religious includes much of what is today called Christian Education. Leaders in every religious sect realized the necessity to teach in some way the dogmas of its persuasion. Each denomination has set about to perpetuate itself in the training of young minds. Out of the Reformation thrust of Europe there arose the realization that without trained leadership, the known Church might decay and disappear from its influential role in the lives of the people. At times there was more emphasis upon the laity's becoming informed about parental involvement in the children's instructional process.[6]

Martin Luther's concern with the education of his own children at home and the preoccupations with reading and understanding the whole counsel of God led to the Protestant Reformation. His belief that everyone should be

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[5]Paul A. Kienel, The Philosophy of Christian School Education (Whittier, California: Association of Christian Schools International, 1978), p. 1.

[6]Ibid., pp. 158-59.

able to read the Scriptures in his own language, so that the individual could not be led astray spiritually by unscrupulous churchmen, led naturally to the establishment of small schools where reading was stressed along with the memorization of certain creeds and liturgy.[7]

> After the nailing of the 95 theses and the Diet of Worms, the movement demonstrated a new standard of principles by which education was to function . . . 1) the authority of the Bible was substituted for the authority of the church as the infallible rule of life and moral practice, and 2) individual judgment was substituted for collective responsibility. Luther, together with Calvin, stressed the importance of living a worthy life here as well as anticipating the life hereafter; both affirmed Christian living as the highest goals in education.[8]

The use of materials and methods suited to the levels of the students was encouraged by Calvin, Luther, Melancthon, and Stuurm.[9] The stimulus for parentally directed education for the young as well as the impetus for a well-structured school system was derived from the influence of Comenius, scholar, educator, and theologian. He is credited also with the notion that students should be given textbooks with illustrations.[10]

On the shores of the new country, America, education assumed the shape of its western European ancestry. In New

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[7]Roland H. Bainton, Here I Stand: A Life of Martin Luther (New York: Abingdon-Cokesbury Press, 1950), p. 335.

[8]Kienel, p. 158.

[9]Ibid.

[10]William Van Til, Education: A Beginning (Boston: Houghton Mifflin Company, 1974), pp. 413-14.

England, where Calvinistic and Puritan practices promoted the belief that everyone should be versed in the principles of religion and that those who cannot read cannot understand the laws of the land, compulsory education in principle was fostered. The essence of the Old Deluder Satan law was that youngsters not in school would be getting into mischief. The New England Primer confirmed the thrust of this education as basically religious in its preachments regarding sin and one's duties toward God and man. The charter of Harvard College includes as one of its goals, "training in knowledge and godliness."[11] The local church was the prime determinant of the direction of education in the Middle Colonies and resulted in the diversification of religious beliefs and the lack of homogeneity among the people of Dutch, Quaker, and Catholic persuasions. In the Southern colonies, education was conducted on a private tutorial basis with later plantation schools that served the upper classes. The Anglican church took major responsibility for the token education provided for the lower classes. Of the three approaches to education in the Colonies described above, the one that has persisted, in the opinion of Van Til, is the form that descended in many variants from the New England colonies.[12]

In the beginning, New England colonial children were

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[11]Kienel, p. 164.

[12]Van Til, pp. 133-140.

taught to recite the catechism and the alphabet and to make their letters and cyphers. Young children were instructed in dame schools, where home arts and simple reading and math were the subjects of learning.[13] The Bible was the major source of information, stories, recitation materials, and conduct. Dr. Howard, in concluding remarks as a recent television interviewee on the Phil Donahue Show, stated,

> . . . the first American schools were in churches . . . the first teachers were pastors, and the first textbook was the Bible. We built a pretty solid nation with those basic fundamental principles.[14]

In the years following the institution of compulsory education in the developed areas of early Massachusetts, the Bible-teaching emphasis changed gradually from the need for salvation to the duty to carry out the Golden Rule. Ultimately, the teaching of the Golden Rule gave way to teaching about good citizenship.[15]

Most tax-supported school systems in the period just preceeding the Revolutionary War until late into the 18th century supported some form of citizenship training. During this period most Christians in America placed their families in the trust of the government schools. In essence they assigned to an institution regular involvement

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[13] H. G. Good, A History of American Education (New York: Macmillan, 1962), pp. 37-38.

[14] Dick Minger, prod., Donahue, NBC series, Oct. 1981.

[15] R. Freeman Butts and Lawrence A. Cremin, A History of Education in American Culture (New York: Henry Holt, 1953), p. 98.

in the values training of their children. The home and the church were relied upon to provide the Bible training.

> After the Civil War, Protestants were willing to rely on their dominant position in the nation and the enthusiastic promotion of Sunday School, youth organizations, and later the vacation Bible school, released time Bible teaching and other agencies for religious education.[16]

As long as the government school provided minimal obvious contradiction to the parents' own values framework they were willing to rely on activities within the family and church to supplement academic education with spiritual training. Some church leaders on the other hand had doubts about new philosophical trends which could hardly be separated from the academic education. This concern became more intense as separation of church and state reduced the influence of Biblically centered teaching about morality in the government schools. Mark Fakema writing in 1954 reflected on the development of the schools in the hands of the government:

> What has made the legalizing of education as a State function so profoundly significant is the fact that it implied the eventual secularization of the erstwhile Christian nation. When our schools were in private hands they could be said to be Christian. That is to say, our country was committed in theory, if not always in practice, to the Christian way of living. . . .
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> As soon as the State took over the educational reins, the State schools, in transmitting the heritage of the past to the rising generation gave free passage to that which was secular and regarded that which was religious as contraband. The inevitable result was

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[16]Robert W. Lynn, Protestant Strategies in Education (N. Y.: Association Press, 1964), p. 7.

> that the life for which these schools prepared increasingly became secular. . . .[17]

Scattered groups of parents and churches began to organize the type of school that would meet the compulsory education requirements while reinforcing the philosophy of the Christian family. The Christian Reformed Church and Mennonite groups were some of the earliest sponsors of such schools. An early organization, The National Union of Christian Schools, reported sixty schools in their group in 1917, eighty-nine in 1929, and two hundred schools in 1957.[18] The change in the government schools foreseen by church leaders was so gradual that many Christian parents after several generations of trusting the government system were slow to take the action their leaders encouraged.

In the most recent period of our history the motive for Christian schools became more distinct when Bible-centered morality was eliminated from the classroom by the courts.[19] Now moral teaching of whatever sort would be carried out by teacher example rather than in more formalized ways. As conflicts that arose from "busing" in the 60's began to create strife in public schools, Christian parents joined other concerned parents and

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[17] National Union of Christian Schools, Course of Study for Christian Schools (Grand Rapids: William B. Eerdmans Publishing Company, 1953), p. 375.

[18] Frank E. Gaebelain, Christian Education in a Democracy (New York: Oxford University Press, 1951), p. 105.

[19] Lynn, p. 8.

responded to these problems by opting for private and religious education for their children. Increasing lack of discipline and increasing violence in the schools were among the major contributors to what has been called "white flight."

Criticism of the public schools in the United States found its way into the widely read periodicals of our nation. An article describing the reasons for the flight to private schools reported problems in the quality of the education. It cited budget limitations, teacher incompetency, and falling test scores.[20] These kinds of accusations, along with the growing realization that the times required more sophisticated knowledge to hold a job, caused discontent with public schools, and many middle class families became involved in the crossovers from public to alternative schools. This motive for seeking what was seen as a better educational opportunity added "bright flight" (continued defections of gifted and motivated students) to the acknowledged "white flight."[21] In the last ten years public school enrollment dipped eleven percent in the western states while private school enrollments climbed nineteen percent. In the South the number of students in public schools declined six percent while private enrollments increased by thirty percent. Some

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[20] Williams, "The Bright Flight," p. 66.

[21] Ibid.

educators are worried that if the "bright flight" persists unchecked, it could erode financial and political support for public education.[22] On the other hand private schools are viewed as the "healthiest segment of the educational system these days. . . . In an era of dwindling enrollments, demographers predict a twelve percent increase in private school pupils in 1988."[23]

Many of the increasing private school enrollments are in Christian fundamentalist schools. Whereas many parents in the recent past may have been motivated to enroll their children in Christian schools primarily to ensure disciplinary and academic features of private education as part of the "white flight" and "bright flight" phenomena, increasing numbers are becoming explicitly concerned about the philosophical incompatability of secular humanism with Christianity. Such awareness was mentioned frequently in enrollment interviews when parents were asked why they wanted Christian education for their children.[24] Parents of students involved in this "right flight" expect not only that their children will receive an education of high quality in an atmosphere of discipline but also that the values of the parents will be supported

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[22]Ibid.

[23]Williams, "Why Public Schools Fail," p. 62.

[24]Paul A. Kienel, The Christian School: Why it is Right for Your Child (Wheaton, Illinois: Victor Books, 1974), pp. 43-47.

in the program of the schools.

The Christian school movement is not on a course to replace free public education. Reaction to the problems a parent may perceive in public education may raise doubts that focus his attention on his religious commitments and the Christian schools that exist to provide education that reinforces the value system of Christian families. Paul A. Kienel, executive director of the Association of Christian Schools International, the largest association of Christian schools in the United States, lists ten reasons for sending a child to a Christian school. These reasons, briefly summarized, clarify the impetus of the Christian school movement. (1) The child is a gift from God, (2) The parent is accountable to God, (3) The philosophy of the public school is one of secular humanism, and the parent cannot rely on this institution to reinforce the values of his Christian framework.[25] Dr. Walter Fremont, present dean of the School of Education at Bob Jones University, summarized in his unpublished thesis in 1961 the philosophical reason for the existence of the Christian schools:

> Christianity is founded upon a system of Bible truths which is rather comprehensive in nature and should affect all aspects of life; therefore, it is necessary that this truth become a vital part of the education of the child. The desire on the part of Christian parents to have their children trained in this evangelical Christian philosophy has paved the way

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[25] Kienel, Reasons for Sending Your Child to a Christian School, pp. 13-19.

for the continued increase of Christian Schools.[26] C. Rowan Lunsford, speaking in 1974 at the twenty-sixth Annual Spring Conference of the Baptist Day School Association of Southern California, said, "Total integration of sacred and secular aspects of education is the *sine qua non* of the Christian School movement."[27] Calvin Cummings pictures secular education (public schools) as a "separation from our roots."[28] He believes the purpose of Christian education should be to assist parents to fulfill their responsibility to God for the training of their children. "The Christian School should exist for the purpose of banding together for the task of developing children in bearing the fruits of righteousness to the glory of God."[29]

It can be seen that the purpose of the fundamentalist Christian school is set in a desire for Biblical truth to become pervasive in the curriculum and instruction patterns of the school. Just as the belief that the tax-supported schools were Protestant led to the inception of

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[26] Walter G. Fremont, "Administrative Competencies in Christian Day Schools," Diss. Pennsylvania State Univ., 1967, p. 7.

[27] C. Rowan Lunsford, "Forward," in *Making the Christian School Christian* (Sepulvedas, Calif.: Department of Baptist Day Schools, 1974), p. 3.

[28] David B. Cummings, ed., *The Purpose of a Christian School* (Phillipsburg, N. J.: Presbyterian and Reformed Publishing Co., 1979), p. 1.

[29] Ibid., pp. 1-6.

the Catholic School System in America,[30] fundamentalist Christian school leaders believe that the incursive religion of secular humanism in the tax-supported schools of this age provides an intolerable dualism in the teaching of a Christian value system. Claude E. Schindler, Jr., the superintendent of Dayton Christian Schools (Ohio), carries this notion further in asserting

> . . . religious neutrality in the public schools is impossible. We can separate church and state, but we cannot separate religion and education. The ultimate end of education, the nature of persons educated, the nature of truth: all these are religious questions requiring religious answers. The answers may issue from the religion of secularism, humanism, or pragmatism, or they may issue from the religion of Christianity; but they will be religious answers.[31]

Many Christian people are unable to rationalize what seems to them an apparent unevenhandedness demonstrated in the Supreme Court's disavowal of Bible reading and prayers and which some of them may even regard as the Court's espousal of the religion of secular humanism as the state religion to be taught in the tax-supported schools of America.

According to certain key humanist documents, secular humanism is a religion, having been so declared in Humanist Manifestos I and II, published in 1933 and 1973. The doctrines of humanism are based upon scientism, evolutionism, environmentalism, and uniformitarianism.

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[30] Claude E. Schindler, Jr., and Pacheco Pyle, Educating for Eternity (Wheaton, Ill.: Tyndale House, 1979), p. 16.

[31] Ibid., p. 17.

Humanist Manifesto II, which claims that it is "endorsed by countless human beings from all walks of life as a document for our time," is composed of seventeen affirmations that set forth the following tenets:

1. That the old traditional religions are ineffectual for providing solutions to the problems of the present world system, and

2. The right to individual freedom and autonomy and the encouragement of tolerance of alternative life-styles without the influence of repressive religious, ideological, or moral codes, and

3. The importance of individual liberties, dignity, privacy, and the right to participate in social self-determination processes, and the equal treatment of ideologies, individuals, and economic alternatives, and

4. The transcendence of national sovereignty, obsolescence of war, world approaches to regulation of planetary resources including population, wealth, and raw materials, and free inter-cultural intercourse and communication.[32]

In order to promote a satisfying one-world system wherein individuals have sufficient material goods, engage in a pleasing lifestyle, and practice self-determining behaviors without fear of the imposition of undesirable creeds, Humanist Manifesto II makes considerable reference to the employment of scientific methodology and technology as implementing strategies. Man's capabilities to regulate more effectively the resources of his planet would seem to require substantial emphasis upon the development of a scientifically literate populace and a cadre of specialists

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[32]Paul Kurtz, ed., Humanist Manifestos I and II (Buffalo, N. Y.: Prometheus Books, 1981), pp. 15-24.

who will be able to assist in the accomplishment of humanist objectives summarized above. The urgency for this impetus can be understood from introductory statements in Humanist Manifesto I:

> Today man's larger understanding of the universe, his scientific achievements, and his deeper appreciation of brotherhood, have created a situation which requires a new statement of the means and purposes of religion. . . . To establish such a religion is a major necessity of the present. It is a responsibility which rests upon this generation.[33]

To the fundamentalist Christian, the objectives expressed in Humanist Manifestos I and II seem to be based upon tenets that are evolutionary, revolutionary, and self-volitionary. The self-serving nature of the goals and the methodology for their attainment direct praise toward mankind rather than to Deity.

Although fundamentalist Christians may find much to disagree with in the Manifesto affirmations, one of the greatest points of variance concerns the place of science in achieving humanist goals for mankind. In a working statement, The Christian Teaching of Science, prepared by the faculty of Bob Jones University, guidelines are given for the employment of science as a strategem for dealing with the natural world. In this handbook, science is defined as "the systematic study of nature, based on

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[33]Ibid., p. 8.

observations."[34] In order to be dealt with scientifically, a phenomenon must be observable by man's senses either directly or with the aid of instruments. This observation would disallow all "speculations concerning ultimate origins from the lawful domain of science."[35]

The faculty argue that "there is nothing inherently unChristian in the methodology of science if it is properly executed," and that "its merits may be taught in good conscience, provided that the limitations of science are also carefully enumerated."[36] Some of the following limitations are given as illustrative of the philosophy proposed for guiding the development of science curricula for the Christian school:

1. Science is fallible. The discipline of science is human activity and is therefore subject to all limitations of human nature. (Isaiah 55:9; I Cor. 1:18-21; I Cor. 3:12-21a)

2. Science is changeable. Over the past 50 to 100 years, science textbooks have recorded theories as well as the facts themselves that have been subject to change; i.e., the indivisibility of the atom, the number of human chromosomes, and the extinction of the coelacanth.

3. Science cannot properly deal with ultimate origins. Since no human observer was present at the origin of the world, no scientific observations could be made concerning origins.

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[34]Robert D. Bell, et al., The Christian Teaching of Science (Greenville, S. C.: Bob Jones University Press, 1981), p. 1.

[35]Ibid.

[36]Ibid., p. 9.

4. Science is totally unable to deal with the spiritual realm of existence. Since observations can be made concerning only the material world, scientific information will be incomplete at best, leaving out information of the most important sort--that having to do with eternal verities.

5. Science cannot prove a universal negative, or a blanket statement of denial. The statement, "There are no sea monsters," is one example of a universal negative. In order to prove such a statement scientifically, one would have to look for sea monsters in all parts of all the oceans at the same time. This is impossible, because observers cannot be stationed in all of these places at the same time. Statements such as, "There are no miracles" and "There is no God" are in this same category.

6. Science cannot make value judgments. There is nothing in the methodology of science that allows it to distinguish between right and wrong. Through the application of science we obtained atomic energy but no moral guidelines for its use.

7. Science is frequently forced to deal with models rather than reality. The inaccessible atom is represented by a mathematical model which is understood to be inaccurate but workable for certain applications. The fact that science regularly concerns itself with something other than reality comes as a genuine surprise to many people.

8. Science has been unable to develop a satisfactory understanding of some of the most basic things with which it deals. The definition of matter . . . "anything that occupies space and has mass," only describes two of the properties of matter. "Energy . . . the ability to do work" tells what energy does, not what it is. Explaining how the earth "reaches up" to pull objects toward the earth is beyond the knowledge of present-day science. The true essence of energy, gravity, and electrostatic forces remains unknown.

If science as deemed by the faculty of Bob Jones University is inadequate in describing basic concepts underlying the phenomena of nature, can deal only with the material nature of the universe, and cannot regulate moral employment of its findings, it would follow from their argument that science cannot retain the central position it occupies in the statement of the means for achieving the "good life" expressed in the Humanist Manifesto I.[37]

Leaders of the expanding Christian school movement have realized the distinctiveness of Christian education and the improbability of achieving established religious objectives in the present public school system. They are concerned about the employment of the methodologies of a non-Christian view of science in shaping their material world as well as the values systems of their children. Where the subject matter of science may include the teaching of evolutionary concepts, sex education, abortion, contraception, human genetic engineering, and euthanasia, and where the Biblical basis for approaching the application of these ideas may be disallowed, Christian leaders and parents believe public schools are not the answer. They were not always so concerned, however.

The Development of Science Teaching in Elementary Schools

A review of the historical development of schools in America indicates that the subject matter that has come to be called "elementary science" was bound up in the teachings of early religious schools. Although historians are not inclined to give an exact date for the beginnings of science teaching in the early schools, it appeared to

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[37] Ibid., pp. 9-12.

Underhill that science content may have been found in the earliest of the books used in elementary schools.[38]

> . . . it is interesting to note that much of this early (1750-1880) science instruction was . . . marked by a strong religious note. Particularly was this true in the case of natural history, zoology, astronomy, and geology. The textbooks widely used at that time indicate that their authors utilized facts of the four sciences in order to prove that the Creator was wise and benevolent, and in order to strengthen the student's faith in a supernatural ordering of natural events . . .[39]

Hadley gave the following rationale for a religious justification of nature study:

> Nature study can develop a child spiritually more effectively than any other subject in the curriculum. If properly taught, nature study can teach the child the laws of nature, the vastness of God's universes (sic) and the delicate nicety of balance of everything in the cosmos. Just as soon as we can get a breadth of view in a generation of our young people it will help to solve some of these spiritual problems.[40]

It is probable that illustrations of religious teaching and science subject matter can be found together in the elementary school printed materials that have been employed over much of the history of science in America. Smith's view of this issue is

> . . . since modern science tends to reject teleological explanations, the use of sciences in "revealing the wonders of divine creation" is no longer as common as

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[38]O. E. Underhill, The Origins and Development of Elementary-School Science (New York: Scott, Foresman and Company, 1941), p. 6.

[39]Herbert A. Smith, "Educational Research Related to Science Instruction for the Elementary and Junior High School: A Review and Commentary," Time, 3 May 1963, pp. 206-207.

[40]Ibid., p. 206.

> it was in the nineteenth century, but examples of it are still found, not only in classroom practice, but in modern textbooks as well. In some parts of the country where "fundamentalist" religious views are dominant, the teaching of science is designed to help students see a religious purpose in the world . . .[41]

Examples of recent publications by "fundamentalist" organizations are included in Appendix A and seem to support Smith's contention.

The discussion that follows employs the framework suggested by Carpenter as a means for outlining the history of science teaching in the elementary school.[42]

1. Science material scattered desultorily through elementary curricula (prior to 1845).

2. The stage of "object teaching"; <u>circa</u> 1845-1875.

3. Object teaching became too rigid and formalized; <u>circa</u> 1875-

4. The "Nature Study" stage; <u>circa</u> 1880-1920.

5. Freed from nature study, and groping uncertainly in the area of content; <u>circa</u> 1920-1930.

6. Craig and others clarified many of the issues in the selection of content; <u>circa</u> 1927-

7. The present period, in which the emphasis seems to center in a search for improved instructional techniques.

Earliest efforts to incorporate science content in the elementary schools usually involved natural subjects (nature), and quite often the materials and ideas were

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[41] Smith, pp. 206-207.

[42] Regan Carpenter, "A Study of the Effectiveness of the Problem Method and the Textbook Discussion Method in Elementary Science Instruction," Diss. New York University, 1958, p. 10.

handled as incidental learning.[43] As the ideas of Comenius became more widely accepted, the use of real objects and "manipulatives" in the teaching process were seen during the mid-1800's. The ideas of Comenius and Pestalozzi concerning object teaching and sense perception have had great influence upon elementary science teaching in that their methods for the first time in the history of education tended to subordinate the printed words to the use of children's senses.[44] Prior to 1920, however, the term "elementary science" had been used to describe the content of the American publishers' reprintings of the British didactic children's literature, much of which was developed in Europe as a result of the influence of John Locke and Francis Bacon. The task of adapting certain of this literature for use in regular classrooms was facilitated by the National Education Association when it was organized in 1857.[45] However, the cost of these materials limited the use of the literature to private tutors directing children's observation and study of natural phenomena.

These early textbooks, ". . . were largely designed to teach morals and conduct, and they contained dialogues based on philosophical speculations concerning fire, water, cold, autumn, and so on."[46] Authority rather than

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[43] Underhill, p. 6. [44] Carpenter, p. 16.

[45] Smith, p. 199

[46] Carpenter, p. 13.

observation or experimentation characterized all aspects of elementary education in the beginnings, and the imparting of factual information dominated teaching.[47] Throughout the "pre-history" of science education the educational aims and objectives of science teaching were likely to be moralistic and religious in character.[48] Smith reports further on this:

> The purposes which the predecessors of the elementary science program were to serve included a chaotic admixture of religious indoctrinations, cautionary prescriptions, and wishful thinking. The originators of these earlier programs exhibited massive naivete as to the effectiveness of the instructional program in achieving these aims. Perhaps nothing has been more discrediting to the educational process than the void which has existed between gradiose statements of objectives and the instructional procedures designed to achieve them.[49]

List of objectives had included statements such as "belief in the value of the truth" and "to develop a simple reverence for nature." However, as the development of science teaching in the elementary schools continued, a shift away from religious themes toward utilitarian and descriptive purposes occurred.[50]

The second major stage in the development of science teaching in American elementary schools began as the adaptation of Comenius' object teaching and Pestalozzi's sense perception methodology to the morality-nature-religion

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[47] Carpenter, p. 13.

[48] Smith, p. 206.

[49] Ibid.

[50] Ibid., p. 207.

content of science.[51] The best-known American adaptation of this fusion was the Oswego method. In the twenty-year period following the introduction of this method to the American schools, there arose a rather formalized approach to the application of object teaching. This approach that incorporated the almost rote descriptions of objects imposed upon students is viewed, in retrospect, to have retarded the development of early efforts to establish process skills such as interpretation. The underlying principles of faculty psychology (including the serial development of the student's faculties) dictated the emphasis upon observation and memorizing in the primary years to the exclusion of reasoning capabilities of students.[52]

The reaction to this early burnout of object teaching shifted focus away from methodology to settle almost exclusively upon content, nature studies. After the discreditation of object teaching, natural phenomena remained the exclusive content of elementary science. During this period, local school districts greatly accelerated their production of science teaching manuals.[53] This content-centered science curriculum was greatly

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[51]Carpenter, p. 14.

[52]Gerald S. Craig, "Elementary School Science in the Past Century," Science Teacher, February 1959, p. 12.

[53]Ibid., pp. 12, 13.

promoted by Dr. Liberty Hyde Bailey and his associates at Cornell University, who were responsible for the publication and dissemination of over one-half million nature study bulletins annually.[54] The end of the nearly fifty-year reign of nature study in elementary schools can be attributed to (1) the formalization of classroom procedures (as in object teaching), and (2) the following four major criticisms:

> a) the lack of emphasis upon the study of physical sciences,
>
> b) the extravagant claims made for emotional and aesthetic outcomes,
>
> c) the lack of organization . . . isolated and unrelated phenomena were studied,
>
> d) the methodology was based on the notion that children in the lower grades cannot reason.[55]

When the nature study emphasis dissipated, nothing of substance moved into the apparent vacuum created until about 1920 when the practical values of science and the significance of science in the development of a democratic society began to emerge as valued criteria.[56] During this period of groping, however, it is significant that regression of science as a viable component of the elementary school curriculum was only limited--science had established itself as an integral part of the program.[57]

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[54]Carpenter, p. 21. [55]Ibid., p. 22.

[56]Ibid.

[57]Ibid., p. 23.

It was at this point that curriculum designers in science were giving increased emphasis to the grade placement of science content and to the derivation of objectives which should be sought through elementary science instruction. As a result of these efforts, educators began to see advantages in organizing the entire elementary school science program. Inevitably, entire states adopted programs for their schools.[58] One clear advantage of these efforts was that the study of nature was balanced with the teaching of physical science, which, until this time, had not been a regular part of the elementary school curriculum.

The aims and objectives of science instruction were influenced by changes in educational philosophies and new ideas in psychology which resulted in increasing emphasis upon the child as the focal point of the instructional process. Gerald S. Craig in 1927 provided definitive guidelines for the development of elementary science objectives.

> Objectives should conform a) to those scientific conceptions which when understood greatly influence the thought reactions of the individual and which have modified thinking in many fields; b) to the goals in science which are important because of their function in the establishment of health, economy, and safety in private and public life; c) to those facts, principles, generalizations, and hypotheses of science which are essential to the interpretation of natural phenomena which commonly challenge children.[59]

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[58] Ibid., pp. 23-25.

[59] Ibid., pp. 24-25.

Schools gradually began to react against the old methods of teaching isolated, unrelated facts . . . having little apparent organization . . . and began to develop courses of study for use in local school systems. The attempts to incorporate larger educational units in this unified approach to science education were often unsuccessful because of the varying specific needs among districts and states.[60] Several developmental efforts to structure the elementary science program took place during the ensuing thirty years, and in 1956, Glenn O. Blough, distinguished contributor in the field of science education, enumerated the following characteristics of a good elementary science program:

> Is based upon problems interesting to learners
>
> Is non-academic in approach and not overloaded with useless vocabulary
>
> Gives children the opportunity to ask questions and bring objects to class, but is not dependent upon an incidental approach
>
> Is aimed at sound objectives harmonious with those of general education
>
> Is frequently evaluated in terms of these objectives
>
> Is integrated with other school subjects
>
> Includes content from all areas of science
>
> Is built around meaningful educational experience and not around costly science apparatus
>
> Utilizes the home and the community as resources for learning and as places to apply learning

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[60] Ibid., p. 25.

Has continuity; is organized with a minimum of omission and overlap

Is planned in relation to the science experiences which the children are likely to encounter in the higher grades

Includes a variety of activities and materials.[61]

Many of the elementary science programs being employed today seem to exhibit most of the foregoing traits. Possible weaknesses may appear in the manner in which science subject matter may be integrated with other subject matter (social studies, mathematics, language arts), and in the way science learnings are carried beyond the classroom.

In the elementary science developmental stage, which Carpenter calls "the present period," circa 1955-, he believes that there has been a return to an emphasis upon methodology rather than upon content.[62] Strategies such as problem solving and inquiry have been adopted as euphemisms to incorporate essentially the same concepts that prior statements of scientific method had encompassed. Certain procedural and operative dimensions (scientific method) have become entangled with particular mind sets (scientific attitudes) in the more recent science curriculum projects that have seemed to de-emphasize what was

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[61] G. O. Blough, "The Principal and the Science Program," The National Elementary Principal (April 1956) 34-35.

[62] Carpenter, p. 27.

previously termed "scientific method."[63] It seems likely that Conant's dictum, "there is no scientific method," had been partly responsible for this shift in emphasis in the direction of science programs in elementary schools.[64]

"During the 1950's and 1960's a national effort to improve pre-college education resulted in the development of new courses and teaching materials in elementary . . . science . . . and resulted also in the offering of a large number of institutes to increase the knowledge of school teachers and to help them learn to use the new courses and materials effectively."[65] In the 1970's, however, there came a great reduction in the number of institutes for teachers and a substantial decline in usage of the new courses and materials. It seems to be one of the great mysteries of our time to account for this inchoate prodigality. The number of commentators who have attempted to provide a rationale for the decline in science education in the curriculum of American schools is considerable. In a widely read New York Times article that appeared in 1979, the following reasons were provided to explain why science had "lost its place in line" in the curriculum priorities of the schools:

1. the shifting emphases due to the "back-to-the-

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[63] Smith, p. 221.

[64] Ibid.

[65] Leonard E. Klopfer, "Science Education in the 1980's," <u>Science Education</u>, 64, No. 1 (1980), 1.

basics" movement reaction to declining test scores and academic competencies,

2. increased public skepticism regarding the benefits of some scientific achievements,

3. the moderation of the cold war, which reduced the sense of urgency in the training of professional scientists,

4. reduced NDEA spending for science from 106 million to 38 million,

5. the declining enrollments in public schools leading to budget cutbacks and trimming of certain types of costly programs such as science courses in the high schools.[66]

The recent trend toward reduction of "frills" and emphasis on skills in the elementary school has effectively squeezed the time available for other curriculum priorities. Many of the post-Sputnik "alphabet" science programs (ESS, SCIS, SAPA, etc.) are not employed in the instructional procedures of elementary teachers simply because the newer teachers do not know of their existence.[67] Instead, teachers are using textbooks written by "conventional wisdom" that makes students improve skills of listening, reading, and memorizing. The pressure of competency testing in the schools has resulted in focus on simpler, less meaningful instructional objectives and has diminished the importance of learning concepts and relationships, according

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[66]Edward B. Fisk, "Post-Sputnik Fervor Wanes as 3-R's Gain," The New York Times, 22 April 1979, pp. 1-2.

[67]"Inquiry-Based Science Studies Are Giving Way to Rote Learning," Phi Delta Kappan (November 1979): 225.

to the National Research Council.[68]

Klopfer, looking toward the 1980's, presses the case further. He believes that the curricula and the science teaching ideas spawned in the 1960's have "either been assimilated or ignored by teachers of science . . . but that the instructional approaches used by many teachers have hardly changed at all."[69] Viewing the problem from Stake's perspective, Kloper says that the emphasis upon information acquisition and the avoidance of investigatory aspects of science restrict students' opportunities to experiment. In many respects the science programs that derived from sputnik fervor have much in common with the science teaching approaches of the 30's and 40's, a period of social reconstruction when the single text, reading-for-information approach was widely practiced.[70]

A final reason frequently given to explain the decline in science teaching in the elementary schools deals with the manner in which the newly developed science programs were piloted during the developmental process. Klopfer says that selective attention had been given to teacher training and the provision of ancillary realia in order to make the programs work. As programs became widely disseminated, the established benefits lacked transfer-

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[68]Ibid.

[69]Klopfer, p. 1.

[70]Ibid., p. 4.

ability, perhaps through lack of commitment of the participants and inadequate resources.

"The decade and a half from about 1960 through 1975 was a period of ferment and innovation in science education in the United States."[71] Many of the programs developed during this time were the result of the active involvement of scientists as well as educators. The evidence of science teaching in the elementary schools of America over the years seems to point to increasing content coverage and emphasis upon teaching the skills of "doing science" although the results seem disproportionate to the expenditure of essential resources.

Examination of Major Research in Elementary Science Education Since 1955

Turning from the considerations of philosophers and historians, the writer wishes to set out the most recent research findings related to science education in elementary schools for the purpose of establishing the specific direction of his survey of science teaching practices in elementary Christian schools. The following studies will be reviewed in the remainder of this chapter:

The Status of Pre-College Science, Mathematics, and Social Science Education: 1955-1975 (a literature review). Stanley L. Helgeson, et al.

Case Studies In Science Education. Robert E. Stake and and Jack A. Easley, volumes 1 and 2, for the school year 1976-1977.

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[71]Ibid., p. 1.

Report of the 1977 National Survey of Science, Mathematics, and Social Studies Education. Iris R. Weiss, Research Triangle Park.

A Survey of Science Teaching in Public Schools of the United States, volume 4 - Elementary Schools. Robert W. Howe, director ERIC/SMEAC, 1971.

Science Teaching in the Elementary Schools: A Survey of Practices. Paul E. Blackwood, school year 1961-1962.

Each of these studies contributes to the understanding of the nature of science teaching in the elementary schools and assists in the formulation of appropriate strategies for the undertaking of the survey of Christian school science teaching practices.

The Literature Review by Helgeson et al

With the advent of scientific research and public interest in the exploration of space, there had been increasing awareness of the need for the development of personnel to meet the challenges of the new technology. Millions of federal and state dollars were spent to investigate, improve, and evaluate trends and to report the findings of "scientists, educators, and learning theorists in the development of science curriculum materials," and the expenditures marked "the first major investment of federal monies directly in curricular and instructional concerns."[72] The years from 1955 to 1975 are unmatched in

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[72]Stanley L. Helgeson, Patricia E. Blosser and Robert W. Howe. The Status of Pre-College Science, Mathematics, and Social Science Education: 1955-1975. Volume I: Science Education (Columbus, Ohio: Center for Science and Mathematics Education, 1977), p. 1.

the degree of activity in science education. An extensive review of the abundant literature of this period was conducted by the Ohio State University under the direction of Dr. Stanley L. Helgeson in conjunction with the clearinghouse for science education, the ERIC Science, Mathematics, and Environmental Education Clearinghouse (ERIC/SMEAC). This was one of three comprehensive efforts by the National Science Foundation (NSF) to analyze and report the status of pre-college science, mathematics, and social studies. It appears that over 600,000 citations had been culled from among the following resources: Current Index to Journals in Education (CIJE), Resources in Education (RIE), Education Index, Readers Guide to Periodical Literature, Dissertation Abstracts International (DAI), the National Institute for Education (NIE) library, the National Science Foundation (NSF) files. Also included were documents retrieved from state departments of education, results of questionnaires received from state departments of education, and reports from site visitations in 14 states. Selections for reporting were based upon the following criteria:

1. generalizability of results based upon size of population, sampling techniques, and methods of analysis;

2. summarization of data or research reports (e.g., review of research);

3. importance or significance as indicated by publication in a referred journal or as a committee report;

4. representativeness of a type or kind of document

(e.g., curriculum guides).[73]

Approximately 6,000 documents were employed in the final report, about 600 of which were selected for bibliographic treatment in Helgeson's report. For the purposes of this review, Helgeson's literature search will be selectively summarized in respect of those factors having the most relevance for elementary school science teaching.

Enrollment factors. Public elementary school enrollments increased from 1955 to 1969 and then began to decline, with 1968 as the peak year for K-6 enrollments.[74] Because school districts were being consolidated and enrollments were increasing, a small number of school districts had come to enroll a substantial percentage of the students of the United States--about one third to one half--indicating that a relatively few (730) school districts determined the educational programs for a large number of pupils.[75]

Elementary science curriculum. Helgeson summarizes the science curricular patterns:[76]

> 1. Prior to the late 1950's the curriculum of an elementary school was based primarily on a textbook. A curriculum for most schools was either one textbook series for grades 1-6 or two series: one used for the lower grades and the second used for the upper grades.
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> 2. With the use of Federal funds (mostly NSF), alternatives to the existing materials were developed in

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[73]Ibid., p. 4.

[74]Ibid., p. 7.

[75]Ibid., p. 13.

[76]Ibid., p. 16.

the 1960's. These materials had a marked effect on classroom instruction, other instructional materials prepared by publishers, and curriculum guides.

3. Data indicate that about 30% of the elementary schools have used or are using the NSF sponsored materials.

4. During the 1970's several publishers produced materials that are modifications of earlier NSF sponsored materials. These modifications have been based on feed-back from use of the earlier materials.

5. Many of the curriculum materials produced during this period of time show a marked influence of the ideas of Piaget, Gagne, and Bruner.

6. Summaries of objectives for elementary school studies stated by teachers, administrators, and science educators in the 1960's and 1970's show substantial similarity.

7. Content of many programs produced since 1955 show substantial agreement with the objectives reported from surveys.

8. Recent materials show the impact of concerns about the environment, energy, and natural resources.

9. During the past five years there has been a growing concern on the part of some educators and citizens that knowledge objectives of the elementary school program were de-emphasized too much. Some of the recent materials illustrate this concern as do textbook adoption patterns.

10. While there are substantial data regarding implementation and use of materials, there are relatively few data on quality of use.

Efforts to improve elementary science teaching as a result of fears of Russian superiority in space technology were undertaken jointly by teams of scientists and psychologists. Science content was organized around major themes (concepts or conceptual schemes) and designed to be taught by reconciling the child's cognitive readiness with the task requirements for pursuing specific learning activities.[77] All of the new programs incorporated student-centered activities and materials that had been subjected to extensive pre-testing by teachers. Teachers were required to adopt new outlooks on the amount of student interaction, degree of management, and indirect instructional modes.[78] The three programs described in Chart 1 were widely distributed commercially and are perhaps the best known of the elementary science projects. They also represent three somewhat different philosophies and seem to provide a cross section of the thinking of science curriculum specialists.[79]

Other science curriculum projects were produced in the 1960's. These seemed to overcome certain perceived deficiencies of the initial programs and were designed to meet needs not addressed previously. There were emphases on concepts, processes of science, attitudes toward science, and the use of hands-on activities. Content incorporated into the newer programs reflected concerns about pollution, use of natural resources, and energy conservation. Examples of these approaches include the following:[80]

> Conceptually Oriented Program in Elementary Science (COPES), a spirally organized series of learning experiences leading to understanding of five major science concepts, K-6; New York University, NY.

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[77]Ibid. [78]Ibid.

[79]William K. Esler and Mary K. Esler, <u>Teaching Elementary Science</u> (Belmont, California: Wadsworth Publishing Company, 1981), p. 136.

[80]Ibid., p. 146.

Chart 1

A Comparison of Three Elementary School Science Programs Developed in the Early 1960's[a]

Title and Acronym	Science--A Process Approach (SAPA II)	Science Curriculum Improvement Study (SCIS)	Elementary Science Study (ESS)
Sponsor	American Association for the Advancement of Science; Washington, D. C.	Lawrence Hall of Science; University of California, Berkeley, California	Education Development Center; Newton, Mass.
Publisher	Ginn & Co., Lexington, MA	Rand McNally, Chicago, IL	McGraw-Hill, New York, NY
Description	Revision of a less flexible form; is an activity-oriented program with 105 modules built around various processes of science; has teacher instruction booklets, kit materials, storage units; K-6	An ungraded, sequential physical and life science program adapted to the needs of children that employs challenging investigations in a laboratory approach; K-6	Children are able to explore the physical world directly in a hands-on "discovery" based approach; 56 units; K-9
Science content	Much content; pattern not evident	Evolving sequence broad concepts	Much content; pattern not seen

Chart 1 (continued)

Title and Acronym	Science--A Process Approach (SAPA II)	Science Curriculum Improvement Study (SCIS)	Elementary Science Study (ESS)
Major objective	Process skill development	Science literacy	Satisfaction of curiosity by "doing science," problem-solving
Nature of student activities	Teacher promotes development of student process skills	Teacher directs and assists students in discovery	Teacher manages students in unstructured "messing about"
Program flexibility	Prescribed by printed guide	Moderate	Very adaptable to other programs
Amount of teacher decision-making in using activities	Little	Some	Considerable

[a] William K. Esler and Mary K. Esler, Teaching Elementary Science (Belmont, California: Wadsworth Publishing Company, 1981), pp. 135-145, 496-499.

Individualized Science (IS), comprehensive integrated system of individualized science on five levels including both physical and biological science units, K-6; Learning Research and Development Center, Pittsburgh, PA.

Minnesota School Mathematics and Science Center (MINNEMAST), math and science coordinated for kindergarten and primary grades, K-3; MINNEMAST center, Minneapolis, MN.

Unified Sciences and Mathematics for Elementary Schools (USMES), an interdisciplinary program that challenges students to solve real problems in school and community settings, K-8; USEMES, Education Development Center, Newton, MA.

University of Illinois Astronomy Program (UIAP), a program of sequential development of the basic understanding of astronomy incorporating relevant process skills, 5-8; University of Illinois, Urbana, IL.

Over some time, concerns were raised regarding an apparent disproportionate emphasis upon the attainment of process objectives at the expense of knowledge objectives.[81] Data are lacking which would correlate quality of instruction and material use, longitudinal studies dealing with retention of science learning, and the relationship of teacher philosophy regarding what science should be taught and how it should be taught.[82]

Instructional patterns in science. The components of the instructional process frequently identified by researchers include class size, amount of instruction time, the use of science teaching realia and audio-visual methodology, and the attitudes of teachers toward perceived barriers to effective science teaching.

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[81] Helgeson, p. 19. [82] Ibid., p. 20.

During the period of Helgeson's study, the average class size declined from over thirty students to about twenty-four students. The amount of time per week for science was 60 minutes in grade one and showed regular increases through the grades to about 120 minutes in grade six. Classes employing NSF materials devoted more time to science than those that did not use the NSF materials. This emphasis in the use of hands-on activities and laboratory equipment seemed to be attributed to the availability of NDEA funds for science.[83] Nevertheless, substantial numbers of teachers did not emphasize this type of activity but conducted science instruction primarily as a lecture-discussion session followed in frequency by demonstration procedures. There is also evidence to support the increasing use of television and films, especially in the lower grades.[84]

The realization that science instruction can be improved when attention is focused upon real and/or perceived barriers to effective teaching has motivated considerable research in this area. In several studies, over 60 percent of respondents identified certain factors to constitute such barriers. These factors included lack of consultant services, inadequate room facilities, insufficient science knowledge, inadequate in-service opportunities, lack of funds for supplies and equipment, and the

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[83]Ibid., pp. 32-33. [84]Ibid., p. 32.

unfamiliarity with (newer) science teaching methodology.[85] Perhaps the most frequently reported barrier concerns problems related to facilities, supplies, and equipment and seems to relate to school enrollment levels and funding priorities.

Preservice teacher education. The major impact of preservice guidelines has come from state certification agencies, and these guidelines have been employed by education faculties in the development and modification of their programs. A review of twelve state certification boards revealed extensive reciprocity among colleges and universities that conduct "approved" programs. Certification patterns are based upon courses completed rather than upon performance, and these patterns reflect little impact of the post-Sputnik curriculum developmental efforts. "Elementary teacher candidates are seldom required to take more science content than that required for the general education component of their undergraduate program."[86] States planning for certification program modifications are including efforts to "provide for more process skill development and such topics as humanism, relating science to contemporary social problems, extended field-based experiences, and the involvement with inner-city students and other minority groups."[87] The extent of preservice

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[85] Ibid., p. 33.

[86] Ibid., p. 50.

[87] Ibid., p. 57.

research has been limited in its scope and generalizability, and no definitive theory of science instruction has been widely practiced.[88]

Inservice teacher education. Teacher inservice education programs are often developed in order to meet some particular expressed need relating to performance, sometimes referred to as a "barrier to effective teaching." Of thirteen so-called barriers to science teaching, Hone considers some of these "scarecrows" (self-imposed limitations in attitudes), which she believes can be overcome through direction in the use of self-renewal materials such as teacher guides and textbooks that are readily available in classrooms.[89] Other problems in instructional competence in science can be met through training in creative approaches to planning, effective use of available space in the classroom, and learning to improvise with inexpensive equipment.

In spite of the numbers of teachers involved in NSF-funded programs, the need for inservice in science continues primarily for the following reasons:[90]

1. the constantly changing and expanding body of science knowledge,

2. inadequate preservice programs,

3. the additional modifications of science curriculum improvement projects,

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[88]Ibid., p. 66. [89]Ibid., p. 86.

[90]Ibid., pp. 97-102.

4. ineffective or unavailable science consultant services, and

5. the disparity between priorities for science in the elementary school and the requirements for scientific literacy in our society.

Controlling and financing elementary science education. With respect to educational function, structure, finance, or instruction, it is evident that the states have accelerated their influence over the activities of the schools.[91] There are at least six areas in which this pattern of expansion has been reported through the literature:[92]

1. policies regarding school size and consolidation,
2. policies regarding the school curriculum,
3. policies regarding certification practices,
4. policies regarding the selection and purchase of textbooks and materials,
5. policies relating to minimum competencies and accountability, and
6. policies regarding equality of educational opportunity.

In terms of the consolidation efforts of school districts, more students have been transported to elementary schools where they have been able to spend less time before and after classes. With respect to the curriculum, there have been specified requirements in terms of science subject matter including conservation, hygiene, drug abuse education, sex education, outdoor education, and nature study.

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[91]Ibid., p. 120. [92]Ibid., pp. 120-125.

In addition to the inclusion of new or controversial subject matter, the effect of time requirements or special classes in reading or mathematics can reduce the emphasis upon science instruction. The statement of objectives of the state school system that do not include science effectively reduces the amount of science taught at all levels. States had increased their requirements related to certification, especially from the 1960's to the early 1970's, but did not continue to upgrade requirements in science certification after 1974.

The literature abounds with data indicating that substantial numbers of teachers do not enjoy teaching science, do not enjoy science themselves, and do not enroll in any science-related course work after they graduate.[93] Over the past two decades states have increased their influence on policies related to minimum competencies and accountability, but there is no pattern of positive influence upon science teaching in these efforts.

In an analysis of the centralization of state authority on thirty-six areas of educational policy, Wirt developed a rating scale of "centralization of authority." Ratings ranged from 6.00 (total state assumption of control) for Hawaii to 1.86 for Wyoming, with the mean established at 3.59 (between extensive/limited local option under state mandated requirements) and the S.D. at .56.[94]

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[93]Ibid., p. 122. [94]Ibid., p. 127.

These data suggest that the role of the state is more important than commonly thought and that the influence of the state appears to be growing.[95]

Reports of financial trends in supporting public instruction in science are given by Helgeson. During the period between 1955 to 1976, the percentage of financial support from Federal and state sources increased while the percentage of support from local sources decreased. There has been a pattern of the adoption of state categorical aid programs following the passage of similar Federal categorical aid programs, but gains for science instruction in the states have not followed this pattern. When Federal funds were withdrawn, programs that supported the teaching of science in the elementary schools were discontinued.[96] "Reduced support from the NSF, as well as relatively small amounts of money from the Office of Education, the National Institute of Education, and other Federal agencies, has been the pattern for science education since the late 1960's."[97] The report of financial trends concludes with the notion that almost nothing is known about the cost effectiveness of science education instruction.[98] In the analyses of needs assessment efforts in the literature, it is not surprising to find that "the greatest single need facing

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[95]Ibid., p. 131. [96]Ibid., p. 140.

[97]Ibid. [98]Ibid., p. 144.

education is an improved program of financial support."[99] Science education is rarely included in state needs assessments.

Other needs often mentioned in the reports of independent researchers include improved science teacher education, continuing research in science teaching-learning and the communication and application of that research, and the need for equal educational opportunity. Helgeson concludes his report of the status of precollege science educational practices in U.S. schools by saying that although there has been much activity in elementary science education during the twenty-year period studied, there does not seem to be much to show for it in terms of increased interest in or financial support for science.[100] In spite of the special assistance programs of funding and curriculum development efforts, "the major objectives in science education have not changed appreciably over the past twenty years."[101] There seems to be rather a shift of concern for priorities that does not include science education in elementary schools.

The significance of Helgeson's comprehensive review of the literature of science education as it reflects factors, conditions, and patterns relating to elementary science teaching, must figure prominently in developing

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[99]Ibid., pp. 192-193. [100]Ibid., p. 193.

[101]Ibid.

any analyses of trends which may be shared by elementary schools in both public and private education.

The Case Studies in Science Education

The second major aspect of the National Science Foundation evaluation of the status of pre-college science in the United States is the two-volume report of the Case Studies in Science Education by Robert E. Stake and Jack A. Easley, Jr. This collection of field observations of science teaching during 1976-1977 at a sampling of eleven diverse and balanced school district sites incorporated the input of over ninety project associates and workers, required eighteen months to complete, and cost approximately $300,000. Observers worked independently at their sites for from 4 to 15 weeks and submitted case study reports that were preserved intact and compose volume one of the CSSE report. These individual reports were later augmented by cross-site conclusions and "triangulation" (focused representations of individual viewpoints) by members of the University of Illinois team who guided the development of this study.[102]

The case study approach, which studies "a bounded system, emphasizing the unity and wholeness of that system,

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[102] Robert E. Stake, Jack O. Easley et al, Case Studies in Science Education: Volume II Design, Overview and General Findings (Urbana, Ill.: Center for Instructional Research and Curriculum Evaluation, University of Illinois, 1978), i.

but confining the attention to those aspects that are relevant to the research problem at the time,"[103] permitted wide latitude in the investigating and reporting procedures employed by the observers. The result was an "experience-orientation with issue-based images and meanings forming the conceptual basis for the work."[104] "The data are reported mostly in incident narrative language of the anthropologist"[105] and represents a "description of the behavior of science education in its habitat"[106] in which "greater consideration is given to secondary schools."[107]

This important study provides a dimension of science education ordinarily not reported in literature digests and survey efforts. As in the study by Helgeson, these CSSE findings are reported selectively from the point of view of the relevant elementary school science teaching practices and concerns that are most applicable to the present study. The following discussion, which includes CSSE vignettes, is meant to be representative of that portion of the Case Study reports dealing with K-6 science that does not pertain to the findings in mathematics or social studies.

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[103]Ibid., Volume II, Chapter C, p. 31.

[104]Ibid., Volume II, Chapter C, p. 3.

[105]Ibid., Volume II, Chapter C, p. 17.

[106]Ibid., Volume II, Chapter C, p. 22.

[107]Ibid., Volume II, Chapter C, p. 12.

Concerning the science curriculum.

> The science curriculum, then, may be thought of as a kind of activity, or subset of activities, that takes place in the context of many other kinds of human activities comprising the organization known as school.[108]

The conclusions of observer Jacquetta Hill-Burnett at "Archopolis" (identification code name for an eastern seaboard city site) are tempered by the realization that in the school setting many factors influence the direction and effectiveness of science instruction. Referring to another site Howard Levine states that "the Urbanville district-wide teaching of science is being squeezed between a perceived need for both the basics and vocational education." He also believes that "there is absolutely no articulation between the three major grade units K-6, 7-9, 10-12, and very little articulation between classes in a unit."[109]

A common observation among all site observers was that science has low priority among teachers and administrators. Wayne Welch states, "reading and language arts dominate the curriculum, even at the upper levels."[110] The pecking order of subject matter offerings places Health/

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[108] Robert E. Stake, Jack A. Easley et al, Case Studies in Science Education: Volume I The Case Reports (Urbana, Ill.: Center for Instructional Research and Curriculum Evaluation, University of Illinois, 1978), 9-12.

[109] Ibid., Volume I, Chapter 5, p. 28.

[110] Ibid., Volume I, Chapter 5, p. 9.

Science fifth in order just ahead of Music and Art.

The curriculum also seems to be badly out of tune with both the capabilities of the teachers and the abilities of the students. "Teaching science-as-inquiry through discovery, or learning science by doing what scientists do, was not widely practiced in the classroom."[111] Another observer states, "every year teachers cover the first chapter, 'What is a scientist?'"[112] It is quite apparent that science teaching is textbook-bound, as evidenced by this excerpt from an observer's commentary: "(Teacher): 'How do we learn?' (Student chorus): 'We learn by reading.'"[113] Believing the textbook content to be overblown and of little help to the less able reader, teachers show their concern through these typical reactions:

> We can get them (students) to use words like "molecular structure," "models," and "chemical substance" and all those good things, but they just can't handle it. And our new science program emphasizes that in the second grade. I'd say 75% of them won't get the fifth grade universe science material; "wave particle theory"; and "spectroscopic analysis of compounds"; and "continual motion of bodies in space." Not a chance.[114]

> So we put these kiddos in large groups so we can have small groups in mathematics and reading and there is absolutely nothing at hand for the slower than average child in science.[115]

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[111]Ibid., Volume I, chapter 9, p. 6.

[112]Ibid., Volume I, Chapter 10, p. 19.

[113]Ibid., Volume I, Chapter 9, p. 9.

[114]Ibid., Volume I, Chapter 1, p. 27.

[115]Ibid., Volume I, Chapter I, p. 27.

> The treatment of science on the K-6 level is really nothing more than show and tell.[116]

Concerning the frequency of science teaching. The following excerpts from the CSSE reports of observations speak eloquently for themselves.

> Frankly we don't teach much science. Usually science is taught along with social studies and is in a unit like "Dinosaurs" or "Transportation."[117]

> . . . science takes time. (She teaches) a little science before the school's science fair each year.[118]

> In the typical teaching schedule, many teachers use the last hour of the day for physical education, science, art, music, and health to be "worked in" during the week. Science is losing the battle . . . it receives very little attention.[119]

> Science teaching was infrequent and weak in the elementary schools in both the School Without Schools Program and the regular school program.[120]

> The science program in the elementary schools at W.C.S.D. (California) is almost non-existent.[121]

Dr. Welch expresses the overwhelming concensus of CSSE observers and team members:

> Probably the most important observation for the purpose of this study at the elementary level is the small amount of science that is being taught. Only an occasional teacher or principal who is interested in the area generates interest that may spread throughout the

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[116] Ibid., Volume I, Chapter 5, p. 28.

[117] Ibid., Volume 1, Chapter 1, p. 28.

[118] Ibid., Volume 1, Chapter 1, p. 26.

[119] Ibid., Volume I. Chapter 5, p. 9.

[120] Ibid., Volume I, Chapter 8, p. 9.

[121] Ibid., Volume I, Chapter 7, p. 5.

> building. Otherwise, one is most likely not to see any science at the elementary level.[122]

Reasons put forth to account for this apparent lack of science teaching in the elementary schools are legion and complex. The imposition of government regulations regarding the implementation, direction, and evaluation of federally funded compensatory and remedial programs involve time requirements that impact other areas of the curriculum. The effect of "basic" emphases and federal accountability tends to squeeze non-basic and non-federalized programs, such as science. There are also other constraints that tend to reduce the amount of science in the schools. Expectations for teachers to attend parent-teacher meetings, to take an active leadership role in the community, to complete record-keeping duties, to prepare for several subject areas having two or three different levels of student capabilities, and to be an effective disciplinarian leave many teachers with little "left over" to develop creative hands-on science approaches in the classroom.

Along with the constraints of governing agencies and the expectations for teacher performance, the oft-recurring theme regarding the physical setting for teaching science is heard. Sometimes the way the building is built or adapted for use by students and teachers presents an unfortunate roadblock to instruction.

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[122]Ibid., Volume I, Chapter 5, p. 9.

> The new school building is "an architect's dream and a teacher's nightmare."[123]

> Open space (contributes to the problem of lack of hands-on activities) . . . concept here is too large for much besides demonstration.[124]

Adequate space with attendant security which supports continuing science activities is at a premium in most schools.

> A teacher reported that materials left over from an experiment in-progress were stolen from a locked storage room, one of many such incidents that frustrated the accomplishment of hands-on approaches and the accumulation of even simple equipment and adequate supplies.[125]

While looking for information relating to science teaching practices, a case study worker may become aware of problems that have broader implications for education.

> Whatever the complaints (about the building), it's an interesting thing about the school that once inside, you lose much sense of what lies outside. It's one of those things that is so obvious to all the teachers that they have long ceased to question it.[126]

There are, however, occasions when the building is suited precisely to the instructional concept:

> A primary teacher from Houston suburbs remarked, "Science is the little building where more science got taught than in this whole huge building put together. Our schools are being built too large. Science is not a large group activity." ". . . the little building had more than the fine science aide; it had the right size for small children to do science.[127]

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[123]Ibid., Volume I, Chapter 11, p. 2.

[124]Ibid., Volume I, Chapter 1, p. 26.

[125]Ibid., Volume I, Chapter 9, p. 23.

[126]Ibid., Volume I, Chapter 11, p. 2.

[127]Ibid., Volume I, Chapter 1, p. 24.

Perhaps even more distressing than the limitations imposed upon the instructional process by the physical structure are those created by lack of organization, neglect, or incompetence.

. In many school districts unnecessary barriers to effective teaching in science are created by inefficient systems in which requests for science supplies and equipment are repeatedly back-ordered, mixed up, and delayed. The vexing knowledge that orders placed this year will not reach the classroom teacher until next year has thrown teachers back on their own feckless abilities to scrounge and make-do with scraps and materials furnished with pocket money.[128] Generally, teachers subscribe to the notion that science is most desirable when it is activity-oriented.[129]

> For science I still believe in a hands-on approach to learning. Kids can't take a concept and read about it, even if they're interested in it. They need to apply it. Science is most useful if it is something they can apply.[130]

> When we had fossils in the room, the kids enjoyed them. They examined them, looked them up in books, and talked about them. This is primary science to me.[131]

Activity-oriented programs require equipment and supplies in order to be effective. Many schools, however, have negligible budget provisions for these. In rural

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[128] Ibid., Volume I, Chapter 9, p. 23.

[129] Ibid., Volume I, Chapter 1, p. 24.

[130] Ibid., Volume I, Chapter 4, p. 24.

[131] Ibid., Volume I, Chapter 4, p. 25.

"Urbanville," the annual per student expenditure for science equipment and supplies was reported to be $1.25, an amount deemed by the staff of the school district to be woefully inadequate.[132] Trends indicate that as science teaching priorities are moved back because of "basics," inflation, and declining enrollments, "the monetary resources (for science) continue to be cut back."[133] As a final coup, where activity "kits" are available in the classrooms, "the texts and the concepts in the science kits don't fit."[134]

The litany of constraints, expectations, physical limitations, and disparity between theory and practice present a distressing picture of elementary school science teaching as it has been chronicled recently in the CSSE reports. It is encouraging, therefore, to come across certain evidence that science teaching in the elementary school is "alive and well."

Rob Walker, reporting on Greater Boston's "Patriot" elementary school, said, "My impression is that the physical plant makes science difficult . . . in spite of the limitations, the science program at Patriot is better than average for the rest of the district."[135] At "Vortex," an urban renewal area in Pennsylvania, Gordon Hoke observed, "All

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[132]Ibid., Volume I, Chapter 5, p. 15.

[133]Ibid., Volume I, Chapter 5, p. 28.

[134]Ibid., Volume I, Chapter 1, p. 26.

[135]Ibid., Volume I, Chapter 11, p. 46.

4, 5, 6 grade students attend planetarium showings twice a year."[136] A sixth grade teacher, during the Columbus, Ohio School Without Schools Program, met her children for frequent field trips to locations for enrichment experiences having science content.[137] Indications of interesting and effective science teaching are to be found, but they are infrequent.

What of the help to be rendered by science consultants and advisors within the school district? Nearly every school district has someone with the title of science consultant who acts in an advisory capacity with elementary teachers. This individual may also have additional subject matter areas in which he advises, or he may have administrative responsibilities. "Yet in the district where the services of several consultants and science advisors are available, these services go unused."[138] Typically, science advisors are not supposed to teach but only to support the classroom teachers. Science advisors report that "many teachers 'feel inept' in this area," a familiar complaint.[139] Stufflebeam and Sanders put the case more strongly in the conclusions reached in their Columbus, Ohio, report; "regular consultant assistance was avaiable to all

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[136] Ibid., Volume I, Chapter 10, p. 18.

[137] Ibid., Volume I, Chapter 8, p. 10.

[138] Ibid., Volume I, Chapter 11, p. 47.

[139] Ibid.

elementary teachers but they uniformly resisted it."[140]

It seems clear that an important part of the science education process is the manner in which the individual teacher can overcome certain critical barriers that limit her effectiveness. Some of these "barriers" mentioned frequently and in different ways in the CSSE reports include the following: (1) lack of adequate science background in basic science as well as the specialized methods for teaching it, (2) lack of interest in the subject, (3) lack of management skills, which inhibits productive employment of hands-on science activities. Although the teacher may operate under a variety of constraints, expectations of other people, and physical limitations and may struggle with disparate theory and practice, the evidence of real or perceived barriers to instruction may be the most crucial area in the improvement of science education in the elementary schools.

> Everyone agreed that the most important parts of the learning equation are the teacher and the student.[141]

> The difference between the science and social studies classes I observed emphasized again that the teacher is the "magic ingredient."[142]

Summarized in the final chapter of the <u>Case Studies in Science Education</u> are the following observations and

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[140] Ibid., Volume I, Chapter 8, p. 9.

[141] Ibid., Volume I, Chapter 5, p. 28.

[142] Ibid., Volume I, Chapter 11, p. 47.

conclusions reached by the team:[143]

> What science education will be for any one child for any one year is most dependent on what that child's teacher believes, knows, and does--and doesn't believe, doesn't know, and doesn't do. For essentially all of the science learned in school, the teacher is the enabler, the inspiration, and the constraint.
>
> A child learns a great deal about science out of school. A few children have science hobbies or reading interests, sometimes finding surrogate teachers, so that they gain substantial understanding of science without the school's help. Most children are unable to do that. For most, systematic science learning will occur only if the teacher can cope with the obstacles and is motivated to teach something of the knowledge and inquiry of the scientific disciplines. For other children such learning is unlikely.
>
> Decisions as to changing the science curriculum were largely in the hands of teachers--even on major choices they had the primary veto power. They often could not bring about the changes a few would have liked, but they regularly could stop curriculum changes they opposed, either at the district level or in the classroom. They were largely alone in a personal struggle to select and adapt available materials to educate a distressingly reticent student body.
>
> The role that teachers play in setting the purpose and quality of the science program was apparent in all our case studies and reaffirmed in our national survey.

Almost everyone interviewed wanted a strong science program, but most were quick to add that there were other things that needed bolstering first, things like reading, vocational skills, writing ability, and remedial courses. Each of the eleven communities was reported to be "different, complex, interesting, and sometimes the science program . . . was a part of what people were most proud of, or least proud of--but not often . . . there were too many other

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[143]Ibid., Volume I, Chapter 19, pp. 1-2.

critical matters."[144]

> Many teachers were busy narrowing down to a "basic skills curriculum"; most were teaching pretty much as they always had, on their own, relying on the textbook or workbooks, treating science as something important, but something that could be learned later if not now.[145]

Three National Surveys of Science Teaching in the United States

Are the findings of private researchers and case workers able to provide an accurate and complete picture of science education in the elementary schools of the United States? It is possible to question the generalizability of the conclusions of researchers who operate under real and self-imposed limitations dealing with selected populations of learners and contrasting dissimilar teaching methodologies, for example. Similarly, broad generalizations developed from a relatively few selected schools observed using a "bounded system" case study approach may have to be qualified by other procedures that use alternative methods. Such corroboration may be found in the employment of survey techniques that can be useful in the determination of the relative frequency and distribution of selected factors and the significance of postulated relationships among those factors.

The motivation to provide the most accurate and

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[144] Ibid., Volume I, Chapter 19, p. 8.

[145] Ibid., Volume I, Chapter 19, p. 8.

complete picture of science education in the United States led the National Science Foundation to conduct a thorough literature review, a series of case studies, and a national survey.[146] The literature review and the case studies have been discussed previously. The Report of the 1977 National Survey of Science, Mathematics, and Social Studies Education, is the most recent national study and the first of three such studies to be reviewed in this chapter for relevant information.

The National Science Foundation contracted to Research Triangle Institute (RTI) the project of conducting a survey of science education in the United States. It was accomplished in order to provide an additional measure of evaluating the effectiveness of instruction in the schools. Because the NSF uses the broader distinction "science" to incorporate both mathematics and social studies, the report of the data will be limited to the more traditional use of the term. In addition to the limitation stated, the review will also deal with only those factors that pertain to the significant questions under consideration that were surveyed in grades K-6.

The RTI report, supervised by Dr. Iris R. Weiss, includes data from approximately 408 of each K-3 and 4-6

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[146] Panel on School Science Commission on Human Resources. The State of School Science (Washington, D.C.: National Research Council, 1979), p. 1.

elementary school division.[147] Tables reflect the number of principals surveyed to be about 800, with an additional 800 teachers. Questionnaires sought information concerning background data, science curriculum, materials and methods, and in-service activity. More than 150 tables containing descriptive information for characterizing science teaching in elementary schools are given in this 300-page report.

A portion of the study was devoted to gathering information regarding the involvement of super-district and state administrative personnel and programs that have an impact upon local school science teaching. The report summarizes state guidelines for time to be spent in science instruction, requirements for specific science subjects to be taught, the use of standardized testing in science, the status of science competency programs, the proportion of time spent by state supervisors of science instruction, and dollar expenditures for statewide coordination of science.

Finally, it is unusual that the results of this survey, together with the NSF Case Studies and the Literature Review, have been formally reviewed by eight other agencies at the request of the sponsoring organization. Although there may be evidence of overkill, the independent evaluations of this survey tend to identify trends and

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[147] Iris R. Weiss, Report of the 1977 National Survey of Science, Mathematics, and Social Studies Education (Triangle Park, N.C.: Center for Educational Research and Evaluation, Research Triangle Institute, March 1978), p. 1.

reveal unmet needs in the science teaching practices and programs in schools.

The 1971 Survey of Science Teaching in Public Schools of the United States

During the school year, 1970-1971, a second major national survey of science teaching was conducted by the faculty of Science and Mathematics at The Ohio State University and reported in four volumes by ERIC/SMEAC under the direction of Robert W. Howe.[148] This project presents collected "bench mark" data on the teaching of science in the public schools of the United States. It was conceived as part of a trend analysis of changes taking place in programs, instruction, facilities, and teacher education. An interesting feature of this study was the organization of data by geographic regions, which permitted inspection of regional variations in science teaching programs. Perhaps the most important concerns of the study dealt with the extent to which the various science curriculum improvement projects were being used in the teaching of science.

The sample size for the elementary section of the survey was established at 10,000 schools. Random selection of schools was based upon population statistics of student

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[148] Robert W. Howe et al., Science Education Reports: A Survey of Science Teaching in Public Schools of the United States, Volume 4--Elementary Education (Columbus, Ohio: ERIC Information Analysis Center for Science, Mathematics, and Environmental Education, 1974), preface.

enrollments reported by each state. The random selection of teachers and science classes was accomplished by employing a three-stage sampling design. Each elementary school was represented by data provided by comprehensive questionnaire sets returned by the principal and one teacher of science. Of the 9,711 questionnaire sets mailed to selected elementary schools, 2,675 sets were employed in the analyses procedures, representing about 3.9 percent of public elementary schools in the United States and the District of Columbia.

The 1962 Survey of Science Teaching in the Elementary Schools

In the school year 1961-1962, Paul E. Blackwood undertook the first national survey of science teaching practices in the elementary schools of the United States.[149] Acting under the auspices of the Department of Health, Education, and Welfare, questionnaires were sent to elementary school principals who were selected from among 34,000 school districts and school enrollment size. Responses were obtained from 1,476 elementary school principals. This initial effort to survey the status of science teaching practices in elementary schools established a baseline of information and concerns that has provided

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[149] Paul E. Blackwood, Science Teaching in the Elementary Schools: A Survey of Practices, Department of Health, Education, and Welfare, No. 749 (Washington, D.C.: Government Printing Office, 1965) iii.

both a stimulus for research and a background against which changes in practices might be charted.

Although each of the three aforementioned national surveys contributes greatly to our knowledge of science education in the elementary schools of the United States, the studies unfortunately are not comparable because they deal with different sample populations, range over at least fifteen years, and employ different instrumentation. Approached cautiously, however, some of the data can be inspected for certain common elements that may provide somewhat of a picture of the changes in science education in the elementary schools over the period from 1960 to 1977.

In order to examine informally the nature of changes that may have occurred in science teaching practices, the following arrangement of salient data from the three surveys is presented in tabular and narrative form to accommodate the procedures to be followed in reporting the findings of the present study of science education in Christian elementary schools.

Area 1: School Organization for Teaching Science

A) Are there guidelines for amount of time to be spent for science instruction?

Table 1

Percent of States with Time Guidelines
for K-6 Science (Weiss, p. 21)
N = 49 States

	Yes	No	Unknown
Nation	27	55	18
N.E.	25	63	13
S.	31	50	19
N.C.	33	33	33
W.	15	77	8

Table 2

District Guidelines for Minimum
Minutes Per Day Science
(Weiss, p. 22)
N = 326 districts

Grade	K	1	2	3	4	5	6
% districts	12	28	29	30	30	32	36
avg. min./day	16	17	18	20	26	30	34
std. error	.7	1.0	1.1	1.2	1.6	1.9	2.0

B) What percent of the year is science actually taught?

Table 3

Percent of Public Schools Teaching Science
More than Half Year (Blackwood, p. 8)
N = 1476 schools

Grade	1	2	3	4	5	6
% schools	71	76	77	81	84	88

C) Is your school departmentalized for teaching science?

Table 4

Percent of Public Schools with
Departmentalized Science
(Blackwood, p. 48)
N = 1476 schools

Grade	K	1	2	3	4	5	6
% schools	.1	2.6	3.8	4.8	12.7	26.3	46.0

Table 5

Percent Schools Having Departmentalized Science
(Howe, p. 13) N = 2640 schools

All Grades	47%
S.D.	.5

It will be seen that about 27% of the 49 states reporting had minimum time guidelines for science instruction in grades K-6 and that the average time spent in actual science instruction ranged from 16 to 34 minutes per day for the 326 districts (Weiss, 1977). Blackwood (1962) determined that from 71% to 88% of grades in 1476 representative schools had science more than half of the school year. The progression through the grades in the departmentalization of science instruction is to be expected and shows that nearly one-half of 1476 schools surveyed had departmentalized instruction for the sixth grades. Howe (1971) discovered nearly the same thing, but the data are not reported for the separate grade levels.

Area 2: School Facilities for Science and Class Enrollment

A) In what type of room is science most often taught in your school?

Table 6

Percent Use of Specified Room Types for Science (Blackwood, p. 25; Weiss, p. 129)

	Blackwood (% of 1476 schools)		Weiss (% of 558 classrooms)	
Grades	1-3	4-6	K-3	4-6
regular classroom with no special facilities	87.8	80.1	38	34
regular classroom with special features	9.4	15.9	54	54
a special room or lab (or other)	2.7	3.9	0	9

B) What is the average number of students in science classes?

Blackwood (1962) reported a range of from 24 to 31 pupils in schools of varying total enrollments, with an average of between 26 to 27 pupils. (Rural schools had much lower averages in science classes.) Howe (1971) found a 25 to 1 pupil-teacher ratio, whereas Weiss (1977) gave the following breakdown:

Table 7

Average Class Size for Science
(Weiss, p. 67) N = 1476 schools

Grades	Class Size	Std. Error
K-3	23.5	.36
4-6	26.6	.65

Over the past fifteen years it appears that the number of pupils enrolled in science classes has remained fairly constant when expressed as a national average, but the science room seems to have changed in terms of the addition of special features for teaching science. The availability and use of special rooms for this purpose has doubled.

Area 3: Science Textual and Curriculum Resources

A) What is the status regarding the adoption of science textbook series?

Table 8

The Use of Textbooks in Science Teaching

	Blackwood, p. 74 % of 1476 schools		Howe, p. 15 % of 2586 classes	Weiss, p. 89 % of 558 classes	
Grades	1-3	4-6	K-6	K-3	4-6
No textbook adopted	17.8	4.5	not specified	37	10
One textbook adopted	58.8	67.0	53*	46	56
Two or more textbooks	23.5	28.5	42*	18	34

* includes workbook(s)

B) What is the most commonly used science textbook?

Table 9

The Most Commonly Used Science Textbooks
(Weiss, p. B-44)

	Percent of Classes	
	K-3	4-6
Concepts in Science (Brandwein)	12	16
Science: Understanding Your Environment (Mallinson)	5	10
New Laidlaw Science Program (Smith)	5	7
Heath Science Series (Schneider)	4	5
Science Curriculum Improvement Study: Life Science	4	3
Modern Elementary Science (Fischler)	4	-
Science: A Process Approach (SAPA)	2	3
Science Curriculum Improvement Study: Physical	2	2

C) What is the frequency of use in the science curriculum improvement projects?

Table 10

Percent of Use of Science Curriculum Improvement Projects

	Grade	ESS	SAPA	SCIS	Number
Howe	K-6	8	14	5	2675
Weiss	K-3	5	4	11	287
Weiss	4-6	9	9	12	271

Schools and teachers appear to be using one science textbook series in their teaching. The frequency of use of the eight most reported science textbooks accounts for only 38% of K-3 classes and 46% of 4-6 classes. Perhaps science is not taught in some of those classes or a variety of textbook series totaling less than two percent each in frequency cf use are being employed in science instruction. There is also some disparity between the reported data for SCIS text use (four percent Life Science plus two percent Physical Science) seen in Table 9 when compared to the stated use of the SCIS program (11% plus 12%) seen in Table 10 (Weiss).

D) How are selected science-related topics handled in the curriculum?

Table 11

Percent of Schools that Teach Health
in Various Ways
(Blackwood, p. 60)

	1-3	4-6
Taught as a separate subject	37.7	45.3
Taught with science	24.5	27.9
Taught with physical education	4.4	4.1
Integrated with all subjects	26.5	14.8
Other	.3	.3
Combination	6.6	7.7

Table 12

Percent of Schools that Teach Conservation
Education in Various Ways (Blackwood, p. 74)

	1-3	4-6
Taught as a separate subject	.9	1.8
Taught with science	26.9	27.8
Taught with social studies	18.4	19.1
Integrated with all subjects	47.4	42.7
Other	.6	.3
Combination	6.2	8.3

Table 13

Percent of Schools Including Selected Topics in Grades K-6 (Howe, p. 15) 2 = Yes, 1 = No

	Mean	S.D.	N
Environment/conservation	1.83	.37	2535
Drug abuse education	1.80	.40	2552
Health education	.42	.49	2610

Table 14

Percent of Science Classes Treating Metric Concepts (Weiss, p. 119)

	K-3	4-6
Not used in classes	42	31
Used in classes	49	65
Missing	9	4

It appears that health education has claimed a substantial role in the curriculum of the elementary schools, having been taught both as a part of science and as a separate subject. Teachers report that both health topics and conservation education have been integrated, presumably with social studies or language arts. The data reported in Howe's study seem to suggest that the topic of "health" had been subsumed by an emphasis upon drug abuse education.

Finally, it is interesting to note the increase in emphasis upon the use of metric concepts (Weiss) when few references indicating their widespread adoption are given in the literature prior to 1965.

Area 4: Supplies and Equipment for Teaching Science

A) What is the extent to which supplies and equipment are available?

Table 15

Percent of Schools by Availability of Supplies and Equipment All Grades, All Schools (Blackwood, p. 75)

Very Plentiful	7.8
Generally adequate	46.0
Far from adequate	35.4
Completely lacking	10.8

Table 16

Availability of Supplies and Equipment
(Howe, p. 14)*

	Supplies		Equipment	
	1-3	4-6	1-3	4-6
Mean	2.55	2.58	2.53	2.54
S.D.	.54	.51	.54	.52
N = schools	2433	2444	2359	2383

*3 = adequate, 2 = inadequate, 1 = lacking

Table 17

Adequacy of Supplies and Equipment
(Howe, p. 14)*

	Supplies	Equipment
	1-6	1-6
Mean	2.49	2.48
S.D.	.60	.59
N = teachers	2639	2623

*3 = adequate, 2 = inadequate, 1 = lacking

It can be seen that supplies and equipment are generally rated adequate to somewhat less than adequate, and that this pattern had been reported in 1961 and again in 1972. Howe's study revealed little difference between the assessments of the administrators and the teachers (availability vs. adequacy) regarding these factors. It is surprising that the RTI study conducted by Weiss did not deal with the appraisal of supplies and equipment in the schools surveyed.

B) How much money is spent for supplies and equipment for science?

Table 18

Percent Annual Per Pupil Outlay for Science Supplies/Equipment (Blackwood, p. 26)

Cents	% schools
0 to 20	40.1
21 to 40	9.4
41 to 60	11.7
61 to 80	10.6
81 to 100	4.6
101 to 125	4.6
126 to 150	3.4
151 and over	15.6

Table 19

Percent of Frequency of Schools with Budget for Supplies/Equipment (Howe, p. 14)
Yes = 2, No = 1

	Supplies	Equipment
Mean	1.59	1.52
S.D.	.49	.50
N	2555	2596

Table 20

Percent of Schools with Budgets for Science Supplies and Equipment and Average Amount of these Budgets Per Pupil (Weiss, p. 126)

	Sample N	% schools	Average $	Std. error
Supplies	155	20	1.56	.15
Equipment	107	16	3.05	.31

Blackwood reported that in the 1961 survey, 60% of schools spent less than $.60 per pupil annually for supplies and equipment for science instruction. Howe claimed that just under 60% of schools had a budget for science supplies and equipment. In the most recent study by Weiss, only one fifth of schools had a supplies budget, and fewer schools reported a budget for science equipment. Dollar amounts for both of these categories had increased substantially over the fifteen-year period between the Blackwood study and the Weiss report. Serious questions can be rasied, however, concerning the adequacy of the budgeted monies for supplies and equipment in view of science educators' priorities for hands-on inquiry learning and the inflationary dollar erosion.

Area 5: Availability and Frequency of Use of Methods and Tools for Teaching Science

A) What is the frequency of the most often employed teaching methods?

Table 21

Science Teaching Methods Ranked
(Blackwood, p. 20; Howe, p. 18; Weiss, p. 60)

	Blackwood	Howe	Weiss
Lecture/discussion	1	1	1
Science demonstrations	3	2	2
Projected visuals	2	3	3
Group lab work	4	4	4
Individual written work	not given	5	5

Table 22

Learning Activities Used Most Often
(Howe, p. 18)
4 = most often to 0 = not used

	Mean	S.D.	N
Science demonstration	2.05	1.30	2464
In-class written work	.90	1.06	2347
Individual lab activity	.88	1.24	2291
Group lab activity	1.41	1.46	2392
Independent study	1.13	1.22	2350
Projected films	1.45	1.17	2455
Lecture/discussion	2.72	1.53	2500
Excursions/field trips	.65	.88	2290
Programmed instruction	.27	.77	2136

Table 23

Frequency of Use of Teaching Techniques; % classes (Weiss, pp. B-60, 61)

	Never		Less than once/mo.		At least once/mo.		At least once/wk.		Just about daily		Missing	
	K-3	4-6	K-3	4-6	K-3	4-6	K-3	4-6	K-3	4-6	K-3	4-6
Lecture	33	12	5	6	12	9	22	43	18	23	11	8
Discussion	1	1	3	1	10	4	37	32	39	58	10	5
Demonstration	5	5	19	16	30	37	22	32	13	5	12	5
Lab work/manipulatives	11	13	15	19	23	25	30	25	7	11	14	8
Individualized work	34	7	14	18	20	28	12	29	6	13	14	6
Programmed instruction	72	73	4	13	3	3	3	2	1	1	17	7
Excursions/field trips	23	24	53	65	10	6	1	0	0	0	13	4

It may be seen overall, from Tables 21, 22, and 23, that the preferences for teaching methods in science classes have seemed to change little between 1961 and 1977. Blackwood's use of the categories "used very often, used occasionally, and used rarely or never" (see page 5 of his questionnaire), without qualifying referents, seems to lack precision. The study by Weiss suggests that more science is being taught in the upper elementary science classrooms (a persistent finding), as revealed in Table 23. Frequency data here must be tempered by remembering that a fairly large proportion of teachers do not teach science on a "just-about-daily" basis. When Andrew examined the teaching schedules of New Hampshire elementary teachers, he found a decrease in patterns of from two to five times per week for science to only once per week.

A concern that is a corollary of teaching methodology is the manner in which students are grouped for the instructional procedures. Weiss reported the following:

Table 24
Average Percent of Time Spent in Various Instructional Modes (Weiss, p. 111)

	K-3	4-6
Entire class	52	52
Small groups	18	18
Individuals	30	30
N =	272	262

Table 25

Frequency of Use of Various AV Materials by % of Classes (Weiss, p. B-72, 73)

	Not required		Needed unavail.		Less than once/mo.		At least once/mo.		At least once/wk.		Missing	
	K-3	4-6	K-3	4-6	K-3	4-6	K-3	4-6	K-3	4-6	K-3	4-6
Motion picture films	8	3	12	7	21	29	31	45	17	14	11	3
Filmstrips	7	3	11	7	33	31	28	41	12	14	10	5
Slides	40	25	18	27	23	33	4	5	1	1	14	9
Tapes	40	31	16	17	15	29	9	12	7	4	12	7
Records	31	38	18	20	22	25	11	8	5	4	13	6
Overhead projector	26	13	3	6	42	35	11	26	6	14	13	6
Standard television	54	50	10	17	13	15	5	4	6	8	12	7
Closed circuit television	65	58	12	21	6	7	1	4	1	3	16	8

Table 25 (continued)

	Not required		Needed unavail.		Less than once/mo.		At least once/mo.		At least once/wk.		Missing	
	K-3	4-6	K-3	4-6	K-3	4-6	K-3	4-6	K-3	4-6	K-3	4-6
Micro-scopes	37	8	21	27	28	59	na	na	na	na	14	7
Models	27	9	26	25	33	59	na	na	na	na	15	8

B) What is the availability and frequency of use of selected audio-visual tools?

Information recorded in Table 25 can be summarized in the following generalizations:

1. Films and filmstrips are the most frequently required audio-visual materials K-6.

2. Models and microscopes are more often required in grades 4-6.

3. Other than the items mentioned in the above statements, about 35 to 50 percent of classes K-6 report that their texts or science curriculum guidelines neither incorporate nor require the use of such aids as slides, tapes, records, or television.

4. As a corollary to the above, of those 50 to 65% of classes where such aids are required, they are not available at least 10% of the time.

5. In terms of frequency of use, it appears that films, filmstrips, and overhead projectuals are clearly front-runners followed by tapes.

Considered with Table 24, the favorite audio-visual methods and materials are employed with the greatest frequency in entire-class instructional modes.

Area 6: Characteristics of Instructional and Resources Personnel for Teaching Science

A) What is the average number of years of teaching experience for K-6 teachers?

Table 26

Average Number of Years Teaching Experiences for Teachers
(Howe, p. 16; Weiss, p. 138)

	Grades	Years	S.D.	Number
Howe	K-6	9.96	8.24	2657
Weiss	K-3	10.4	.38	287
Weiss	4-6	10.5	.48	271

B) What percent of elementary teachers are male?

Table 27

Percent of Elementary Science Teachers by Sex
(Howe, p. 16; Weiss, p. 141)

	Grades	% male	% female	Number
Howe	K-6	34	66	2659
Weiss	K-3	2	98	287
Weiss	4-6	33	67	271

C) What percent of elementary science teachers hold advanced degrees?

Table 28

Percent of Elementary Science Teachers
with Advanced Degrees
(Howe, p. 16; Weiss, p. 139)

	Grades	Percent	Number
Howe	K-6	27	2661
Weiss	K-3	28	287
Weiss	4-6	30	271

D) How many hours of college science and science teaching methods do elementary teachers have?

Table 29

Total Hours of College Science & Science
Teaching Methods for Teachers of
Grades K-6 (Howe, p. 16)

College Science			Science Teaching Methods		
Mean	S.D.	Number	Mean	S.D.	Number
17.25	15.78	2507	3.62	4.47	2507

E) To what extent is science consultant help available to elementary teachers?

Table 30

Percent of Schools in Which Science is Taught by Given Persons (Blackwood, p. 52)

	% schools
Classroom teachers with no help from elementary specialist	81.6
Classroom teachers with help from staff science specialist	5.7
Classroom teachers with help from central office specialist	6.9
Special science teachers on school staff	3.2
Special science teachers from central office	.1
Classroom teachers with special competence; exchange classes	1.6
Regular classroom teachers using television	.9

Table 31

Availability of Consultant or Supervisory Help in Science (Howe, p. 14)
Yes = 2, No = 1

Mean	S.D.	Number teachers
1.60	.49	2629

Table 32

Degree of Difficulty Posed by Lack of Consultant Help for Science (Howe, p. 17)*

Mean	S.D.	Number teachers
1.91	.77	2605

*Great difficulty = 3, some difficulty = 2
no difficulty = 1

Table 33

Percent of Elementary Science Teachers Who Attended at Least One NSF Workshop (Howe, p. 15; Weiss, p. 69)

	Grades	Percent	Number
Howe	K-6	14	2675
Weiss	K-3	2	287
Weiss	4-6	12	271

The character of the instructional personnel in elementary science teaching includes the fact that females taught most of the science in grades K-3 and outnumbered male teachers 2 to 1 in grades 4-6. Teachers of elementary science were, on the average, about midway in their eleventh year of teaching experience, and about one in three had an advanced degree. Howe discovered that the average elementary science teacher had completed about 17 hours of science and about 3+ hours of science methods. (Howe's data do not seem to specify whether these hours were quarter hours or semester hours; both types of information were requested in the questionnaires.) Blackwood found that over 80 percent of teachers were teaching science without the help of a science specialist. Howe determined that such help was available about 60 percent of the time and that the lack of consultant help for science teaching posed "some difficulty." In view of the preceding findings in the case studies and the findings of independent researchers, it appears that teachers had available more consultant help than they had been using. Support for this notion seems to be contributed by both Howe and Weiss, who report that teacher attendance at NSF sponsored science workshops was under 15 percent.

Area 7: Teacher Attitudes Toward Science Teaching and Perceived Barriers to Effectiveness

A) To what extent do teachers seem to be satisfied with teaching science?

Table 34

Teacher Satisfaction with Teaching Science
(Howe, p. 18)*

Mean	S.D.	Number
3.64	1.09	2622

*5=very satisfied; 1=very dissatisfied

B) What are the most frequently mentioned barriers to science teaching?

Table 35

Ranking of Selected Barriers to Science Teaching
(Blackwood, p. 28; Howe, p. 17; Weiss, p. B-127)

	Blackwood (1476 admin.)	Howe (2618 teachers)	Weiss (558 teachers)
Room facilities	3	1	2
Supplies	2	4	
Lack of funds	4	2	1
Size of class enrollment			4
Amount of time to teach science	9		3
Amount of time to prepare			5
Knowledge of science	5	5	
Knowledge of science methods	8	6	
Lack of in-service opportunities	6	7	
Lack of consultant assistance	1	3	

When teachers and administrators were provided opportunity to respond to a list of specific problem areas in science teaching, many of the same factors were identified as barriers to effectiveness. Room facilities and supplies/ equipment are related to the perceived lack of funds for science instruction. A secondary concern for teachers regards the availability and articulation of specialized assistance in teaching science. Teachers and administrators seem to recognize the need for better training and in-service programs, but other priorities seem to be operating to limit science teaching efforts. Such reduction in science teaching priority is not often ranked among the top ten barriers to effective science teaching. Under the circumstances, it may be somewhat easier to understand why teachers report that they are at least content with the status of their efforts to teach science in the elementary schools.

Conclusion

The review of the findings of independent researchers, case study reporters, and national survey data seems to portray a fairly consistent picture of trends in elementary science education since 1955.

1. The period is unequaled in the history of elementary science teaching in research activity, financial support from a variety of governmental and private sources, and in the production of specialized curriculum and instructional materials.

2. Teachers of science average over ten years of experience, have about an average basic science background and minimal instruction in science teaching methodology; one in three teachers has an advanced degree, and about one third of teachers are males who teach mainly in grades, four, five, or six.

3. Little data exists regarding the cost-effectiveness of science instruction practices.

4. The most frequently cited barriers to effective science teaching are
   a. lack of dollar support for adequate facilities, supplies, and equipment,
   b. inadequate programs of in-service and consultant assistance in science,
   c. inadequate pre-service preparation in basic science and methods.

5. The primary conclusion of the CSSE Reports reaffirmed in the NRC evaluation is that "the teacher is the key."

6. There have been increases in
   a. the number of special purpose rooms for science,
   b. the teaching of metric concepts,
   c. the per capita spending for supplies and equipment,
   d. the use of readily available projectual media.

7. There have been decreases in
   a. class size affecting pupil-teacher ratios,
   b. overall support for elementary science at Federal and state levels.

8. There have been increases followed by decreases in
   a. student enrollment figures,
   b. the amount of time spent in science instruction in the classroom,
   c. the employment of NSF-developed programs and in-service attendance.

9. There have been changes in priorities for science at all levels, which tend to embrace an emphasis upon non-science "basics."

10. There are factors which apparently have remained unchanged throughout the period, such as
    a. the teacher's dependence upon a single textbook,
    b. the employment of preferred teaching methods

> such as reading, lecture-discussion, and written work whose outcome seems to be the acquisition of information.

In spite of the apparent declines, elementary science has attained a respected position in the curriculum. Beginning with religious philosophies and the teaching of God's natural revelation to man, science teaching in the lower schools has undergone changes that at various times have emphasized moralizing, object teaching, sensory perception, nature study, rote memorization of content, and the development of conceptual schemes, process skills, and inquiry learning.

Over the past thirty years, as the number of Christian schools has grown from about two hundred to more than ten thousand schools, many Christian school educators have deemed the subject matter of science to be especially critical in its curriculum development efforts. The belief that the increasing abrogation of its capabilities to meet its educational objectives through the traditional tax-supported school system has created among the Christian school leadership a demand for sufficient high-quality instructional materials for elementary science, and properly trained teachers to use them.

In the absence of adequate data to assist decision makers in this curriculum development task, the writer has sought to organize the findings of science education researchers, historians, and Christian school leaders in order to develop a strategy for assembling a data base for appraising the science teaching practices of elementary Christian schools in the United States.

Chapter 3

DESIGN, METHODOLOGY, AND PROCEDURES

Introduction

In the preceding chapter, the character of the Christian school movement was described and its rapid growth explained. A brief account of the development of science teaching in America was given, and the initial affinity of science teaching content with early religious instruction was noted. Finally, the changes in patterns of instructional practices for elementary science for the twenty-five year period from 1955 were examined in detail. In this chapter are described the various procedures employed in the accumulation of a data base of information concerning the science teaching practices in selected elementary Christian schools in the United States.

Selection of Survey Methodology

Survey methodology was adapted for accumulating the necessary information primarily because it seems to offer a compact, cost-efficient means for obtaining a large amount of data. The substantive nature of the three national surveys reviewed and discussed in Chapter Two provide sufficient precedent for the application of tested procedures and offer the possibility of certain, though limited, parallelism.

The Target Population

The size of the target population, elementary Christian schools of the United States, has been estimated by leaders in the few national organizations of Christian schools to be at least ten thousand schools.[1] The normal reporting procedures employed by state and Federal agencies for providing school population statistics do not include the non-denominational, separatist, and independent Christian schools that are the focus of this study. Statistical information which may include some of these schools is often reported as "other." One of the primary tasks, therefore, of this survey is to set out the parameters of the target population.

One of the characteristics of the elementary Christian schools studied is that they have been established as an outgrowth of a local church ministry where the desire of parents is to reinforce the teachings of the home and the church through the regular instruction of a distinctively Christian day school. The affirmation of certain of these basic tenets is an important criterion in the determination of the philosophical guidelines regulating the direction of the curriculum in these schools. Accordingly,

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[1]Dick Minger, prod., "Fundamentalist Christian Schools," Donahue, host Phil Donahue, NBC, Oct. 1981.

the following statement, adapted from Bell, et al, has been prepared for use in screening the survey returns so as to represent the target population most accurately.

> We recognize that God created man in His own image, that this image was marred through disobedience to his Creator, and that God provided for the restoration of His image in man through the Person and the work of His Son, Jesus Christ. We affirm that the scriptures are inspired and inerrant and provide the only dependable direction for establishing relationships between God and man and among men on the Earth. We believe that the Christian School is an extension of the Christian educational ministries of the home and church, and that its purpose is the development of the student in the image of God.[2]

The target population, then, is that group of Christian school personnel who are able to subscribe to the statement above and whose schools have a strong relationship to the local church ministry.

The Selection of Questionnaire Recipients

An examination of the methodology employed in the three national surveys reviewed in Chapter Two indicated that the most cogent statements concerning the nature of the instructional practices and preferences had involved both the administrators and the teachers. In addition, other considerations seem to have required input from both the principals and the teachers. The first of these considerations is that the principal is best qualified to

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[2]Robert D. Bell, et al., The Christian Philosophy of Education (Greenville, S. C.: Bob Jones University Press, 1978), pp. 1-11.

provide background information and summary data regarding the science program for the entire school. Second, it would seem to be unproductive to attempt an independent survey of teachers without the cooperation and assistance of the chief administrator of the school. Third, there are apparent differences between the instructional procedures for science in grades one to three and those of grades four to six. These are mainly differences in the extent of departmentalization, the amount of time allocated for science, and the preparation of the teacher for science teaching. It was decided, therefore, to prepare two different questionnaire forms: one for the administrator and one for teachers. In this way, general information as well as specific details concerning teaching practices and preferences could be assayed and data could be cross-checked. The results would be greater accuracy and balance in reporting.

The Rationale for the Selection of the Questions for the Principal's Questionnaire

It is suggested that the reader refer to the principal's questionnaire before proceeding with the rationale for the selection of each of the questions.

CHRISTIAN ELEMENTARY SCHOOL SCIENCE CURRICULUM QUESTIONNAIRE (Principal's Form)

GENERAL INFORMATION

1. Check all positions of person completing this form: Principal___, Sup't.___, Pastor___, other____________.

2. Check one of the following that best describes how your school is organized:
   a) It is part of the ministry of one local church.____
   b) It is an association of Believers who represent more than one local church. ____
   c) It is one of a group of similar schools in a denominational association. ____
   d) It is not church-related. Please describe:____.

3. Please examine the following statement. If it seems to describe the major purpose of your school, mark "yes." Mark "no" if it does not, and modify the statement to express the school's major purpose more accurately:

   "We recognize that God created man in His own image, that this image was marred through disobedience to his Creator, and that God has provided for the restoration of His image in man through the Person and the work of His Son, Jesus Christ. We affirm that the scriptures are inspired and inerrent and provide the only dependable direction for establishing relationships between God and man and among men on the Earth. We believe that the Christian School is an extension of the Christian educational ministries of the home and church, and that its purpose is the development of the student in the image of God." Yes___, No___. (Comment below)

4. Including this year, how many years has your school been in operation? __________

5. Please specify the enrollment for each of the following grades for September, 1980:
   How many students total in grades K____, 1____, 2____, 3____, 4____, 5____, 6____.

6. Please give your best estimate of the following:
   a) How many other Christian Schools are there within a 10-mile radius of your school? ________.
   b) How many miles from your school is a public science facility such as a museum or planetarium? ______.

7. What is the approximate population of the city in your school's address? Please circle one of the following:
   under 1,000 1,000 to 5,000 5,000 to 25,000 25,000 to 50,000 50,000 to 100,000 over 100,000.

SCHOOL ORGANIZATION FOR TEACHING SCIENCE

8. For what part of the school year and how days per week is science taught in each grade?

grade	is not taught at all	taught half year or less	taught more than half year	no. of days per week
K				
1				
2				
3				
4				
5				
6				

9. Is there a recommended or stipulated number of minutes per week for science instruction in each grade? No__, yes___; if "yes", please indicate for each grade the number of minutes per week:
   K____, 1____, 2____, 3____, 4____, 5____, 6____.

10. Is your school in grades K - 6 departmentalized for teaching science at any grade level? No__, yes__.
    (For this study, departmentalized should be interpreted to mean that students have a special science teacher at scheduled times during the week.) If "yes", circle the grades for which science is departmentalized:
    K 1 2 3 4 5 6

(Please continue on the back of this paper.)

INSTRUCTIONAL PERSONNEL

11. What is the total number of classroom teachers of grades K-6 in your school? (full time___+ part time___)=____.

12. How many of the total teachers counted in the above question actually teach science? ______.

13. Describe the professional science teaching preparation of the teachers referred to in question 12 above. How many teachers would you place in each of the following categories;
    superior____, good____, fair____, poor____, no professional preparation to teach science____.

14. Is there someone who is recognized as a science consultant who assists your teachers in science? No___, yes___.
    If "yes", is this person ... (check one response)
    a) a regular teacher of grades K, 1, 2, 3, 4, 5, or 6 assisting on a formal basis?____
    b) a regular teacher of grades 7, 8, 9, 10, 11, or 12 assisting on a formal basis?____
    c) a regular teacher within grades K-6 assisting on an informal basis?____
    d) a principal, supervisor, or some other administrator?____
    e) someone from outside your school organization?____

SCIENCE TEACHING RESOURCES AND MATERIALS

15. What is the status regarding the adoption of science textbook series? Check one box for each grade level.

	K	1	2	3	4	5	6
a) There is no science textbook series adopted.							
b) A single science textbook series is adopted.							
c) Two or more science textbook series are adopted.							

16. What is the title and publisher of science textbook series, if checked above?

17. In what type of room is science most often taught in your school?

	K	1	2	3	4	5	6
a) A regular classroom with no special facilities for science.							
b) A regular classroom using temporary or portable equipment.							
c) A regular classroom with special facilities for science.							
d) A special room to which students go for science classes.							
e) Other; please specify:							

18. To what extent are supplies and equipment for science demonstrations and activities available in your school?

    SUPPLIES: are defined as perishable or easily breakable materials needing frequent replacement, such as glassware, chemicals, electric bulbs, batteries, and wire.

    EQUIPMENT: is defined as non-consumable, non-perishable items, such as microscopes, aquariums, and tools.

	completely lacking	inadequate	adequate	good	very good
SUPPLIES for grades 1,2,3					
SUPPLIES for grades 4,5,6					
EQUIPMENT for grades 1,2,3					
EQUIPMENT for grades 4,5,6					

19. Give your best estimate of total dollars to be spent for science supplies and equipment this school year. $______

20. Please answer the following question from the viewpoint of an administrator:
    "With the exception of 'more money', what would be the most acceptable and most effective means for improving the quality of science teaching in the Christian Elementary School?"

End of questionnaire. Please return all three forms in mailer furnished. THANK YOU for your help!

The first seven questions deal with general information about the school.

(P - 1) The first question intends to determine whether the school administrator is engaged in other major responsibilities in the organization.

(P - 2) The second question requests information concerning the school's relationship to its regulating body. If the school is not related to a local church body or if it is part of a denominational association, it would not meet the criteria established for the universe under consideration in the present study. (See Target Population, p. 107.)

(P - 3) The third item relates to the statement of purpose for the Christian school. Responses to this doctrinal declaration reveal the extent of the distinctive Christian philosophical basis that may be found among Christian school organizations. As stated previously, the declaration is adapted from the Bob Jones publication, The Christian Philosophy of Education, and addresses these major tenets: the special creation of man, the Fall of man, the Deity of Christ, the inspiration and inerrency of the original scriptures, and the efficacy and dependability of the application of scriptural Truth in ordering the lives and activities of mankind. In addition, the declaration is consistent with Biblical principles when it states that the work of the school is not to be viewed in isolation but rather as an extension of the teachings and practices of the home and the local group of believers. Considered together, P - 2 and P - 3 provide a means for determining that the respondent schools represent a group of Christian schools whose beliefs, purposes, and authority for organization appear to be similar.

(P - 4) The fourth question uses the phrase "years of school operation" as a means to determine the duration or stability of the educational program in the Christian schools sampled. Responses to this question may provide information about changes taking place in the character of curriculum and instructional practices as schools develop and their personnel gain experience.

(P - 5) The fifth question requests the total enrollment by grade levels K-6 in order to derive more accurate enrollment figures for the Christian school movement than seem to be available currently.

(P - 6) Question 6a requests information concerning the proximity of other Christian schools. The motivation for this question arises from the consideration of the feasibility of an itinerant group providing in-service science workshops and consultation in areas where there may be several schools. Question 6b requests the estimated mileage to a public science facility such as a

museum or planetarium in order to discover whether the development of study units employing readily accessible science facilities may be profitably pursued. The precedent for this notion comes from the Stake Case Studies, where students and teachers were reported to have made use of the science lectures, demonstrations, and experiences provided by local museums and planetariums. The provision of these types of services and the occasion for incorporating them into the science curriculum would be particularly advantageous if it should be found that the Christian school science budget is limited.

(P - 7) The seventh question intends to determine if the Christian school phenomenon is an artifact of the problems of the large city or if Christian schools are found with equal frequency among all population levels. One would also be looking for relationships between school enrollments and the population potential for providing students to attend the schools. Population categories are standard designations employed on regular travel maps and offer a readily usable resource for locating smaller communities not recorded in ordinary population tables.

Questions 8, 9, and 10 deal with the school organization for teaching science.

(P - 8) It is recognized that science may not be taught for a full year in many schools where it may alternate with other subjects such as health, music, or art. Accordingly, question 8 requested two types of information: the science teaching pattern for the school and the number of science teaching days per week. Provision also is made to indicate that science is not taught at all for particular grade levels.

(P - 9) To sample the frequency of use of particular curriculum guidelines regarding the recommended number of minutes for science teaching per week, question 9 requested information by grade levels. Such requirements are found as state requirements, but a question arises about the extent to which these guidelines can be discovered for Christian school science programs.

(P - 10) Departmentalization for science, which often involves the exchange of subject area classes among two or more teachers, is a recognized characteristic of science programs having greater emphasis upon laboratory approaches and is more often found in upper elementary classes. Question 10 seeks the extent to which this public school practice may be found in Christian schools.

Questions 11 through 14 request information concerning the instructional personnel.

(P - 11) Question 11 requests data for total teachers K-6, full time and part time, to assist the researcher in determining the teacher-pupil ratio. Considered with the enrollment figures from P - 5, this information should give a picture of single and combination grade practices.

(P - 12) Question 12 narrows the response given in question 11 to include only teachers of science. Comparisons of responses to questions 8, 10, 11, and 12 would provide evidence for categorizing teaching practices as self-contained, team-teaching, or open.

(P - 13) The administrator is requested in this item to appraise his teachers' professional preparation to teach science. Categories are superior, good, fair, poor, and no professional preparation to teach science.

(P - 14) The presence of someone who is a recognized "stimulant" or who may direct the activities of teachers in teaching science, can be a helpful adjunct to effective science programs. Question 14 directs the administrator to indicate whether the individual is a regular member of the faculty, assists on a formal or informal basis, and may have elementary or secondary orientation. Responses to this question can be expected to relate to potential lines of communication to be explored in in-service efforts.

Questions 15 through 20 address practices and conditions in science teaching resources and materials commonly associated with science programs in elementary schools.

(P - 15) Question 15 requests information about the practice of science textbook adoption for each grade in the school. Data are sought for single, multiple, as well as non-textbook approaches to science teaching.

(P - 16) Textbook series identified in the above question are to be specified by title and publisher in P - 16. Since the precedent is that the textbook is a controlling factor in the science curriculum, responses to this question would reveal the particular content, philosophy, and methodology being employed in the schools.

(P - 17) In the development of activities for science to be carried out by the teacher and the students, it is necessary to know the extent to which specialized facilities for science teaching in the elementary schools are available. If it may be concluded that most science teaching is done in the regular classroom, that finding would seem to provoke curriculum development emphasis upon simplified activities.

(P - 18) Taken in the context of the apparent differences between the primary and intermediate grade level approaches, data is requested for the availability and quality of supplies and equipment for grades 1, 2, and 3, as well as for grades 4, 5, and 6. The administrator is asked to give his appraisal of this component of science teaching resources on a school-wide basis. The information provided by responses to this item, and to P - 17 (room type for

for science), should be helpful in the determination of major conditions regulating the potential for science curriculum development. The writer's experience suggests that the conditions for teaching science regarding room type, supplies, and equipment are less adequate in the Christian schools than in public elementary schools overall.

(P - 19) Corroboration for the above concern is sought in the request for a dollar estimate of current school year expenditures for science supplies and equipment.

(P - 20) It was deemed most expedient to place this free response item at the end of the Principal's Questionnaire. It is a request for his opinion concerning the most acceptable and most effective means for improving the quality of science teaching in the Christian elementary school with the exception of "more money." Responses given here may give direction for addressing certain needs in teacher preparation, in-service efforts, awareness emphases, and the occasion for dialogue relating to priorities in Christian education.

The reader may wish to refer to Chart C-1 located in Appendix C to ascertain the major sources for the selection and incorporation of the various items appearing on the Principal's Questionnaire. Where several sources are given, it can be seen that several researchers have considered the particular questions relevant to the science education survey task. Some items in this survey of Christian schools are unique to this study.

CHRISTIAN ELEMENTARY SCHOOL SCIENCE CURRICULUM QUESTIONNAIRE (Teacher's Form)

BACKGROUND INFORMATION

1. Counting this year, how many years have you been teaching?___ | 2. Basis now employed: full__, part time___.

3. Circle highest degree status held: non-degree, BA/BS, MA/MS, other:________ 4. Sex: female__, male__.

5. Number of semester hours____or quarter hours____ of college science and science teaching methods taken.

6. Did you graduate from a Christian College or University? No__, yes__: school name____________________.

7. State certification held? No__, yes__: for what state(s)?______________________________________.

8. Christian school certification held? No__, yes__: in what organization(s)?________________________.

9. For each science class you teach this term.....

a) What is the enrollment?			
b) What is the grade level?			
c) How many minutes per week?			
d) How many weeks per year?			

10. What is your science teaching schedule this term? Record the grade level in each box appropriate:

	Mon	Tues	Wed	Thur	Fri
Before lunch					
After lunch					
Variable					

TEACHING MATERIALS

11. Please give the following information about the main science textbook used by students in your class(es):

title	publisher	date published	for what grade level?

12. To what extent are supplies and equipment for science demonstrations and activities available in your school?

SUPPLIES: are defined as perishable or easily breakable materials needing frequent replacement, such as glassware, chemicals, electric bulbs, batteries, and wire.

EQUIPMENT: is defined as non-consumable, non-perishable items, such as microscopes, aquaria, and tools.

	completely lacking	inadequate	adequate	good	very good
SUPPLIES					
EQUIPMENT					

13. During this academic year, about what proportion of science instruction will students handle materials such as seeds, leaves, batteries, rocks, and magnets? Check the most accurate percent of annual instructional time:

0%___ 25% or less___ 25% to 50%___ 50% to 75%___ more than 75%___.

SELECTED TOPICS TAUGHT IN SCIENCE CURRICULA

14. After each of the topics listed below, please write in one of the following code numbers:

1 = The topic is included in the science you teach.
2 = The topic is taught as a part of some other subject to your class, e.g., math, Bible, gym, or current events
3 = The topic is taught as a part of another grade level by someone else.
4 = The topic is not included in the curriculum of your elementary school.

HEALTH___, SCIENCE CAREERS___, CREATION/EVOLUTION___, OUTDOOR EDUCATION___,

CONSERVATION/POLLUTION___, SAFETY___, DRUG ABUSE EDUCATION___, METRIC SYSTEM___.

15. Within the past five years, have you participated in a) curriculum conferences, b) in-service training activities, or c) workshops whose primary purpose was to assist elementary classroom teachers in improving their science teaching capabilities? No___, yes___.

(Please continue on the back of this paper.)

SCIENCE TEACHING METHODS & EQUIPMENT

16. Please check the teaching tools that are available for your use and indicate how much you use each kind of tool in teaching science.

teaching tools for SCIENCE:	available?		the average frequency of your use for SCIENCE classes:					
	no	yes	none	1-2 times per year	2-4 times per semester	1-3 times per month	1-2 times per week	more than twice/wk.
Motion picture projector								
Slide/filmstrip projector								
Overhead projector								
Tape and/or record player								
Television and/or video tape								
Commercial charts/models								
Bulletin boards								
Flannel boards								
Microscope(s)								
Science picture sets								

17. In the following, please place a checkmark beside each teaching method you use during your SCIENCE classes:

a) Science demonstration______
b) In-class written work______
c) Individual lab activity______
d) Group lab activity______
e) Independent study______
f) Projected visuals______
g) Lecture/question/answer______
h) Excursions or field trips______
i) Programmed instruction______

18. In question 17 above, please place the number "1" beside the teaching method you use most frequently in your science classes. Place a "2" or "3" beside the teaching methods used second and third in frequency. Use the numbers only once.

SCIENCE TEACHING CONCERNS

19. The next item contains a list of teaching factors thought to have an effect on science teaching. Indicate with checkmarks how you believe each of these factors affects your science teaching:

teaching factors for SCIENCE:	inhibits greatly	inhibits somewhat	neutral no effect	enhances somewhat	enhances greatly
Room facilities for teaching science					
Supplies and equipment for science					
The size of class enrollment in science					
Regular assistance from a science consultant					
The amount of time to teach science					
The amount of time to prepare for science					
Your knowledge about science or methods					
In-service science training or workshops					
The degree of your interest in science					
The emphasis or priority for science in school					

20. How satisfied are you with teaching elementary school science? Please check one response below:

very dissatisfied____, dissatisfied____, neutral____, satisfied____, very satisfied____.

21. Please answer the following question from the viewpoint of a classroom teacher:
"With the exception of 'more money', what would be the most acceptable and most effective means for improving the quality of science teaching in the Christian Elementary School?"

THANK YOU for your participation in this project. Please return this form to your administrator.

The Rationale for the Selection of Questions for the Teacher's Questionnaire

The first eight questions provide a background of information regarding characteristics of teachers selected by their administrators to participate in the survey of science teaching practices in selected schools.

(T - 1) It is desired to know the number of years of teaching experience of each respondent.

(T - 2) Teachers are asked to indicate the basis of their employment: full time or part time.

(T - 3) Teachers are requested to give the status of attained degrees. Such information is expected to provide a measure of overall educational quality for the schools in the study as well as needed data for science teaching capability.

(T - 4) Responses to question four, sex, will assist in revealing the extent to which male teachers have been attracted to Christian elementary school teaching.

(T - 5) How many hours of basic science and science methods were taken in college?. The data given by this question will be taken as a minimum criterion for planning developmental efforts in science curriculum and in-service.

(T - 6) It is desired to learn through this item the proportion of Christian school teachers who have received at least some of their college training at a post-secondary Christian school. Respondents are requested to identify the Christian college or university.

(T - 7) There is concern among administrators and parents regarding the capabilities of private school teachers. Some base line data are desired to reflect the status of state certifications held by Christian school teachers responding in this survey.

(T - 8) There are private certifying agencies that attempt to inspect and certify teachers belonging to their organizations. Such agencies adopt many of the practices and standards of state certifying agencies and incorporate certain affirmations of Biblical doctrinal statements or positions. One of the beliefs of some Christian certifying boards centers on the concept that, on the grounds of separation of Church and State, the state should not be able to certify religious instruction. It is desired to test how widespread may be the practice of Christian school certification for its teachers. Respondents are requested to identify the particular certifying organization, if applicable.

Questions 9 and 10 provide information relating to the characteristics of enrollment and scheduled frequency for teaching science classes.

(T - 9) Grade levels and enrollments are to be given for each science class taught by the respondent. The question provides opportunity for the teachers to record scheduled combination classes and departmentalization. Teachers are requested to give data concerning the number of minutes per week and the number of weeks per year in order to provide the most clear determination of total science instruction time. It is believed that this approach may be unique to this study.

(T - 10) In this question, teachers are asked to identify the particular grade level of science taught during each day of the week. It is also desired to learn whether science is taught during a particular part of the day (before or after lunch). The precedent for this concern arises from this researcher's informal discussions with other science educators rather than from known research dealing with the scheduled placement of science instruction in the elementary school day. The writer has heard references to teachers' using science as a "fun thing to do on Friday afternoon," an activity with minimal academic outcome for the students. Then, too, there are typical morning priorities that seem to include only reading and mathematics as basics. It is desired to test the notion of time priorities for science instruction.

Questions 11 through 13 address the primary teaching materials and their employment in the science teaching practices of the respondents.

(T - 11) The science textbook is identified by teachers in this item. This information may be considered with the same item on the Principal's Questionnaire, and comparisons of intents and practices may be made.

(T - 12) Significant precedent exists for the inclusion of questions concerning the adequacy of supplies and equipment for science. Howe's survey (1961) detailed only three categories, but these seemed inadequate for the most accurate reporting. Accordingly, the categories "lacking," "inadequate," and "adequate" were enlarged to include "good" and "very good," in the belief that teachers might mark "adequate" as the top condition, whereas it might have been much better--"good" or "very good." Similarly, "inadequate" may have been perceived as a mid-point between two unsatisfying extreme choices, forcing a choice that was not most descriptive. Distinctions in this item are provided for consumable supplies as well as non-consumable equipment for science, a standard practice.

(T - 13) In an attempt to uncover what many have called "hands-on" experiences in science, the writer employs a question specifying certain manipulatives commonly found in science curricula at varied levels. When the percent of annual instructional time for science is requested, variables such as the number of days per week, the length of the instructional year, and the number of minutes per class are reduced as considerations in arriving at usable data for all grades as percentages. The item also tends to characterize the manner in which the teacher may employ the textbook as a primary tool or as a resource in the process.

Questions 14 and 15 request information relating to specific topics often included in the subject matter of elementary science.

(T - 14) Adapted from Fitch and Fisher, this question elicits data that may indicate the extent to which certain content is being handled in the elementary school curriculum and where the responsibility for teaching it lies. It is of particular interest to the writer to ascertain what materials may be in place for the teaching of science careers, creation/evolution, and drug abuse education in the context of the science class in the Christian school. If there is evidence of activity in the areas of outdoor education and conservation, this interest should support developmental efforts in this direction. It is also desired to determine the extent to which metric teaching is proceeding.

(T - 15) The wide-ranging question here asks simply, "Have you been engaged in any science teaching improvement experiences within the past five years?" If there should be found to be a substantial percentage of "yes" responses, further inquiry may be directed to such schools. It is postulated, however, that there will be minimal affirmation for this in-service effort.

Questions 16 through 18 address the availability, of frequency of use of, and preference for the employment of commonly recognized teaching tools (audio-visual devices) and methods for the teaching of elementary science.

(T - 16) It is desired to know the extent of the availability of audio-visual hardware that exists in the sample of Christian schools. Such information should be helpful to curriculum developers as they design teaching strategies to incorporate existing media into their instructional programs. Respondents are directed to check one column under availability and one other column under the best response for average frequency of their use of each teaching tool.

(T - 17) In this question about methods employed by the teacher for science instruction, all methods used are to be check-marked.

(T - 18) In this item, teachers are requested to review the above question and rank the three most frequently used teaching methods for science. In each of the above questions (16, 17, and 18), the precedents are well established in all the surveys of science examined for this study. The major exception to the foregoing statement is the category of science teaching tools called "flannel boards." The writer wishes to ascertain whether a commonly employed device for teaching in Sunday schools (flannel board), readily available in many school rooms doubling as teaching rooms on Sunday, may be used in regular science teaching.

Questions 19 and 20 include different types of opinionnaires concerning teacher-perceived barriers to science teaching effectiveness and teacher satisfaction with teaching science. Question 21 is an open-ended question regarding the most acceptable and effective means for improving the quality of science teaching in the Christian elementary school.

(T - 19) Each item appears on at least two national surveys of science as "barriers to science instruction." If the findings should show significant agreement with respect to a given category, programs in pre-service and in-service should be adjusted to take advantage of such information. Certain designations of "neutral" would seem to be the occasion for programs directed toward the improvement of attitudes, e.g., "Regular assistance from a science consultant," "In-service science training or workshops," and "Your knowledge about science or methods."

(T - 20) Satisfaction with teaching science recorded on a five-point scale would seem to offer the opportunity to gauge the level of attainment compared (in the thinking of the teachers) to the expectation for their science teaching. The question is raised about whether high satisfaction with science teaching means that a good job is being done. Or might this mean that teachers had not viewed the potential for the task seen by others? Or would "satisfied" reflect some type of loyalty to the school or its personnel? Clearly, these responses need to be interpreted in the context of other responses such as T - 19, T - 1, and T - 3.

(T - 21) The same free response item incorporated in the Principal's Questionnaire, but to be answered from the viewpoint of a classroom teacher, should elicit a number of areas to consider in the improvement of programs of science teaching in the elementary schools. Perhaps some of the responses will be unique to the Christian school program.

The reader may wish to refer to Chart C-2 located in Appendix C to ascertain the major sources for the selection and incorporation of the various items appearing on the Teacher's Questionnaire.

In reviewing the two forms of questionnaires employed in the survey of science teaching practices in Christian schools, the reader should recall that the motivation for developing the particular questions was to establish for selected schools a base of information relating to science teaching in elementary schools. This information will help Christian schools to set goals for the task of curriculum development and production of textual and ancillary materials having appeal for the needs for Christian schools. Such information provided by this study will also aid in the determination of guidelines for the content and methodology for pre-service and potential in-service programs.

Considerations in Developing the Format of the Questionnaires

The following guidelines were established by the writer in order to provide the greatest potential for the respondent's cooperation in supplying the most accurate information. (1) Each form must not exceed two sides of one sheet of paper, (2) there must be adequate space around the questions to enhance readability, (3) it should appear to the reader that the researcher's concerns reflected in the questions are worthy of the respondent's time, (4) the task of writing the responses should not impose an unnecessary burden upon the respondent, and (5) the questionnaire should preserve the respondent's anonymity.

In order to elicit accurate data, the items should be stated without ambiguity. The mode of desired response should be clearly understood by the readers, and the responses should involve minimal writing effort. Categorical responses should offer realistic and discrete groupings. Items requiring similar responses should be organized so as to reduce confusion among responding modes. Finally, but perhaps most importantly, the questions themselves should communicate the intent of the researcher.

These concerns regarding questionnaire appearance, readability, significance, accuracy of response-potential, and communicability prompted the writer to organize a preliminary screening process to obtain needed criticisms with respect to these elements. Initial guidance was sought from the writer's project director, committeemen, and science/math center personnel at Michigan State University. Suggestions related to question content, significance of items, and format problems. Additional assistance was gained from administrators and faculty members in the School of Education at Bob Jones University. Revised drafts of the questionnaires for the principal and the teacher were evaluated by a group of teachers and administrators enrolled in a graduate level course, Testing and Educational Research, during the summer of 1980 at Bob Jones University. Suggestions were obtained relating to readability, communicability, amount of time required for responding to the items, and general impressions of the questionnaires and the procedures to be followed. Additional information was gained from the critique of the cover letter to be sent to the principal of participating schools.

A third revision of the questionnaires was prepared and distributed to administrators of two Christian schools in the Greenville, South Carolina, area. Packets containing a cover letter, the Principal's

Questionnaire, and two Teacher's Questionnaires were sent to administrators. The returned forms were examined by the writer, and discussions with each of the participants were held. In addition to seeking detailed information concerning the clarity and the interpretation of the items on the questionnaires, the researcher desired information relating to items requiring data perceived to be "sensitive" in nature. For example, would participants hesitate to provide accurate information relating to adequacy of supplies and equipment for science if it seemed to place their school rating in this item in "completely lacking?" Other items thought by the writer to be sensitive included P - 9 (recommended minutes for science instruction), P - 13 (the number of fair or poor or unprepared teachers of science), P - 19 (total dollars to be spent for science supplies and equipment), T - 16 (the frequency of use of teaching tools), and T - 20 (teacher satisfaction with teaching science). In the cases examined, there seemed to be no apprehension in responding to the items in a direct manner. Two participants indicated that their anonymity aided the freedom with which responses were given. Respondents' comments were very positive concerning the questionnaires and the methodology employed in the enlistment of their participation.

Final drafts of the questionnaires, incorporating suggestions and improved layout, were prepared and reproduced by commercial offset printing.

Sampling Procedures

A population of Christian schools was identified from a 1980 mailing list of 7,628 subscribers to information published by the Bob Jones University Press. This list was examined and purged of duplications, non-U.S. subscribers, schools whose names could identify them as only pre-school or kindergarten or academies (secondary only), and schools whose names could identify them as having a denominational affiliation (e.g., Catholic, Adventist, and Lutheran). A final list of 5,761 schools was derived and presumed to be composed of Christian schools having some elementary grades K through 6.

Through the employment of a table for determining needed size of a randomly chosen sample from a given finite population in order to develop a 95 percent level of confidence,[3] the researcher determined that 359 schools should be represented in the sample of 5,761 schools. In estimating the probable returns of questionnaires at one in three, the researcher decided to send requests for participation to 19 percent of the derived list. Accordingly, 1,135 postcards were mailed to elementary Christian school principals requesting their participation in the survey,

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[3]Stephen Isaac and William B. Michael, Handbook In Research and Evaluation, 2nd ed. (California: EDITS, 1980), p. 193.

which was to be conducted a few weeks hence.

An example of the self-return postcard, a request for schools' participation in the survey, is included in Appendix B. The following considerations were adopted as guidelines in the choice of procedures for mailing these postcards to the schools. (1) In order to serve the purpose of a national survey, states would need to be represented by survey returns in the same proportion as they were found on the derived list of 5,761 schools. (2) Requests for participation would be less costly in the form of a postcard than in the form of a questionnaire packet, and the postcard would serve the purpose of confirming the existence and correct mailing address of schools returning the cards. (3) Schools participating in the survey would be promised a gift pamphlet[4] as an inducement for prompt cooperation. (4) The initial mailing of the postcards would be about one half the required number as a means for determining the rate of response and the proportion of responses by states. (5) The survey would be timed to be conducted during a period of the school year in which traditional vacation and grading period deadlines would not conflict with attending to survey responses at the local schools. (6) Returns from the initial mailing would be inspected in order to determine the rate of "yes" responses from each state.

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[4]Bell, et al.

(7) On a second mailing of postcards, an attempt would be made to solicit participants where early state returns indicated lower percentages of returns than in the average returns from all states. (8) Follow-up contacts would be made to determine reasons (if not given) for "no" responses to participation in the survey.

Selection of the Sample Population

As stated above, 1,135 self-return postcards, representing slightly more than 19 percent of the derived list of 5,761 schools, were mailed in two groups. For the first group, a ten-percent systematic sampling procedure was employed as follows. The computer-prepared mailing list was ordered by ZIP codes. Each tenth school was selected for each state beginning with a randomly selected number (5). Where states had fewer than ten schools listed, up to thirty percent of the listings were selected for the first mailing. Although the selection process was systematic, it should be noted that the schools had been listed originally because of their inquiry concerning published materials at the Bob Jones University Press, the addresses had been ordered according to ZIP codes, and non-qualifying schools had been deleted. The selection procedures revealed no apparent periodicities due to the systematic selection of schools on the list. The first mailing incorporated the ten-percent systematic selections and the twenty-four additional selections for states having less than ten schools on the list, making a total of 600 cards that were sent on November 19, 1980.

The second mailing of postcard requests for volunteers to participate in the survey was conducted on January 10, 1981, after the preliminary returns had been inspected for balanced proportions among the states. Postcard requests were sent to 535 different schools on the list. These were selected in a systematic way beginning with a randomly selected number (3). States that showed first mailing returns of at least 25 percent were not included in this second sampling procedure. This focus on areas where initial returns were lower than 25 percent was an attempt to gain balanced participation in the survey.

Survey Participation Derived from Principals' Conference

As the writer was in the process of designing the sampling procedures and developing the postcard request forms for mailing to listed schools, the opportunity came to apply a similar request strategy for voluntary participation in the projected survey. The reader's indulgence is requested in the discussion of this phase of the project which is treated here out of chronological order.

At the annual Conference of Principals held at Bob Jones University on November 3, 4, and 5, 1980, administrators from 184 Christian schools in the United States met for the purpose of recruiting teacher candidates. Requests for administrators' participation in the survey were included in a packet of orientation materials distributed to administrative conferees. Informal discussions with these school representatives revealed that many of them had received requests for information concerning school enrollment, subject matter in the curriculum, inventories of equipment, salary schedules, annual expenditures, personal characteristics of the faculty, and the like. Certain "survey-shy" administrators noted that they had had requests for such information from state agencies. No administrators reported having received a questionnaire that dealt specifically with science teaching practices in their schools. Although it became evident that survey efforts would meet with some reluctance, 95 administrators volunteered their participation in the study and were incorporated in the mail-out procedures described below.

Distribution of Survey Packets

Address labels were prepared for Principal Conference survey volunteers as well as the postcard "yes" respondents. Beginning on February 5, 1981, packets containing a cover letter explaining the procedures to be followed, one administrator's questionnaire, and two teachers' questionnaires, were sent to participating schools. Examples of these materials can be found in Appendix B. Schools responding through March 15 were sent the gift pamphlet. Schools not providing complete information were contacted by mail requesting the missing questionnaire(s) or the provision of data omitted in their initial returns.

Efforts were made to obtain complete responses from the participant schools. Each school was to have returned one administrator's questionnaire and two teachers' questionnaires. Teachers' forms were inspected to determine that one of the questionnaires had been completed by a teacher of either grades 1, 2, or 3, and the second by a teacher of either grades 4, 5, or 6. As explained previously, this procedure was employed in order to characterize differences thought to exist between the primary and intermediate level science programs and teaching practices. Only complete sets of questionnaires were employed in the statistical procedures. Non-respondents were sent a reminder postcard, and a random sample of non-participating volunteers was selected for telephone contacts. This effort was, for the most part, fruitless. Most of these administrators indicated that their schools were involved in a curriculum program that did not seem to "fit" the type of questions employed on the survey questionnaire. Data received after April 30, 1981, were not included in the study.

Data Encoding and Analyses

Data contained on all the completed sets of three questionnaires were encoded according to the keys (included in Appendix C) and recorded on standard key punch forms. Coded school and respondent identities were preserved.

Data cards were prepared, justified, sorted, and the data were read into tape files for processing at the Michigan State University computer center. The Statistical Package for the Social Sciences (SPSS), version 8.0, was employed in the statistical analyses procedures. A record of the findings and related commentary is contained in Chapter 4, which follows.

Chapter 4

REPORT OF THE FINDINGS

Introduction

In the accumulation of data for describing the science teaching practices in selected Christian schools of the United States, a sample of an available population was contacted by mail to enlist the cooperation of administrators and teachers in completing survey questionnaires. Questionnaire sets returned by these volunteers were inspected, coded, and analyzed to determine frequencies and central tendencies of the data. Survey returns are reported by geographic regions of the United States because a preliminary inspection of the revised list of schools showed disproportionate numbers of the Christian schools in three geographic regions: Southeast, Far West, and Great Lakes (65%), when compared to New England and the Rocky Mountains (4.7%). State-by-state reports of school locations are given in Appendix D.

Administrators' Participation in the Survey

Of 181 administrators contacted during the November, 1980, Principals' Conference in Greenville, South Carolina, 99 volunteered their cooperation in the survey to be conducted in February, 1981. Forty-nine of these administrators returned the completed set of three questionnaires. See Table 36 for the geographic locations of these respondents.

Postcard Solicitation of Administrators' Participation in the Survey

A total of 1,135 return postcards were mailed in two groups. Of the 478 cards returned, 336 were "yes" and 142 were "no." The reporting of the negative responses may prove interesting to the reader.

Table 35

Classification of Postcard Solicitation Negative Responses

Respondent marked only "no"	86
"Our school is no longer in operation"	27
"We have only pre-school, day care, or kindergarten"	7
"We have only secondary grades"	7
"We are using ACE curriculum; can't help you"	6
"We are too small; don't have a science program"	4
"We can't help because of personal reasons"	5
TOTAL	142

Of the 142 negative responses returned, about 40% offered an explanation for not participating in the survey. The 27 schools reporting that they are no longer in operation suggests an area of inquiry that should be of interest to educators in ascertaining the real proportions

Table 36

Summary of Survey Solicitation and Response According to Geographic Regions

	Great Lakes	Far West	New England	Mid East	Southwest	Rocky Mountains	Plains	Southeast	U. S. Totals
A) Total schools on revised list	1016	1045	137	666	807	135	323	1632	5761
B) Schools represented at Principals' Conference	45	6	2	30	6	3	4	85	181
C) Principals volunteering to participate in survey	26	2	2	19	3	2	2	43	99
D) Principals returning completed survey sets	15	2	1	6	2	1	1	21	49
E) Postcard solicitations mailed to listed schools	198	209	27	129	161	27	64	320	1135
F) Postcard solicitation response . . . "No"	22	33	5	16	24	5	12	25	142
G) Postcard solicitation response . . . "Yes"	67	64	14	39	22	8	22	100	336

Table 36 (continued)

	Great Lakes	Far West	New England	Mid East	Southwest	Rocky Mountains	Plains	Southeast	U.S. Totals
H) Completed survey sets returned; total	41	35	8	19	8	4	13	56	184
I) Percent solicitation response (F+G/A) =	8.75	9.28	13.8	8.25	5.70	9.62	10.52	7.65	8.29
J) Percent survey sets returned (H/A) =	4.03	3.34	5.83	2.86	.99	2.96	4.02	3.43	3.19
K) Percent solicitation response (F+G/E) =	44.90	46.40	70.3	42.60	28.50	48.11	53.12	39.31	42.13
L) Percent survey sets returned (H/G) =	61.10	54.60	57.1	48.70	36.30	50.02	59.03	56.07	54.72

of the Christian school movement that must account for school closings as well as start-ups. For what reasons do Christian schools close their doors? What are the special problem areas in beginning and maintaining a small Christian school?

Fourteen schools reported that they had no elementary grades. Four schools indicated they had no science program. Six schools using the Accelerated Christian Education (ACE) curriculum (see Appendix A), which employs an individualized, independent study, multi-grade level program, apparently believed that survey efforts would not prove worthwhile. Miscellaneous reasons given by respondents ("Too busy," "Thinking of retiring," "Principal is on leave") were submitted in five cases.

What of the 657 postcards that were not returned? If undeliverable, they would have been returned to the sender. The indication is that someone at the stated address received the request. Is the school at that address still in operation? Is there a science program in progress? Is the administrator too busy, or does he simply desire not to participate in the survey procedures? The writer was unable to pursue these inquiries but willingly leaves room for other researchers.

The researcher followed up the 336 affirmative responses to the postcard request by mailing to each school a survey packet containing the questionnaires and instructions for their completion. Survey questionnaires were returned to the researcher over an eight-week period in March and April of 1981. The 184 complete sets of questionnaires employed in the analyses included 184 Principal's Questionnaires, 167 Teacher's Questionnaires (grades 1, 2, or 3), and 167 Teacher's Questionnaires (grades 4, 5, or 6). Seventeen of the schools were "one-man schools," where the administrator was also the chief teacher. All of these schools indicated they were employing the ACE curriculum. Because these schools may constitute a significant proportion of the total Christian school population and because the schools meet the criteria established for Christian schools in terms of their doctrinal position and close relationship to a local, independent church, the 17 administrators' questionnaires were retained in the data analyses. In all, 184 administrators and 334 teachers are included in the total of 518 respondents.

Itemized Report of the Findings on the Principals' Questionnaire

Data are reported according to the format in which the questions appear on the Principals' Questionnaire.

GENERAL INFORMATION

1. Check all positions of person completing this form: Principal___, Sup't.___, Pastor___, other_________

Approximately one third of the administrative respondents are engaged in responsibilities in addition to their school administrative function. It cannot be determined in the case of the six "Teacher" respondents whether these individuals acted at the request of or in lieu of the administrator.

Table 37

Positions Held by Administrative Respondents

Title	Number	Percent
Principal	126	68.47
Superintendent	17	9.23
Pastor	1	.54
Teacher	6	3.26
Principal/Pastor comb.	16	8.69
Teacher/administrator	16	8.69
Blank	2	1.08
TOTAL	184	99.96

2. Check one of the following that best describes how your school is organized:

a) It is part of the ministry of one local church. _____

b) It is an association of Believers who represent more than one local church. _____

c) It is one of a group of similar schools in a denominational association. _____

d) It is not church-related. Please describe: _____

Table 38

School Organizational Pattern

Organizational Type		Number
Part of the ministry of one local church		148
Part of an association of Believers of more than one church		36
One of a group of similar schools in a denomination		1*
School is not church-related		12*
	Total	197

The 13 schools (*) indicating that they are not related to a local, independent church ministry in the manner established in Chapter 3 as a criterion for this study have been omitted from the analyses. Of the remaining 184 elementary schools, the predominant pattern seems to be that these Christian schools are an outgrowth of the ministry of one local church.

3. Please examine the following statement. If it seems to describe the major purpose of your school, mark "yes." Mark "no" if it does not, and modify the statement to express the school's major purpose more accurately:

"We recognize that God created man in His own image, that this image was marred through disobedience to his Creator, and that God has provided for the restoration of His image in man through the Person and the work of His Son, Jesus Christ. We affirm that the scriptures are inspired and inerrent and provide the only dependable direction for establishing relationships between God and man and among men on the Earth. We believe that the Christian School is an extension of the Christian educational ministries of the home and church, and that its purpose is the development of the student in the image of God." Yes___, No___. (Comment below)

Table 39

Statement of Major School Purpose

Number of affirmations		184
Number of negative responses		9*
Number of non-responses (blank)		4*
	Total	197

As part of the selected criteria for this study, affirmations of the basic doctrinal statement were required. Considered together with item two above, these criteria form the basis of the selection of the population of Christian schools reported.

4. Including this year, how many years has your school been in operation? __________

Table 40

Years of School Operation
N = 181

Mean	12.635	Std. Dev.	14.930
Mode	4.000	Std. Err.	1.110
Median	8.059	Range	98.000

The most frequently reported figure (4 years) would indicate that these schools had been begun in 1978. The United States mean (12.635) suggests that there was a Christian school developmental spurt during 1969-1970. A decade-by-decade presentation of this information extending back to 1881 is provided in Table 41 below.

Table 41

Years of School Operation by Decade
N = 181

Total years of school operation	Percent of schools	Number of schools
1 to 10	64.6	117
11 to 20	20.4	37
21 to 30	7.2	13
31 to 40	3.3	6
41 to 50	0.6	1
51 to 60	1.2	2
61 to 70	0.6	1
71 to 80	1.2	2
81 to 90	0.6	1
91 to 100	0.6	1
TOTALS	100.3	181

The largest number of fundamentalist Christian schools (nearly 65%) are less than ten years old. About 20% of these schools have been in operation for 11 to 20 years, and an additional 7% have operated for 21 to 30 years. The remaining 8% of schools have operated for 31 to 100 years. Three principals did not provide information regarding the length of operation of their schools.

5. Please specify the enrollment for each of the following grades for September, 1980: How many students total in grades K____, 1____, 2____, 3____, 4____, 5____, 6____.

The fundamentalist Christian schools sampled for this study reported a total enrollment of 29,550 students for the 1980-81 school year. Four ACE schools in the study did not report their enrollments. The differences in the number of valid school reports from 180 in kindergarten to 171 schools in grade 6 can be understood in the light of Table 40 (p. 146), which indicates that the mode for these schools is 4 years. That is, there are more lower elementary grades than there are other grade levels in these schools. There are between 22 and 23 students per school attending grades 2, 3, 4, 5, and 6, whereas there are 25 to 26 students in grade 1 and about 29 kindergarten enrollees.

Chart 2

Distribution of Christian School Enrollments
School Year 1980-1981; N = 180

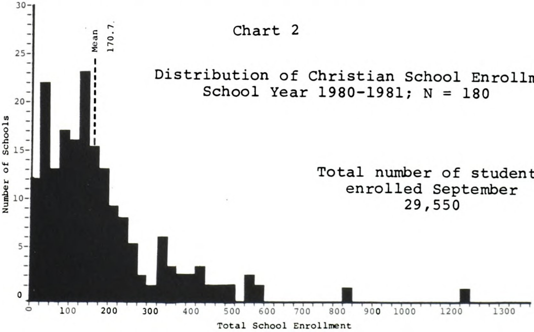


Table 42

Total Enrollment Per School by Grade Levels

	K	1	2	3	4	5	6
Enrollment (29,550)	5222	4629	4064	3956	3946	3929	3804
Number of schools	180	180	179	175	174	174	171
School mean	29.01	25.71	22.70	22.61	22.68	22.58	22.25
Std. dev.	21.17	19.48	18.24	18.30	19.18	19.53	20.47
School median	24.83	22.17	18.31	19.00	17.40	16.75	15.92
School mode(s)	22	22	16/20	5/8	17	5/24	15

6. Please give your best estimate of the following:
a) How many other Christian Schools are there within a 10-mile radius of your school? ________.
b) How many miles from your school is a public science facility such as a museum or planetarium? ______.

Table 43

The Number of Other Christian Schools
in 10-Mile Radius of Sampled School
N = 179

Number other schools in area	0	1	2	3	4	5	6	7	8	9 or more
Number schools reporting	31	36	28	23	12	12	6	4	4	23
Percent schools reporting	17	20	16	13	7	7	3	2	2	13

About one fifth of schools reported that there are no other Christian schools within a 10-mile radius. Almost 50% of schools indicated that there are from one to three other schools in the area, 13% reported that there are 9 or more Christian schools in their areas.

Fundamentalist Christian schools reported that 70% of the time they would need to travel no further than twenty miles to visit a public science facility such as a museum or planetarium. Twenty-four percent of the 174 schools providing this information are within 5 miles of such a facility (see Table 44).

Table 44

Proximity of Sampled Christian Schools to Public Science Facility

Miles to travel	0-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46+
Number schools	41	41	23	15	11	5	1	3	3	31
Percent schools	24	24	13	9	6	3	1	2	2	18

N = 174

7. What is the approximate population of the city in your school's address? Please circle one of the following:
under 1,000 1,000 to 5,000 5,000 to 25,000 25,000 to 50,000 50,000 to 100,000 over 100,000.

Table 45

Principal's Estimate of Population of City in School's Address

Population	Number of Schools	Percent of Schools
Under 1,000	9	5
1,000-5,000	19	11
5,000-25,000	35	20
25,000-50,000	36	21
50,000-100,000	22	13
Over 100,000	52	30

N = 173

Fundamentalist Christian schools can be found at all population strata from under 1,000 up to and including areas of over 100,000. Forty-one percent reported their locations to be in regions of from 5,000 to 50,000 population, and 30% indicated the size of the city in their school's address to be in excess of 100,000 people.

SCHOOL ORGANIZATION FOR TEACHING SCIENCE

8. For what part of the school year and how days per week is science taught in each grade?

grade	is not taught at all	taught half year or less	taught more than half year	no. of days per week
K				
1				
2				
3				
4				
5				
6				

Table 46

Percent of Christian Schools Teaching Science at Given Grade Levels

Grade level	K	1	2	3	4	5	6
Percent	75.6	95.4	98.3	100	100	100	100

The indication is that virtually all of the schools reporting teach science as a regular part of their curriculum sometime during the year. Seventy-five percent of kindergartens and over 95% of first grades include the teaching of science. Established patterns of teaching science at each grade level are given in the frequency Table 47. There appears to be a trend toward teaching science from one-half year to a full year and from fewer days per week toward a full week as students move from kindergarten to sixth grade. Common practice in the kindergarten seems to be to teach science for one day per week for a half year or two days per week for a full year. In the third grade, there appears to be a shift away from one-half year science (13% for 5 days) to a full year program. Few schools report a half-year science

Table 47

Percent of Christian Schools Teaching Science by Days Per Week and Grade Level

	One half year; no. days					Full year; no. days					
Grade	1	2	3	4	5	1	2	3	4	5	N
K	20	11	15	0	8	11	20	5	1	9	172
1	14	8	13	1	7	12	23	10	1	12	173
2	10	9	8	1	8	10	24	12	3	14	174
3	5	4	3	1	13	5	19	20	5	24	172
4	0	2	2	1	6	3	14	26	8	39	172
5	0	1	1	1	6	2	12	19	8	48	173
6	0	1	1	0	8	3	8	17	13	50	166

program for their intermediate levels 4, 5, and 6 but indicate full year patterns that favor five day per week scheduling. It cannot be determined whether administrators interpreted the half-year pattern to mean a semester program that alternated with other subject matter or that their science teaching schedule was conducted all year for approximately half time. In an effort to determine the actual science teaching contact time, data was derived from the Teacher's Questionnaire (Table 65) to show total minutes (hours) on an annual basis.

9. Is there a recommended or stipulated number of minutes per week for science instruction in each grade? No__, yes__; if "yes", please indicate for each grade the number of minutes per week: K____, 1____, 2____, 3____, 4____, 5____, 6____.

The majority of schools (more than 60%) do not require a stipulated number of minutes per week for science instruction at grades K through six. In the 40% of schools requiring a stipulated number of minutes of science instruction each week, there does not seem to be any consistent pattern. There is only slightly increased response at the 31 to 60 minutes and at the 91 to 120 minutes (Table 48) per week frequencies. For those schools reporting minimum stipulated science instruction minutes, about one third indicate that two or more hours per week are required.

Table 48

Required Number of Minutes Per Week for Science; Percent by Grades

	Grade levels					
	1	2	3	4	5	6
None required	63	61	60	60	59	60
1 to 30 min.	10	11	8	6	5	3
31 to 60 min.	17	17	9	7	7	9
61 to 90 min.	4	4	7	2	2	1
91 to 120 min.	2	4	7	7	5	5
121 to 150 min.	2	3	8	11	10	7
151 to 180 min.	0	0	1	1	4	2
181 to 210 min.	1	0	1	4	7	7
211 to 240 min.	0	1	1	1	1	5
241 and up	0	0	0	1	1	1
N =	164	170	172	169	170	167

10. Is your school in grades K - 6 departmentalized for teaching science at any grade level? No__, yes__.
(For this study, departmentalized should be interpreted to mean that students have a special science teacher at scheduled times during the week.) If "yes", circle the grades for which science is departmentalized:
K 1 2 3 4 5 6

Departmentalized science instructional practices were reported in 22% of schools where there were greater frequencies in grades 5 and 6. The majority (78%) of schools indicated they had no departmentalized science instruction.

Table 49

Frequency of Christian School Departmentalization for Science Instruction

N = 177 schools	K	1	2	3	4	5	6	Undepartmentalized
Percent of schools	1	1	0	2	2	6	10	78

INSTRUCTIONAL PERSONNEL

> 11. What is the total number of classroom teachers of grades K-6 in your school? (full time___+ part time___)=____.
> 12. How many of the total teachers counted in the above question actually teach science? _____.

Administrators reporting for 181 schools indicated there were 1634 full-time and 9 part-time teachers in their schools. There were 1625 teachers of science in grades K through 6. Two additional schools reported having no teachers, but an inspection of the questionnaires revealed that the administrators were serving in a dual capacity for a limited number of pupils.

> 13. Describe the professional science teaching preparation of the teachers referred to in question 12 above How many teachers would you place in each of the following categories;
> superior____, good____, fair____, poor____, no professional preparation to teach science____

Principals declined to rank 421 of their teachers (1625 - 1204). About ten percent of the teachers were given superior ratings regarding the professional science teaching preparation they had received, and about nine percent of the teachers were rated as not having received professional

Table 50

Principal's Ranking of Christian School Teachers' Preparation to Teach Science

	Superior	Good	Fair	Poor	Not Prepared	Total
Number of teachers	126	541	371	59	107	1204
Percent of teachers	10	45	31	5	9	100

N = 175 schools

preparation to teach science. Forty-five percent of teachers were rated as having received "good" professional preparation for science teaching. An equal number of rated teachers were deemed "fair," "poor," and "unprepared" for teaching science.

14. Is there someone who is recognized as a science consultant who assists your teachers in science? No___, yes___.
If "yes", is this person ... (check one response)
a) a regular teacher of grades K, 1, 2, 3, 4, 5, or 6 assisting on a formal basis?___
b) a regular teacher of grades 7, 8, 9, 10, 11, or 12 assisting on a formal basis?___
c) a regular teacher within grades K-6 assisting on an informal basis?___
d) a principal, supervisor, or some other administrator?___
e) someone from outside your school organization?___

Table 51

Status of Science Consultant Personnel

	Number	Percent
There is no one acting as consultant	109	60
A regular K-6 teacher; formal basis	4	2
A regular K-6 teacher; informal basis	2	1
A regular 7-12 teacher; formal basis	22	12
A regular 7-12 teacher; informal basis	7	4
Administrative personnel acts as consultant	18	10
Someone outside school organization	7	4
Two or more categories checked by principal	12	7
TOTALS	181	100

Sixty percent of schools do not have someone acting as a consultant to assist the teachers in science instruction. Where the elementary school is part of a K-12 program, the science teacher in the high school frequently assists teachers on a formal (12%) and informal (4%) basis. The science consultant role is taken by administrative personnel about 10% of the time and in 7% of cases, there are two or more persons who may act as consultants. Such personnel were identified on the questionnaires in two cases by the titles, "curriculum coordinator," and "supervisor of elementary instruction."

SCIENCE TEACHING RESOURCES AND MATERIALS

15. What is the status regarding the adoption of science textbook series? Check one box for each grade level.

	K	1	2	3	4	5	6
a) There is no science textbook series adopted.							
b) A single science textbook series is adopted.							
c) Two or more science textbook series are adopted.							

Table 52

Textbook Adoption Policy

	Percent of Grades Reported						
	K	1	2	3	4	5	6
No science textbook adopted	50	13	6	3	4	2	3
A single textbook is adopted	50	84	91	94	92	94	92
Two or more textbooks are adopted	0	3	3	2	5	5	5
N =	180	179	176	176	176	171	170

With the exception of kindergarten, there is a high frequency of science textbook adoption at all grade levels in the elementary Christian schools. Certain ACE schools have indicated that the printed materials called "Paces" used in their schools were not considered to be textbooks, accounting for at least half of the "no science textbook adopted" data.

16. What is the title and publisher of science textbook series, if checked above?

Table 53

Christian School Textbook Adoption Frequency
N = 179

Rank	Publisher	Percent of schools
1	Abeka books, Florida	37
2	Bob Jones Univ., S. C.	24
3	Abeka and BJU combination	7
4	Accelerated Christian Ed., Texas	6
5	D.C. Heath Co.	2
6	Harcourt, Brace, Jovanovich	2
7	Abeka and ACE combination	2

It can be seen that for the school year 1980-1981, the fundamentalist Christian schools in the sample employed science textbooks that were published by organizations that produce materials for use in Christian schools. Of the seven top ranking publishers, Abeka, Bob Jones University, and Accelerated Christian Education, including combination usages, account for about 76% of reported usage among sampled Christian schools. Twenty percent of the reports indicated that schools were employing various combinations of well-known publishers' series such as Scott Foresman, Laidlaw, Silver Burdette, Rand McNally, Addison Wesley, and MacMillan. Frequently, the textbooks from Christian publishing companies were employed in the schools in combination with the secular texts.

17. In what type of room is science most often taught in your school?	K	1	2	3	4	5	6
a) A regular classroom with no special facilities for science.							
b) A regular classroom using temporary or portable equipment.							
c) A regular classroom with special facilities for science.							
d) A special room to which students go for science classes.							
e) Other; please specify:							

The standard practice among sampled fundamentalist Christian schools seems to be the use of regular classrooms for science instruction. The incorporation of temporary or portable equipment into the regular classroom for science instruction seems to be evident in increasing frequency through the grades. Very few schools report having special facilities or special rooms for science classes (Table 54).

Table 54

Room Type for Science in Christian Schools; Percent Frequency by Grade

	K	1	2	3	4	5	6
Regular classroom; no special facilities	85	81	82	76	72	67	61
Regular classroom; with temporary/portable equipment	15	19	17	23	27	30	33
Regular classroom with special facilities for science	0	0	0	0	1	1	1
Special room to which students go for science	0	0	0	1	1	1	4
Other arrangements	0	1	1	1	1	1	1
N =	141	167	172	175	174	174	168

18. To what extent are supplies and equipment for science demonstrations and activities available in your school?

SUPPLIES: are defined as perishable or easily breakable materials needing frequent replacement, such as glassware, chemicals, electric bulbs, batteries, and wire.

EQUIPMENT: is defined as non-consumable, non-perishable items, such as microscopes, aquariums, and tools.

	completely lacking	inadequate	adequate	good	very good
SUPPLIES for grades 1,2,3					
SUPPLIES for grades 4,5,6					
EQUIPMENT for grades 1,2,3					
EQUIPMENT for grades 4,5,6					

Few schools report that their supplies or equipment for science instruction are very good. About equal thirds of schools reporting indicated that their supplies and equipment are either adequate or inadequate. About 15% of schools report these teaching materials to be completely

Table 55

Principal's Ranking of Availability of Supplies and Equipment for Christian School Science

Code	Ranking	Supplies 1-3	Supplies 4-6	Equipment 1-3	Equipment 4-6
1	Completely lacking	17%	14%	18%	12%
2	Inadequate	37%	37%	36%	40%
3	Adequate	37%	34%	33%	29%
4	Good	7%	12%	9%	12%
5	Very good	2%	3%	5%	6%
	Mean	2.411	2.554	2.468	2.603
	Std. Dev.	.936	.988	1.031	1.052
	Median	2.398	2.492	2.395	2.443
	Number	175	177	171	174

lacking. The picture seems to be only slightly improved when supplies and equipment availability are compared with respect to primary and intermediate grade levels. When the means for each category are compared, it is evident that the principals' appraisals of supplies and equipment for science lie somewhere between "Inadequate" and "Adequate" for the schools providing this information on their questionnaires.

19. Give your best estimate of total dollars to be spent for science supplies and equipment this school year. $____

Table 56

Principal's Estimate of Dollars to be Spent for Christian School Science 1980-1981

Mean	Mode	Median	Std. Dev.	Range	Number
343.08	0	152.50	534.186	3,000	150

The 150 schools responding to the question of anticipated expenditures for science supplies and equipment indicated that little or no money would be spent for 1980-1981.

20. Please answer the following question from the viewpoint of an administrator:
"With the exception of 'more money', what would be the most acceptable and most effective means for improving the quality of science teaching in the Christian Elementary School?"

Table 57

Christian School Principals' Science Teaching Improvement Suggestions

	Order in which suggestions were stated			
Improvement suggestion category	First	Second	Third	Totals
Greater awareness of science priorities	3	6	0	9
Improved textbooks and printed materials	14	2	2	18
Improved curriculum, instruction	9	7	2	18
More time for teaching, schedule problems	3	2	1	6
Need for consultants, workshops	39	26	1	66
More supplies & equipment, organization	21	9	3	33
Science room, lab areas in school	12	3	0	15
More A-V methods, "hands-on," trips	5	3	1	9
Improved teacher pre-service preparation	41	7	5	53
Need more enthusiasm, dedication, attitude	7	7	4	18
N =	154	72	19	245

The frequency response table developed above as a result of administrators' concerns for the improvement of the quality of science instruction reveals a regard for the place of the teacher in the instructional process. The administrators call for consultant help and workshops and improved programs of teacher pre-service preparation. Two other high-priority concerns are supplies and equipment and improved science textbooks. Of 154 administrators who made 245 such comments on this free response item, the fewest comments (6) were made regarding scheduling problems or the provision of more time for science teaching. Nine comments related to articulation of audio-visual media and methods including field trips and excursions as well as the employment of "hands-on" approaches. An additional group of 9 comments reflected administrators' concerns about the importance of priorities for teaching science in the elementary school.

Itemized Report of the Findings on the Teacher's Questionnaires

Data are reported according to the format in which the questions appear on the Teacher's Questionnaire.

BACKGROUND INFORMATION

1. Counting this year, how many years have you been teaching?__

Table 58

Teaching Experience for Christian School Teachers
N = 331

Years	Teachers %	Cumulative %
1	11	11
2	11	22
3	11	33
4	12	45
5	8	53
6	5	58
7	9	67
8	5	72
9	5	77
10	3	80
11-20	15	95
21-30	4	99
31-40	0.5	99.5
41 and up	0.5	100

Over half of the teachers sampled in fundamentalist Christian schools had taught fewer than five years with the most frequently reported time four years (including the current year). Experience ranged over 45 years with a median of 5.096, a mean of 7.193, and a standard deviation of 6.888.

2. Basis now employed: full__, part time___.

With 334 teachers reporting, 98% indicated they were employed on a full-time basis.

3. Circle highest degree status held: non-degree, BA/BS, MA/MS, other:____

Table 59

Degree Status of Christian School Teachers

Degree type	N =	% Teachers
Non-degree	18	5.4
BA/BS	259	77.5
MA/MS	44	13.2
Theological	12	3.6
Honorary	0	0.0
Other	1	.3
Totals	334	100.0

About 91% of teachers reported they hold BS or MS degrees.

4. Sex: female__, male__.

Of 332 teachers reporting, 254 (76.5%) were female and 78 (23.5%) were male. The distribution of teachers by sex was unequal through the grades with 93% females in the primary grades 1-3 and 60% females in the intermediate grades 4-6.

5. Number of semester hours____or quarter hours____ of college science and science teaching methods taken.

Table 60

Semester Hrs. and Quarter Hrs. Science and Science Methods Taken

	% Semester Hrs.	% Quarter Hrs.
0 hours	21	79
1-6 hours	24	5
7-12 hours	29	6
13-18 hours	18	4
19 and up	8	6
Mean	9.913	3.885
Std. Dev.	11.458	11.459
Median	8.375	.137
Range	90.	99.+
Number	227	60

The 287 respondents reported their recollections of college or university credit hours in science and science teaching methods taken. There appear to have been a few individuals who are teaching in the elementary grades who have earned substantial credits in science, but most of the teachers responding reported that they had earned fewer than ten semester hours or fewer than four quarter hours of science and science teaching methods in their pre-service training.

6. Did you graduate from a Christian College or University? No__, yes__: school name__________________

Christian school teachers indicated that 61% of 334 respondents graduated from a Christian college or university but 39% did not. When asked to identify the Christian college or university, 24.3% indicated they had graduated from Bob Jones University. A total of 87 other Christian colleges and universities were listed but none of them was reported in more than 4% of cases.

7. State certification held? No__, yes__: for what state(s)?__________________________________

Sixty-seven percent of 333 teachers reported they had obtained state certification, and 33% did not have state certification. An inspection of the questionnaires revealed that 57% of these certified teachers were teaching in the state for which they were certified. The other 10% had been certified for a state other than the one in which they were presently employed. The states identified most frequently by certified respondents included: California, 12.9%; Ohio, 8.1%; Michigan, 7.8%; Florida, 5.1%; Tennessee, 4.8%; Pennsylvania, 4.2%. States not mentioned at all included Delaware, Massachusetts, Nevada, North Dakota, Rhode Island, Utah, Vermont, and

Wyoming, as well as the District of Columbia. Of the foregoing, only the state of Delaware had a Christian school contained in the sample of Christian schools reporting.

8. Christian school certification held? No__, yes__: in what organization(s)?________________

The majority of teachers (82%) indicated that they did not hold certification in a Christian school organization. Fifteen percent of respondents claimed to hold certification in a Christian school organization with about equal participation in two national organizations, The American Association of Christian Schools and The Association of Christian Schools International. Another third were distributed among various local or state organizations. One percent of teachers were certified by The Accelerated Christian Education organization, and three percent of respondents indicated only "yes" on their questionnaires without identifying the organization.

9. For each science class you teach this term.....

a) What is the enrollment?			
b) What is the grade level?			
c) How many minutes per week?			
d) How many weeks per year?			

Table 61

Christian School Science Class Enrollments
for Grades 1 through 6

Mean	Std. Dev.	Mode	Median	Number
20.476	8.268	17	20.346	328

The enrollment data given above represent head counts that were determined in February and March for two teachers per school in the sample. The school enrollment data given by the principals (Table 42) incorporated the larger average enrollments for kindergarten and show enrollments for September, 1980. Grade level breakdowns are given in the following table.

Table 62

Frequency of Science Class Grade Levels
in Sampled Christian Schools

Grade level	Number	% Frequency	Cumulative % frequency
1	36	11	11
2	42	13	24
3	59	18	42
comb. 1-3	22	7	49
4	30	9	58
5	40	12	70
6	45	14	84
comb. 4-6	40	12	96
comb. 1-6	12	4	100
N =	326	100	

Forty-nine percent of the teachers sampled teach science at grade levels one, two, or three, or a combination of these grades. Forty-seven percent teach science to students in grades four, five, or six, or a combination of these grades. Four percent of teachers have combination grades made up of primary and intermediate grade levels. Overall, the data seem to indicate a balance of reporting through the elementary schools sampled with lowest frequencies in grades four and one. About 23 percent of teachers report teaching science to combinations of two or more classes.

The following two tables report the number of minutes per week and the number of weeks per year that teachers conduct science instruction in the grades shown in Table 62 above.

Table 63

Minutes Per Week for Science Instruction in Christian Schools

Mean	Std. Dev.	Mode	Median	Maximum	Minimum
111.399	68.704	60	90.417	402	15

Table 64

Weeks Per Year for Science Instruction in Christian Schools

Mean	Std. Dev.	Mode	Median	Maximum	Minimum
29.505	9.332	36	35.608	45	2

The pattern of frequency for science instruction at all grade levels in fundamentalist Christian schools seems to be 60 minutes per week for 36 weeks. Two teachers reporting over 400 minutes per week would need to have spent about 80 minutes per day on science teaching. In an effort to examine the actual science instructional contact time, data for minutes and weeks was multiplied for each teacher reporting and given in Table 65 below.

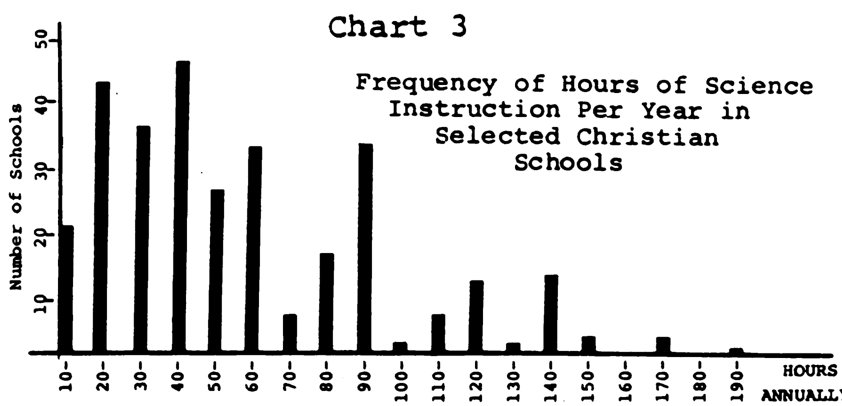
Table 65

Frequency of Minutes for Science Instruction
Per Year in Christian Schools

Mean	Std. Dev.	Median	Mode	Maximum	Minimum
2681.75	2268.12	2700	5400	11100	40

The elimination of the highest maximum of 16081 minutes per year (268 hours or about seven hours per week) for one teacher was deemed expedient in view of the distribution of the other data after translation to annual hours of science instruction.

Chart 3



Frequency of Hours of Science
Instruction Per Year in
Selected Christian
Schools

Only 5.2 percent of schools are responsible for the 5400 annual minute mode. When the data are grouped by 10-hour annual categories, the most often reported instructional hour total for the year is 40 hours (2400 minutes). The 2700-minute median (45 hours) is somewhat shifted to the right because of the many reports of annual instruction time in excess of 90 hours.

10. What is your science teaching schedule this term?
Record the grade level in each box appropriate:

	Mon	Tues	Wed	Thur	Fri
Before lunch					
After lunch					
Variable					

Table 66

Frequency of Scheduled Preferences for Teaching Science in Christian Schools

	Percent of Classes Taught				
	Mon.	Tues.	Wed.	Thurs.	Fri.
Before lunch	17	16	16	16	18
After lunch	66	70	67	69	62
Variable	13	10	13	11	16
Both AM & PM	4	4	4	4	4
Totals	100	100	100	100	100
Number teachers	235	263	235	258	218

Sampled teachers seem to be teaching science "after lunch" about 62 to 70 percent of the time. There does not appear to be a clear preference for teaching science on a particular day although more teachers reported their preferences for teaching science on either Tuesday or Thursday afternoons. Friday seems to be the least preferred day for science. In regard to those teachers who reported teaching science both before and after lunch, it cannot be determined whether their lunch time came in the middle of their science classes or if these teachers were part of a departmentalized approach in their schools. Science seems to be taught in the mornings before lunch by only 16 to 18 percent of teachers sampled.

TEACHING MATERIALS

> 11. Please give the following information about the main science textbook used by students in your class(es):
> title publisher date published for what grade level?

Seventy percent of the 333 teachers reporting indicated their use of textbooks of two organizations that publish textbooks expressly for Christian schools (Table 67). Nineteen percent of schools used the products of six publishing companies, Laidlaw, D.C. Heath, Harcourt-Brace-Jovanovich, Silver Burdette, Scott Foresman, and Rand McNally. About 22% of teachers reporting indicated their usage of a variety of publishers' textbooks under 1% in frequency.

Table 67

Frequency of Publishers' Science Textbooks Employed by Christian School Teachers

Rank	Number of Teachers	Percent of Teachers	Publisher
1	111	41	Abeka
2	98	29	Bob Jones
3	18	5	Laidlaw
4	12	4	D.C. Heath
4	12	4	Harcourt, Brace, Jov.
5	9	3	Silver Burdette
6	6	2	Scott Foresman
Unranked	3	1	Rand McNally (SCIS)
Unranked	74	22	miscellaneous under 1%

There are certain differences among the data for teachers (Table 67) and the data for schools that was reported by administrators (Table 53) concerning the frequency of use of textbooks for science. For example, the 6% figure for the ACE materials evaporated from the teacher report probably because there are so few teachers in proportion to the number of ACE schools when compared to non-ACE Christian schools. An inspection of the questionnaires indicated that of 12 ACE schools, 10 were one-man schools (the administrator was also the teacher), and teacher questionnaires were not submitted for six of the dual purpose individuals. It seems apparent also that the differences between the two tables mentioned above may be due to the possibility that administrators may not be fully aware of teacher practices regarding teachers' textbook usage in science teaching.

12. To what extent are supplies and equipment for science demonstrations and activities available in your school?
SUPPLIES: are defined as perishable or easily breakable materials needing frequent replacement, such as glassware, chemicals, electric bulbs, batteries, and wire.
EQUIPMENT: is defined as non-consumable, non-perishable items, such as microscopes, aquaria, and tools.

	completely lacking	inadequate	adequate	good	very good
SUPPLIES					
EQUIPMENT					

Comparing the responses of teachers given below in Table 68 with those of principals given in Table 55, it appears that there is consensus in rating the availability of supplies and equipment at just about half way between "adequate" and "inadequate." About the same total of responses for both groups indicate supplies and equipment are "good" and "very good"; however, the principals less frequently rate these teaching materials "very good."

Table 68

Teacher's Ranking of Availability of Supplies & Equipment for Christian School Science

Code	Ranking	Supplies	Equipment
1	Completely lacking	16%	14%
2	Inadequate	35%	36%
3	Adequate	35%	35%
4	Good	8%	8%
5	Very good	6%	7%
	Mean	2.524	2.585
	Std. Dev.	1.047	1.062
	Median	2.468	2.496
	Number	313	313

13. During this academic year, about what proportion of science instruction will students handle materials such as seeds, leaves, batteries, rocks, and magnets? Check the most accurate percent of annual instructional time:
0%___ 25% or less___ 25% to 50%___ 50% to 75%___ more than 75%___.

Table 69

Percent of Annual Hands-on Science Instruction Time in Christian Schools

Code	Category	% Teachers
0	0%	1.5
1	25% or less	67.0
2	25 to 50%	24.5
3	50 to 75%	5.8
4	more than 75%	1.2

The mean annual "hands-on" science time was computed to be 1.382 (S.D., .677) with a median of 1.224 and N = 327. Table 69 above indicates that teachers vary in their "hands-on" practices from zero to over 75% of annual science instructional time. A significant amount of time (one-fourth to one-half) each year is spent by 24.5% of teachers, but two-thirds of teachers reporting spend one-fourth or less of their instructional time each year in involving students with handling materials such as seeds, leaves, batteries, rocks, and magnets.

SELECTED TOPICS TAUGHT IN SCIENCE CURRICULA

14. After each of the topics listed below, please write in one of the following code numbers:

1 = The topic is included in the science you teach.
2 = The topic is taught as a part of some other subject to your class, e.g., math, Bible, gym, or current events
3 = The topic is taught as a part of another grade level by someone else.
4 = The topic is not included in the curriculum of your elementary school.

HEALTH___, SCIENCE CAREERS___, CREATION/EVOLUTION___, OUTDOOR EDUCATION___,

CONSERVATION/POLLUTION___, SAFETY___, DRUG ABUSE EDUCATION___, METRIC SYSTEM___.

Table 70

Frequency of Inclusion of Science Topics in Curriculum of Christian Schools

Code	Science Topic Placement	Health	Careers	Cre/ Evol.	Out-door	Con-serv.	Safety	Drug Abuse	Metric
1	With own science	211	75	183	94	186	116	31	38
2	Other sub-ject by teacher	47	23	79	99	50	101	47	187
3	Another grade level	39	51	10	29	42	45	58	41
4	Combinations of above	16	2	45	8	11	15	7	25
	Not taught in curriculum	11	115	6	61	16	25	123	22
	Blank	1	3	2	4	3	3	3	1
	Valid cases	325	269	325	295	308	305	269	314

Of the eight topics listed on the questionnaire for which special feedback was sought, the topic of health is the most frequently taught topic throughout the elementary Christian school science curriculum. It is also the most frequently acknowledged topic receiving attention in other classes and subject matter. The teaching of creation/ evolution appears in each of the four placement areas (Table 70) in frequency about as often as the topic of health. Creation/evolution subject matter is reported to be handled in another subject area (presumably Bible) and in combination with subject matter areas. Conservation ranks about third as a popular topic to teach in the elementary school and has high priority in science teaching. Metric teaching ranks about the same as conservation in frequency of inclusion in the curriculum but is more often handled by the respondent teachers in another subject area, probably mathematics. The two least frequently taught topics in the curriculum of the elementary Christian school were drug abuse education and science careers. Drug abuse information is not often incorporated in the science teaching of teachers but appears to some extent in other subject matter taught by respondents and appears in other grade levels as well. Teachers and administrators may be perceiving that this subject matter is more appropriate for upper elementary grade levels. Science career information is reported to be handled by about one third of teacher respondents, but the topic has low priority among other science topics listed.

15. Within the past five years, have you participated in a) curriculum conferences, b) in-service training activities, or c) workshops whose primary purpose was to assist elementary classroom teachers in improving their science teaching capabilities? No___, yes___.

Participation in science teaching improvement experiences over the past five-year period was reported by just under 54% of 332 teacher respondents. Table 58 shows that 11% of teachers had "one year's experience including the current year." It may be that the 54% participation rate stated above could have been greater if this study had been conducted later in the school year, allowing additional time for regular science workshops.

SCIENCE TEACHING METHODS AND EQUIPMENT

16. Please check the teaching tools that are available for your use and indicate how much you use each kind of tool in teaching science.

teaching tools for SCIENCE:	available?		the average frequency of your use for SCIENCE classes:					
	no	yes	none	1-2 times per year	2-4 times per semester	1-3 times per month	1-2 times per week	more than twice/wk.
Motion picture projector								
Slide/filmstrip projector								
Overhead projector								
Tape and/or record player								
Television and/or video tape								
Commercial charts/models								
Bulletin boards								
Flannel boards								
Microscope(s)								
Science picture sets								

Table 71

Availability and Frequency of Use of Science Teaching Tools in Christian Schools

Teaching tools for SCIENCE	Not avail.	Number of teachers reporting average frequency of usage						Totals
		None	1-2 times per year	2-4 times per semester	1-3 times per month	1-2 times per week	more than twice/ wk.	
Motion pictures	45	98	106	41	28	6	0	324
Slide/film-strips	21	85	106	75	32	8	1	328
Overhead proj.	26	143	76	37	29	11	4	326
Tapes/ records	10	131	77	54	45	11	2	330
TV/video-tape	225	58	14	2	5	4	0	308
Charts/ models	116	33	53	52	38	7	6	305
Bulletin boards	10	36	91	109	48	22	16	332
Flannel boards	60	168	43	24	16	6	0	317

Table 71 (continued)

Teaching tools for SCIENCE	Not avail.	Number of teachers reporting average frequency of usage						Totals
		None	1-2 times per year	2-4 times per semester	1-3 times per month	1-2 times per week	more than twice/ wk.	
Micro-scopes	84	92	81	45	13	1	0	316
Picture sets	139	22	41	59	33	14	2	310
Totals	736	866	688	498	287	90	31	

In Table 71, it can be seen that the three types of science teaching tools reported to be "not available" include television/videotape, science picture sets, and commercial charts and models. The second column "none" reveals that even though flannel boards, overhead projectors, and tapes and records are available, they constitute the three least frequently used science teaching tools. In the third column, "1-2 times per year," about a third of respondent teachers indicated they use films and filmstrips or slides once or twice each year. Ninety-one teachers said they employ bulletin boards for teaching science about twice a year. Forty-eight other teachers report usage at from 1 to 3 times per month, 22 teachers indicated 1-2 times per week, and 16 teachers responded to bulletin board usage for science at "more than twice per week." Where they are available, science picture sets seem to be employed with some regularity, perhaps in conjunction with bulletin board usage. Eleven teachers report their use of overhead projectors, and the same number report use of tapes and records in science on a "1-2 times per week" basis. This frequency represents (11/330) about three percent of the teachers responding.

It is perhaps surprising that only 10 teachers reported that tapes or records for science were not available and that these teaching tools were employed infrequently in the instructional process. On the other hand, one might expect schools with little or no budget for science supplies and equipment to have few microscopes, but only 84 of 316 teachers indicated that microscopes were not available for their use in science classes.

In the interpretation of information presented in Table 71, it is probably unwise to expect the employment frequencies of the selected teaching tools for science to be uniform in each category. For example, the use of motion picture films, microscopes, and television in science instruction may depend upon the topic being considered, video and film order schedules, equipment availability and status of repair, preferences of the teacher, and other factors. What is deemed "good" for the employment frequency of one instructional aid may be "poor" for another. The data simply indicate existing practices reported by participants in the study. It should also be remembered that data in this table include information from teachers at all grade levels, one through six, in about equal proportions (Table 62); so what may be appropriate for use in the primary grades may not be suitable for intermediate grade levels and vice versa. Finally, frequency rates will depend upon the number of days per week for science, which has been noted previously (Table 47) to show increases in the number of days per week through grades one to six.

17. In the following, please place a checkmark beside each teaching method you use during your SCIENCE classes:

a) Science demonstration_____	d) Group lab activity_____	g) Lecture/question/answer_____
b) In-class written work_____	e) Independent study_____	h) Excursions or field trips_____
c) Individual lab activity_____	f) Projected visuals_____	i) Programmed instruction_____

18. In question 17 above, please place the number "1" beside the teaching method you use most frequently in your science classes. Place a "2" or "3" beside the teaching methods used second and third in frequency. Use the numbers only once.

Questions 17 and 18 on the Teacher's Questionnaire were designed to indicate the range of methods employed in science instruction and which ones were most preferred by teachers. Teachers throughout the study left no particular method unchecked in question 17. In question 18, the intention was for teachers to indicate the three methods in item 17 they employed most often in teaching science. Where respondents had chosen more than three preferred methods, only the first three were incorporated in the analyses. Many teachers did not respond to this two-step survey response item. The format for this questionnaire item is probably faulty in that it called for a dual response from each teacher. Only about 48 percent of teachers gave the intended type of responses. Table 72 gives the results for these respondents. The first choice of preferred methods employed in science instruction by teachers in Christian schools was "lecture/question/ answer." This was followed in order by "demonstration" and "in-class written work." The least favored method for teaching science was reported to be "individual lab activity." The figure 12 for "programmed instruction" was

Table 72

Frequency of Favored Science Instruction Methods of Teachers in Christian Schools

Science Teaching Method	Number of teachers ranking selected methods			
	First	Second	Third	Totals
a) Demonstration	7	56	37	100
b) Written work in class	5	49	36	90
c) Individual lab work	1	1	7	9
d) Group lab work	6	15	24	45
e) Independent study	4	9	10	23
f) Projected visuals	1	8	17	26
g) Lecture/question/answer	123	12	6	141
h) Excursions or field trips	0	2	12	14
i) Programmed instruction	12	4	1	17
Teacher respondent N =	159	156	150	465

a total derived from ACE schools, which have an independent student program consisting of a series of questions and answers similar to a workbook. These combination texts/ workbooks are not programmed for individual abilities, nor do they provide self-teaching feedback loops. The writer believes that the manner in which this item was interpreted by certain respondents makes these particular data unreliable. The writer suggests that the totals for the category "programmed instruction" be combined with those in the category "independent study" because it seems to have better descriptive qualities for this characteristic teaching method. Examination of textual materials claimed to be employed in science teaching in the Christian schools surveyed revealed no truly programmed materials among them.

Some science teaching educators are concerned with what can be termed passive versus active learning in science. Their concerns are reflected in the use of "hands-on" activities involving students' participation in handling manipulative materials as a regular part of science instruction. Educators are also concerned about the manner in which the other types of classroom activities are conducted with respect to a passive-active continuum for the student. If the assumption can be made that certain given teaching methods permit student passivity (demonstration, projected visuals, lecture/question/answer), and the others facilitate more student activity, the data in Table 72 can be arranged as follows:

Table 73

Frequency of Favored Science Teaching Methods
Restructed for Passive-Active Assumptions
Concerning Student Involvement

	Totals	"Passive" total	"Active" total
a) Demonstration	100		
f) Projected visuals	26		
g) Lecture/question/answer	141	287	
b) Written work in class	90		
c) Individual lab work	9		
d) Group lab work	45		
e) Independent study	23		
h) Excursions or field trips	14		
i) Programmed instruction	17		198

Two of the most frequently employed methods in science teaching (lecture/question/answer, demonstration) together with the use of projected visuals, constituted over 57% of teachers' preferred methods of teaching science. The six other methods constituted about 43% of the same teachers' teaching method choices. A solid case in favor of either active or passive methodology practices (or preferences) cannot be made from the data in the preceding two tables or from other data in this study.

SCIENCE TEACHING CONCERNS

19. The next item contains a list of teaching factors thought to have an effect on science teaching. Indicate with checkmarks how you believe each of these factors affects your science teaching:

teaching factors for SCIENCE:	inhibits greatly	inhibits somewhat	neutral no effect	enhances somewhat	enhances greatly
Room facilities for teaching science					
Supplies and equipment for science					
The size of class enrollment in science					
Regular assistance from a science consultant					
The amount of time to teach science					
The amount of time to prepare for science					
Your knowledge about science or methods					
In-service science training or workshops					
The degree of your interest in science					
The emphasis or priority for science in school					

In teachers' ratings of factors thought to affect science teaching, there seems to be a greater number of factors thought to enhance rather than inhibit science teaching. Teachers believed strongly that their own interest in science contributed to their efforts. Two additional "enhancers" reported were the teacher's own knowledge about science, and supplies and equipment for science. Inspection of columns four and five together reveals that teachers' interest in and knowledge about science assist their science teaching. In addition, in-service training was thought to be helpful to respondents' teaching of science.

Science teaching "inhibitors" of strongest degree (column 1) included supplies and equipment, room facilities, and teacher preparation time. Inspection of columns one and two together indicates the same relative

Table 74

Christian School Teachers' Ratings of Science Teaching Factors

	1	2	3	4	5	Code			
Science Teaching Factors	Inhibits greatly	Inhibits somewhat	Neutral no effect	Enhances somewhat	Enhances greatly	N	Mean	S.D.	Median
Room facilities	27	92	104	60	37	320	2.962	1.130	2.894
Supplies & equipment	48	103	36	67	65	319	2.994	1.399	2.736
Class size	9	46	126	91	47	319	3.379	.995	3.329
Science consultant help	13	25	140	53	36	267	3.277	.976	3.182
Amount of time to teach	16	78	109	84	31	318	3.113	1.045	3.096
Amount of time to prepare	26	75	96	65	58	320	3.169	1.210	3.115
Own science knowledge	7	74	48	109	79	317	3.565	1.161	3.771
In-service training	9	39	76	117	51	292	3.555	1.026	3.688

Table 74 (continued)

	1	2	3	4	5	Code			
Science Teaching Factors	Inhibits greatly	Inhibits somewhat	Neutral no effect	Enhances somewhat	Enhances greatly	N	Mean	S.D.	Median
Own interest in science	7	29	47	113	120	316	3.981	1.048	4.164
School priority for science	4	34	146	103	29	316	3.377	.844	3.322
Totals	166	595	928	862	553	3104			

priorities of mention for these three inhibiting factors.

With respect to column three, "neutral/no effect," teachers reported most often that science consultant assistance on a regular basis either had no effect or teachers felt indifferent about it. When this notion is viewed in the perspective of Table 51, however, a more reasonable interpretation may be that a majority of teachers do not have regular science consultant assistance. Of 181 schools reporting, 109 (60%) of them stated that they had no one who acted as a science consultant to assist their teachers. It seems apparent that some of the respondents may have had some uncertainty regarding the way to answer this item since there are the fewest number (267) of responses to science consultant help (Table 74).

"Neutral/no effect" responses were also given to school priority for science, class size, and room facilities. The meaning of these ratings seems unclear. Perhaps these factors tend to become accepted as "givens" in teaching. Teachers are least neutral concerning supplies and equipment for teaching science.

One beneficial result of the information revealed in Table 74, teaching factors, relates to the perceptions teachers have concerning the factors that have an effect upon their teaching of science. Strong feelings about factors that enhance or inhibit teaching efforts must be heard in the development and implementation of science curriculum improvement efforts. Likewise, where there are expressions of "neutral/no effect," especially in regard to priorities for science teaching in schools, evidence for change strategy may be found.

20. How satisfied are you with teaching elementary school science? Please check one response below: very dissatisfied___, dissatisfied___, neutral___, satisfied___, very satisfied___.

Only somewhat more than 12% of teachers report dissatisfaction with elementary school science teaching, whereas about 67% of teachers report satisfaction in this area (Table 75). About 21% report neither satisfaction nor dissatisfaction in science teaching efforts. These results seem to correlate well with Table 74, where individual factors were rated by the same teachers.

21. Please answer the following question from the viewpoint of a classroom teacher: "With the exception of 'more money', what would be the most acceptable and most effective means for improving the quality of science teaching in the Christian Elementary School?"

The frequency response Table 76 developed below as a result of teachers' concerns for the improvement of the quality of science instruction reveals the teachers' regard for the importance of supplies and equipment. Also mentioned with equal frequency in "first" suggestions is concern for audio-visual methodology including "hands-on" instruction in science. Perhaps "hands-on" instruction and supplies and equipment are related in the minds of respondents. The third most frequently stated improvement

Table 75

Christian School Science Teachers' Satisfaction with Teaching Science

Category label	Very dissatisfied	Dissatisfied	Neutral	Satisfied	Very Satisfied	Totals
Number of teachers	1	39	68	177	43	328
Percent of teachers	.3	11.9	20.7	54.0	13.1	100

Table 76

Christian School Teachers' Science Teaching Improvement Suggestions

	Order in which suggestions were stated			
Improvement suggestion category	First	Second	Third	Totals
Greater awareness of science priorities	10	19	1	30
Improved textbooks and printed materials	36	15	4	55
Improved curriculum, instruction	32	17	8	57
More time for teaching, schedule problems	36	9	4	49
Need for consultants, workshops	41	13	9	63
More supplies & equipment, organization	38	34	13	85
Science room, lab areas in school	21	12	4	37
More A-V methods, "hands-on," trips	38	29	12	79
Improved teacher pre-service preparation	17	7	3	27
Need more enthusiasm, dedication, attitude	8	13	7	28
Totals	277	168	65	510

suggestion related to needs for consultant and workshops assistance, but it was the suggestion given first most often. This concern was followed in order by "improved curriculum" and "improved textbooks." It may be that the distinction between curriculum and textbooks for science had been artifically determined when the suggestions were categorized. If these two categories are not truly separate factors in the minds of the respondents, the combination of totals would make "curriculum/textbook" the most frequently cited area for science teaching improvement. Of 277 teachers who made 510 improvement suggestions in answers to this free response item, three areas were mentioned least often. These three areas were "improved teacher pre-service preparation," "teacher enthusiasm, dedication, attitude," and "greater awareness of science priorities." Inasmuch as teachers have indicated (Table 74) that "their own interest in" and "knowledge of science" enhance their teaching of science, it could not be expected that teachers would discount their pre-service preparation. Finally, as noted previously (Table 75), teachers seem to be fairly well satisfied with their efforts to teach science.

Comparing the two tables (Table 76 and Table 57) for teachers and principals, it should be noted that both groups share minimal concern for a "greater awareness of science priorities." Other relationships can be seen more clearly as frequency response percentages by comparing the "totals" columns of Table 57 and Table 76 and expressing each subtotal as a percentage of the total number of responses for principals (245) and for teachers (510) in the following new table (Table 77). Principals rank the need for science consultant assistance and workshops first, but teachers rate this third in priority of suggestions. Teachers ranked supplies and equipment first, and principals rated this third. The second most frequent suggestion by principals concerned the status of pre-service preparation of teachers. This focus was not shared by teachers. The writer is of the opinion that there is enough concensus among three or four primary concerns to provide the basis for cooperation among administration and faculty members for effective science teaching improvement activity.

Discussion and Summary of Findings

This survey of the science teaching practices in selected elementary Christian schools in the United States was conducted during 1980-1981 in order to develop a base of information to assist curriculum developers working with in-service, pre-service, and text-production efforts. The responses of 184 principals and 334 teachers are incorporated in the findings reported in this chapter. This represents a 54.7% return of questionnaire sets from principals who had volunteered their participation in the study. In terms of the population from which the sample was drawn, the findings should be understood to be a

Table 77

A Comparison of Frequencies by Percent of Christian School Principals' and Teachers' Science Teaching Improvement Suggestions

	Principals' Totals		Teachers' Totals	
Improvement suggestion category	N	%	N	%
Greater awareness of science priorities	9	3.6	30	5.8
Improved textbooks and printed materials	18	7.3	55	10.7
Improved curriculum, instruction	18	7.3	57	11.1
More time for teaching, schedule problems	6	2.4	49	9.6
Need for consultants, workshops	66	26.9	63	12.3
More supplies & equipment, organization	33	13.4	85	16.6
Science room, lab areas in school	15	6.1	37	7.2
More A-V methods, "hands-on," trips	9	3.6	79	15.4
Improved teacher pre-service preparation	53	21.6	27	5.2
Need more enthusiasm, dedication, attitude	18	7.3	28	5.4
Totals	245	99.5	510	99.3

composite of data from slightly more than three percent of 5,761 school listings. The reports of both general information and data related to specific science teaching practices in elementary Christian schools provide knowledge previously unavailable.

The following generalizations of the findings in this study, reported in Chapter 4, are organized for similar treatment of the report of the findings in the literature search discussed in Chapter 2.

Area 1: School Organization for Teaching Science in Christian Schools

A) About 40% of schools have guidelines for required minutes for instruction.

B) There does not appear to be any consistent practice among schools regarding the amount of time actually spent in science instruction.

C) About 22% of schools reported that some of their grades are departmentalized for science instruction. Only one school reported that any of its primary grades were included in the departmentalization procedures.

D) The frequency of science teaching in the schools showed the following distribution: about 75% of kindergartens, 95% of first grades, 98% of second grades, and 100% of grades 3, 4, 5, and 6.

E) Science is taught with increasing frequency during the week as well as for an increasing number of weeks during the year as the students move through grades K-6.

F) The most frequently reported pattern for science teaching in Christian schools was 60 minutes per week for 36 weeks. A pattern of devoting more time each week for science as children progress from grade 4 to grade 6 is evident.

G) Science is most often taught on a Tuesday and/or a Thursday, but regardless of the day, the afternoon is preferred over the morning by 70% of teachers.

Area 2: School Facilities for Teaching Science and Enrollment in Christian Schools

A) Science is most often taught in a regular classroom without special facilities, but 20 to 33% of teachers report that their rooms have temporary or portable equipment.

B) The average class size for teaching science was reported by teachers to be just above 20 students with 17 students as the most frequently given class enrollment.

C) The average school size was determined to be slightly more than 160 students for the September, 1980, enrollments for grades K through 6.

Area 3: Science Textual and Teaching Resources in Christian Schools

A) Examination of the adoption policies of Christian schools regarding science textbooks revealed that 92% of schools had adopted a single publisher's series.

B) The common practice reported in Christian schools was to employ textbooks published by private, religious companies such as Abeka, Bob Jones University Press, and Accelerated Christian Education. Varied selections of secular science textbooks were being used by about 20% of schools.

C) About 3% or less of the respondents reported that their schools were using printed materials related to science curriculum improvement projects such as SCIS, SAPA, and ESS.

D) The topics of health, evolution/creation, and conservation are recognized subject matter areas for inclusion in the Christian school science curriculum. Metric concepts are most often taught in the mathematics classes. The teaching of career information in science and drug abuse education are reported infrequently as part of the science curriculum of the majority of Christian schools.

E) Forty-eight percent of the schools surveyed indicated that they are no further than 10 miles from a public science facility such as a planetarium or museum.

Area 4: Supplies and Equipment for Teaching Science in the Christian School

A) Both the principals and teachers surveyed agreed that the availability of supplies and equipment for teaching science rated about 2.5 on a five-point scale from "completely lacking" to "very good"; that is, somewhere between "adequate" and "inadequate."

B) Almost 19% of schools expected to spend no money on science supplies and equipment during the 1980-1981 school year, and 48% indicated they would spend $100.00 or less. An additional 14% indicated their expenditures would include up to $200.00 for the current year. Five schools reported allocating over $2,000.00 in this area. It was calculated that average expenditures would be about $280.00 per school or approximately $1.75 per student enrolled.

Area 5: Availability and Frequency of Use of Methods & Tools for Science in Christian Schools

A) The most preferred science teaching methods practiced by teachers were (1) lecture/question/answer, (2) demonstration, and (3) in-class written work.

B) All listed teaching tools were reported to be available and used to some extent by science teachers. Greatest use was reported to be science bulletin boards. The tools least frequently available for science teaching were reported to be video and television equipment. Also infrequently available were science picture sets and charts and models.

C) About 25% of the teachers reported allocating between 25 and 50% of their annual science instruction time for "hands-on" types of activities. Sixty-seven percent reported spending less than 25% of annual instructional time in this manner.

Area 6: Characteristics of Science Teaching Personnel in Christian Schools

A) Forty-five percent of Christian school teachers have taught science for four years or less, and 80%

have taught science for ten years or less.

B) Female teachers outnumber male teachers three to one in grades one through six. Ninety-seven percent of K-3 teachers are female, and 60% of teachers in grades 4-6 are female.

C) Regarding the acquisition of college degrees, respondents reported the following: no degree, 5%; Bachelors degree, 77%; Masters degree, 13%; and miscellaneous theological degrees, 5%.

D) Teachers reported having taken an average of about 10 semester hours or 4 quarter hours of science and science teaching methods in college.

E) Principals of about 40% of Christian schools indicated that they had some form of science consultant help available to their teachers. The consultant task was handled most often by a high school teacher or an administrator. Less than 3% of elementary teachers reported performing a science consultant function.

F) Fifty-four percent of respondent teachers said they had participated within the past five years in curriculum conferences, in-service training activities, or in workshops where the primary purpose was to improve teachers' science teaching capabilities.

G) Principals rated 1,204 teachers' pre-service science preparation as follows: superior, 10%; good, 45%; fair, 31%; poor, 5%; and unprepared, 9%.

H) Sixty-seven percent of Christian school science teachers have state certification. About 15% of these certified teachers were currently employed in states other than the one for which they held certificates.

Area 7: Attitudes of Christian School Personnel Toward Perceived Barriers to Effective Science Teaching

A) Sixty-seven percent of teachers reported that they are "satisfied" with their science teaching efforts.

B) Teachers most often mentioned the following barriers to science teaching: (1) supplies and

equipment, (2) room facilities, and (3) science teaching preparation time. Teachers' science teaching improvement suggestions also included assistance from science consultants and provision of science workshops.

C) Principals most often mentioned improvement suggestions relating to (1) provision of science consultant assistance, (2) supplies and equipment, and (3) the need for upgrading the pre-service preparation of teachers of science.

Area 8: Background and Miscellaneous Data Relating to Science Teaching in Christian Schools

A) The length of operation of Christian schools was most often given as four years. Sixty-five percent of these schools indicated they had been operating for ten years or less, and 85% had been in operation for twenty years or less. Eight percent reported operating for thirty years or more, with two schools reporting histories of over ninety-nine years.

B) One third of the schools indicated that there were at least four other Christian schools within a ten-mile radius. Seventeen percent of the schools reported that there was no other Christian school in the designated area.

C) Christian elementary schools are found in a variety of sizes of demographic regions. Sampled schools reported their city populations as follows: 36% are in cities under 25,000; 33% in cities of from 25,000 to 100,000; and 30% in cities of over 100,000.

D) About 18% of teachers surveyed reported they held certification in one or four national Christian school organizations.

E) Sixty-one percent of Christian school teachers of science reported that they had graduated from a Christian college or university. The largest number (24%) indicated they had graduated from Bob Jones University located in Greenville, South Carolina.

Conclusion

The findings summarized above represent an overview of the science teaching practices in selected Christian schools in the United States. The information gathered from voluntary participants included administrators and teachers who were employed in 184 schools serving 29,550 pupils in various grades kindergarten through six, seems to be fairly complete for these schools. Although it is believed that the data can be considered to be reasonably representative of the population of schools from which this sample was chosen, the confidence level is rather low because the desired number of schools (359) was not realized in the survey. Also, many of the smaller Christian schools are not represented in these findings. This is particularly true for many ACE schools located in Texas that declined to participate.

The results of this study are discussed further in Chapter Five and viewed for their potential to provide meaningful information that would assist in developing textbooks, pre-service programs, and in-service programs for Christian school science teachers. In addition, constructive commentary will be made regarding certain similarities and differences that may be seen among trends in science teaching practices for public and Christian schools. Finally, limitations of this study will be given and suggestions for further study will be made.

Chapter 5

Summary, Conclusion, and Recommendations

Summary

This study is the result of a survey of science teaching practices in selected elementary fundamentalist Christian schools in the United States. The data generated from this effort represent the aggregate of responses from 184 school administrators and 334 teachers in grades kindergarten through sixth and provide one source of information concerning the elementary science programs of the rapidly expanding Christian school movement. These data and the implications that may be drawn from them are viewed as an important part of the development of materials, in-service assistance, and pre-service programs relating to the population of Christian schools under consideration.

The importance of the position of science as a vital concern of fundamentalist Christian educators was noted and the basic tenets of Fundamentalist beliefs in this area were given. Contrasts between secular humanism and fundamentalism were made, and evidence was presented to indicate that these differences as well as other factors have been a part of a back-to-the-basics emphasis that has resulted in the expansion of the fundamentalist

Christian school movement.

The growth of the Christian schools has resulted in the production and development of specialized curriculum materials for science that demonstrate an infusion of religious philosophy in the sequential studies of the natural world. This development seemed to be reminiscent of an earlier period in the history of science education when religious teachings had incorporated a study of the natural world.

An outline of the developments and trends in science teaching in the United States was given for the purposes of establishing appropriate and potentially productive survey procedures. Relevant literature was examined, and major national science surveys were reported for their usefulness in constructing the questionnaires employed in this descriptive research.

The findings presented in Chapter 4 are intended to be of special interest to professionals who are concerned with the development, implementation, and administration of programs of science education at varied levels. A brief account of the major findings is presented in the following eight categories.

1. School Organization for Teaching Science

There does not appear to be any consistent practice among Christian schools in terms of the amount of time actually spent in science instruction. However,

science is taught for some part of the year at all grade levels. All schools reported that science was taught in grades three, four, five, and six. The most frequently reported time for science was sixty minutes per week for thirty-six weeks. The amount of time for science increased through the grade levels. The afternoon is preferred for science teaching, and Tuesday and/or Thursdays are most frequently scheduled for science classes. Departmentalization for science instruction is practiced by fewer than one fourth of sampled schools and seems to be restricted to grades five and six.

2. Class Size and School Facilities for Teaching Science

Typical class sizes in elementary Christian schools may range between seventeen and twenty students in schools averaging 160 students, kindergarten through sixth. Science is most often taught in self-contained classrooms that do not have any special science teaching facilities. About one fifth to one third of teachers indicated that their classrooms have some temporary or portable equipment that is employed in their science teaching.

3. Science Textbooks and Resources for Teaching Science

Over ninety percent of sampled schools revealed they had adopted a single publisher's series for teaching science. The adoption of textbooks produced primarily for use in Christian schools was the norm and involved three

major publishers: Abeka, Bob Jones University Press, and Accelerated Christian Education. About twenty percent of schools were using texts produced by secular publishing houses. There was only a trace of science curriculum improvement programs (SCIP) employed in the sampled schools. Although the topics of health, creation, and conservation are recognized in the content of Christian school science, education in drug abuse and careers are infrequently reported. Metric concepts seem to be utilized in mathematics classes rather than in science classes. The location of many Christian schools may make the utilization of public science facilities such as museums feasible in terms of time and distance.

4. Supplies and Equipment for Teaching Science

Instructional resources for teaching science are not adequately provided for in the science programs of Christian schools in the survey, a point on which all participants seem to agree. An average expenditure of about $1.75 per student was derived from survey data, but this information must be tempered with the understanding that nearly one fifth of schools reported that nothing would be spent for science supplies and equipment during the 1981 school year.

5. Availability and Frequency of Use of Methods and Tools for Teaching Science

Although there is some evidence of incorporation

of "hands-on" activities in the Christian school classrooms surveyed, the most preferred teaching methods reported were the lecture/question/answer, teacher demonstration, and in-class written work approaches. Most of the commonly employed teaching tools were reportedly available for teachers, but there were accounts of infrequent usage of television equipment, commercial charts and models, and science picture sets. Teachers reported high frequency of usage of bulletin boards.

6. Characteristics of Personnel Employed in Science Teaching

About one half of teacher respondents indicated they had fewer than five years' experience in science teaching. Ninety-five percent of teachers reported the acquisition of at least a four-year college degree, and sixty-one percent had obtained their degrees from a Christian college or university. Sixty-seven percent of teachers claimed to hold state certification, and an additional eighteen percent stated they held certification in a Christian school organization. The average total of college course hours in basic sciences and science teaching methods was about ten semester hours. Principals of forty percent of schools reported the availability of some form of science consultant assistance, but fewer than three percent of elementary teachers performed this function. About half of teachers surveyed indicated they had attended a science-improvement seminar or workshop

within the past five years.

7. Attitudes of Personnel Toward Perceived Barriers to Effective Science Teaching

Barriers most frequently mentioned by both teachers and administrators included supplies and equipment, lack of consultant help, inadequate room facilities, and inadequate pre-service teacher training for science. Sixty-seven percent of teachers reported their satisfaction with their own science teaching efforts.

8. Miscellaneous Factors Relating to Science Teaching

Sixty-five percent of Christian schools in the sample had been in operation for less than ten years, but the most frequent figure for years of operation was four years. Christian schools seem to be located in regions varying from under one thousand population to metropolitan areas of over one hundred thousand. Administrators in a majority of cases indicated the presence of from four to nine other Christian schools within a ten-mile radius, and only seventeen percent reported theirs was the only Christian school in the area.

Conclusions

One most interesting conclusion that can be made regarding the findings of this study is that there seems to be little difference between the science teaching practices of teachers in elementary Christian schools and

teachers in public schools in the samples reported for this study. The findings of this study are presented for comparison to the most recent national survey of science teaching practices, the 1977 NSF report prepared by Ira Weiss. Similarities are indicated as follows:

1. The teaching of science is an accepted component of the elementary school curriculum, but science teaching has a low priority.

2. Written guidelines for the amount of science instructional time are available in less than half of the schools included in these studies.

3. There seem to be no consistent practices regarding the amount of science taught to students in the elementary grades, but they vary from school to school and from teacher to teacher.

4. The barriers to effective science teaching seem to be similar for all situations reported. These barriers include supplies and equipment, consultant help, room facilities, and improved pre-service preparation for teaching science.

5. Teachers prefer teaching methods that seem to be teacher-centered and heavily dependent upon the employment of a single textbook as a means of information acquisition by students.

Certain dissimilarities seem apparent between the study and the Weiss survey.

1. The average number of years of science teaching experience is greater for public elementary school teachers than for Christian school teachers.

2. Public school teachers hold an average of twice as many advanced degrees.

3. Public school teachers reported a greater average number of college credits in both the basic sciences and in science teaching methods.

4. Christian schools seem to be employing science textbooks produced especially for Christian schools. These textbooks are supportive of particular religious philosophies.

5. Christian schools seem to have a slightly greater percentage of male teachers in the intermediate grades four, five, and six than reported for public schools.

6. On the average, class sizes are smaller in Christian schools than in the public schools studied.

Other factors remain inconclusive or untouched by findings reviewed for this research.

1. The science capabilities of elementary students in either public or Christian schools are not addressed.

2. The reasons for apparent low priorities for science instruction in the schools are unexplored.

Recommendations

Christian school educators ought to make the most of the strengths of their programs and remedy the perceived weaknesses of programs such as elementary science. The significance to decision makers of the apparent similarities between public school and Christian school science teaching practices may lie in the notion that the results of science education research in the public schools may be applied effectively to making desired changes in Christian school science programs. Research and curriculum development for application to Christian schools should be conducted in the following three areas: (1) the continuing production of specialized science teaching materials, (2) the development of in-service programs that address recognized barriers to effective science teaching, and (3) the articulation of pre-service science programs to redress the problem of minimal standards for training elementary science teachers.

Based on the writer's background and the findings of this study, the following recommendations are suggested for further exploration by the varied community of Christian educators.

1. Clarify and communicate to constituents the purposes for science teaching that incorporate effective teaching/learning strategies and that explicate the meaning of scientific literacy for students in fundamentalist Christian schools.

2. Design instructional media and methods that make the most productive uses of limited facilities, minimal expenditures, small class sizes, existing science teaching schedules, and the schools' proximity to public science facilities.

3. Organize science curriculum improvement workshops for Christian schools that may wish to supplement their own in-service and consultant efforts.

4. Attempt to verify and supplement the findings of this study particularly in regard to pre-service preparation of Christian school teachers.

5. Incorporate usable data in pre-service programs in order to anticipate and treat potential barriers to effective science teaching.

As a stakeholder in the products of Christian education, the writer views with approval the production of textual materials that are consistent with Fundamentalist beliefs. Also acceptable as trends in the Christian school movement are practices of employing increasing numbers of male teachers in the elementary schools and maintaining small class sizes. In addition, the appearance of high proportions of certified (or certifiable) teachers in this study of Christian schools may provide some assurance to educators and Christian school constituents alike that many qualified teachers are found in fundamentalist elementary

Christian schools. In such a climate of concern for the employment of qualified teachers, it may prove interesting to inquire whether Christian school administrators will seek to employ experienced teachers from a surplus created by public school teacher layoffs.

On the other hand, the writer views with disdain the reports of minimal pre-service teachers' exposure to basic science and science teaching methods. If these reports are accurate, the continuation of such pre-service practices seems quite intolerable. When this information is considered in the context that over sixty percent of elementary Christian school teachers have graduated from Christian colleges, it seems clear that the responsibility for redress rests with decision makers in the Christian colleges.

A final suggestion for inquiry involves the determination of the status of Christian school students' competencies in science understandings, skills, and attitudes. Because the approach taken in this survey resulted in the identification of certain circumstances, conditions, and factors in science teaching rather than in an appraisal of student learning, there is still a need to evaluate the effectiveness of Christian school science programs. Evaluation of curriculum efforts cannot be addressed solely by input measures and program intentions.

* ** * * *

This study is an initial inquiry into the science teaching practices of elementary Christian schools of the United States. It should be remembered that these data and the impli-

cations drawn from them may be limited to the broad group of Christian schools and to fundamentalist schools in particular. The following reasons are presented in support of this belief:

1. there was limited participation of solicited schools;
2. there were disproportionately large numbers of Bob Jones University respondents;
3. there is an apparent uneven distribution of fundamentalist Christian schools in the United States;
4. there was no regulation of the administrators' selection of the teacher respondents; and
5. there is difficulty in making precise comparisons of teaching factors among the different schools represented in this study and research that was conducted over varied time periods.

Nevertheless, the information provided in this report may be viewed for its usefulness in the development of a basis for decision making and for additional research.

Appendix A

EXAMPLES OF CHRISTIAN SCHOOL PUBLISHERS' SCIENCE TEXTBOOK MATERIALS

"...the teaching of science is designed to help students see a religious purpose in the world..."
(refer to p. 31)

PLEASE NOTE:

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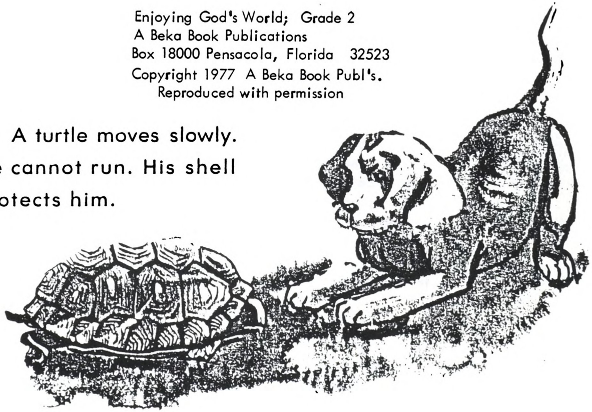
These consist of pages:

221-238

God Gives the Animals Protection

Animals have many enemies. If God had not given each animal some form of protection, many kinds of animals would be quickly killed.

A turtle moves slowly. He cannot run. His shell protects him.

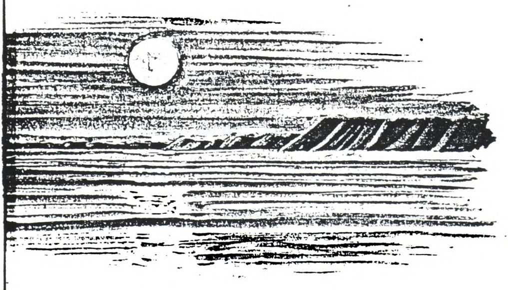


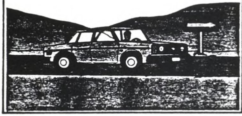
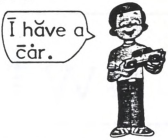
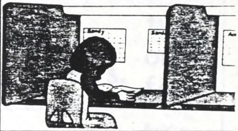
A baby deer is called a **fawn.** Fawns have spotted coats until they are big enough to outrun their enemies. The spots help them to hide in the bushes of the forest.

enough on the beach to avoid later high tides. Uncannily, the grunion arrive about fifteen minutes after the high tide has been reached.

The eggs are deposited below the surface of the sand, and the fish flop back into the sea. Two weeks later when the high tide is again at its highest point, the eggs hatch. In fact, it is the arrival of the waves which triggers the hatching process. The eggs pop open like popcorn as the water reaches them. Waves wash the tiny grunion into the sea.

Who taught the grunion the schedule of the tides? How does this fish know when spring tides occur, and how does it know when the high point of the tide has passed? Is it possible for the grunion to have figured these details out for itself? Only God could have given such a wonderful biological clock or instinct to the grunion. Without this special instinct, the grunion would become extinct because it could not reproduce. How marvelous are the works of God's hands!



wāy	hăve	learn
		

The Earth Moves

God makes the earth move in two <u>wāys</u>.

One wāy God makes the earth turn.

He makes it turn like a top.

One wāy God makes the earth go around the sun

We <u>hăve</u> <u>learned</u> the earth moves in two wāys.

One way it turns around.

We hăve learned it turns around like a top.

We hăve learned it turns.

It turns around one time each day.

One way it moves around the sun.

We hăve learned the earth goes around the sun.

We have learned it goes around the sun each year.

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Accelerated Christian Education
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 Supervisor initial

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The earth moves two ______ wāys.	two one fōur
The earth turns like a ______.	hŏp tŏp mŏp
The earth moves around the ______.	fŭn rŭn sŭn
It moves around the sun each ______.	yēar tēar hēar
Gŏd mākes the earth ______.	move māke learn

Thou shalt take thy rest in ______. Job 11:18

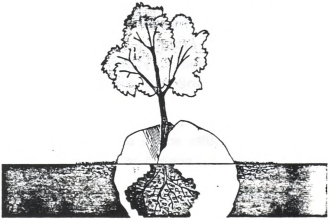
2. Acids make soil.

Acids in rain water, streams, and rivers not only make caves underground, but they also provide new soil for plants above ground. Rivers and streams are fed by rain. As the water runs across the rocks on the sides of hills and mountains, the acids in the water dissolve tiny pieces of the rocks. These tiny pieces of rock are carried in the streams and rivers and are deposited on flat land. There the plants will have new soil in which to grow. This new soil is called sediment.


Water carries dissolved rock to low places.

Good soil will grow large, healthy, green plants. What makes good soil? Farmers know that good soil has to have acids. Farmers buy fertilizer and put it in the soil to make plants grow better. Most fertilizers are made from acids. Acid fertilizers in the soil cause the soil to be richer. Acids in the soil do several things for plants. The acids dissolve minerals, such as iron, in the soil so that plants can absorb the minerals as a liquid. Soils always have in them some remains of dead plants and animals which provide food for new plants. Acids in the soil help to dissolve the dead materials into a liquid form so that the plants can use them for food.

Have you ever seen a tree growing up out of rocks? Perhaps you have seen streets cracked and broken up by the roots of plants. How is a root able to grow into a rock or into a concrete street? Plants have acid in their roots. As the roots make contact with rocks, the acid in the roots dissolves the rocks. The plant is able to break the rocks apart by dissolving the rocks and growing bigger.



(1) Acids in rain water, streams, and rivers provide new ____________ for plants above ground.

(2) New soil is called ______________________.

(3) Good soil has to have ________________.

(4) Most ______________________ are made from acids.

(5) Acids dissolve _____________________________, such as iron, in the soil so that plants can _________________ the minerals as a _________________.

(6) Plants have acid in their ________________.

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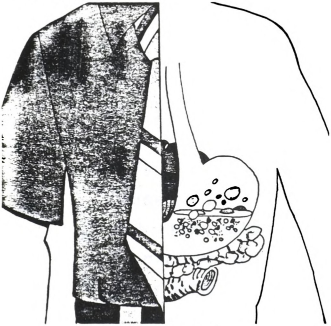
Accelerated Christian Education
P.O. Box 1433 Lewisville, TX 75067

3. Acids aid digestion.

People and animals also depend upon acids to live. Did you know that in your stomach you have one of the strongest acids known? Your body makes this acid to aid digestion. Just as plants have to have their food dissolved in the soil, people and animals have to have their food dissolved in their stomachs. Since the acid in your stomach is so strong, why does it not dissolve your stomach? Your stomach has a protective lining which the acid cannot dissolve. God made your body to protect itself from harm. When the food has been dissolved by the acid, the food is absorbed by your body.



Stomach acids dissolve foods.

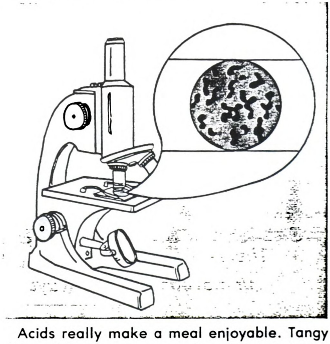
You wouldn't drink an acid which is able to dissolve a piece of metal, but there are some acids which we may eat and drink. It is good for you to drink a juice which contains an acid before eating a meal. Any liquid should be taken at least thirty minutes before a meal. The acid makes your mouth water, making your food easier to swallow. It also starts the digestive process for the food you eat. You should not drink liquids during a meal. A protein food such as meat or cheese should be the first food eaten at a meal in order to activate the acid in your stomach.

4. Acids are used to prepare foods.

If you look closely at a piece of bread, you will see little holes all through it. These holes were made by bubbles of gas in the bread dough. Baking soda and sour milk (an acid) combine to produce bubbles in the dough which make the bread rise. When the bread dough rises in the oven, it becomes light and fluffy. We call these breads "light," or "quick," breads.

A common acid called vinegar is used to preserve vegetables such as cabbages. Tomatoes can be preserved in their own juice because tomato juice contains acids. Preserved foods can be kept for a long time in cans and jars.

Sour cream, another common acid, is used to make tangy sauces for fish, vegetables, and salads. Can you guess why it is sour? The acids in many kinds of foods are produced by bacteria. Bacteria are tiny plants which can be seen only through a microscope. Bacteria are added to milk to make it sour or thicken. Solids are formed in the milk, then are made into sour cream or cheese.



Acids really make a meal enjoyable. Tangy dill pickles, sauces, and salad dressings which contain acids provide a mouth-watering treat when added to meals.

1.05 Both plants and people drink ________

__________________________ .

1.06 The sun helps people to ________

__________________________ tall.

1.07 God made the sun to ____________

__________________________ .

1.08 People and plants are ____________

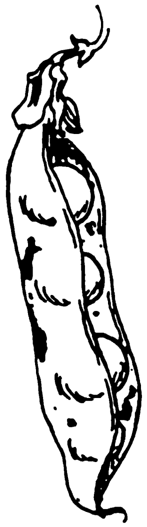
____________________ in many ways.

6/8

My score ______

Teacher check ______________
Initial Date

II. HOW PLANTS ARE THE SAME



God has made many kinds of plants.
Some plants look alike,
but many plants look different.
Plants are the same in many ways
even if they look different.

Most plants grow from seeds.
Roots from the seeds go into the ground.
Stems grow out of the ground
from the seeds.
Plants have leaves
that grow out from the stems.
Plants can have flowers.
Flowers can make seeds.
Then new plants can grow from the seeds.

You are going to study each part of a plant.
228

WORDS TO STUDY

blossom	(blos som)	A flower.
bud		The part of a plant that has the new growth for next year.
main		Most important.
ripe		Ready to eat.
root		The part of a plant that is in the ground.
shiny	(shin y)	Bright.
stem		The part of a plant that holds up flowers or leaves.
sunshine	(sun shine)	The light given off by the sun.
toothpick	(tooth pick)	A small, pointed wooden stick.
tube		Anything long and round with an empty inside.
vein		A tube used to carry something inside from one place to another.

Ask your teacher to say these words with you.

Teacher check ______________
Initial Date

Science LIFEPAC 202
Alpha Omega Publications
P.O. Box 3153 Tempe, AZ 85281

Answer these questions.

1.18 What are the four large bodies that make up the solar system?

a. ____________________ c. ____________________

b. ____________________ d. ____________________

1.19 What are the smaller objects in the solar system called?

a. ____________________ c. ____________________

b. ____________________

1.20 If a boy weighs 60 pounds on earth, how much would he weigh on the moon? ______________

EARTH

Plants, animals, and man depend on God's wonderful creation and each other for life. In this part of your LIFEPAC, you will review the structure of plants and how plants function. You will recall that the five important parts of plants are the roots, stems, leaves, flowers, and fruit.

Animals, too, are an important part of God's creation. You will recall how wonderfully animals are made. Animals can travel long distances by walking, running, flying, or swimming. Each animal is suited for living in the community where he has been placed. Animals eat and digest many different types of food. They breathe by means of lungs, gills, and pores. You will also review in this LIFEPAC something about the actions of mammals, fish, birds, and insects. You will also recall how animals are provided for and protected by God and man.

Plants. When God created the earth, He created both nonliving and living things. Plants are living things. Like all of God's creation, plants were made by design. They serve many purposes in the world. Individual plants have parts that make up their total structure. Those parts, the roots, stems, leaves, flowers, and fruit, are necessary for the plants to live, grow and reproduce.

You remember that all living things need air, light, water, and food. Before God put plants on the earth, He placed all the necessary things on the earth to help plants grow. He made each part of the plant with something special to do.

The roots of a plant reach into the earth's soil to drink up the water and

take up minerals. The water and minerals move up through the stem to feed the leaves, the buds, and the flowers.

From the air the green leaves take carbon dioxide. Light from the sun shines upon the leaves. The carbon dioxide gas combines with the water in the leaves. By the process of **photosynthesis**, the leaves put all these elements together to make food.

Some plants, such as beets and carrots, store their food in their roots. Other plants store food in their stems (celery) or in their fruit (apple and orange trees). In addition to food, some plants are used for shelter and enjoyment.

Plants also have another very important use. They breathe in some of the carbon dioxide that man and animals exhale. The plants then give off oxygen into the air. This process keeps both animals and humans alive. It keeps a balance of fresh air in our natural surroundings.

Leaves drop to the ground and decay or rot. Decaying leaves put minerals back in the soil. The plant, the leaf, the wind, the animals, and decay all work together to keep life going. This process is called the *decay cycle*.

Write *true* **or** *false.*

1.21 ________ Plants take only oxygen from the air to make food.

1.22 ________ Plants need air, light, water, and food to grow.

1.23 ________ The stems and leaves of carrots are storehouses for the food they make.

1.24 ________ Plants take up minerals from the soil.

1.25 ________ Each part of a plant has something special to do.

Answer these questions.

1.26 What are the five important parts of a plant?

a. ____________ d. ____________

b. ____________ e. ____________

c. ____________

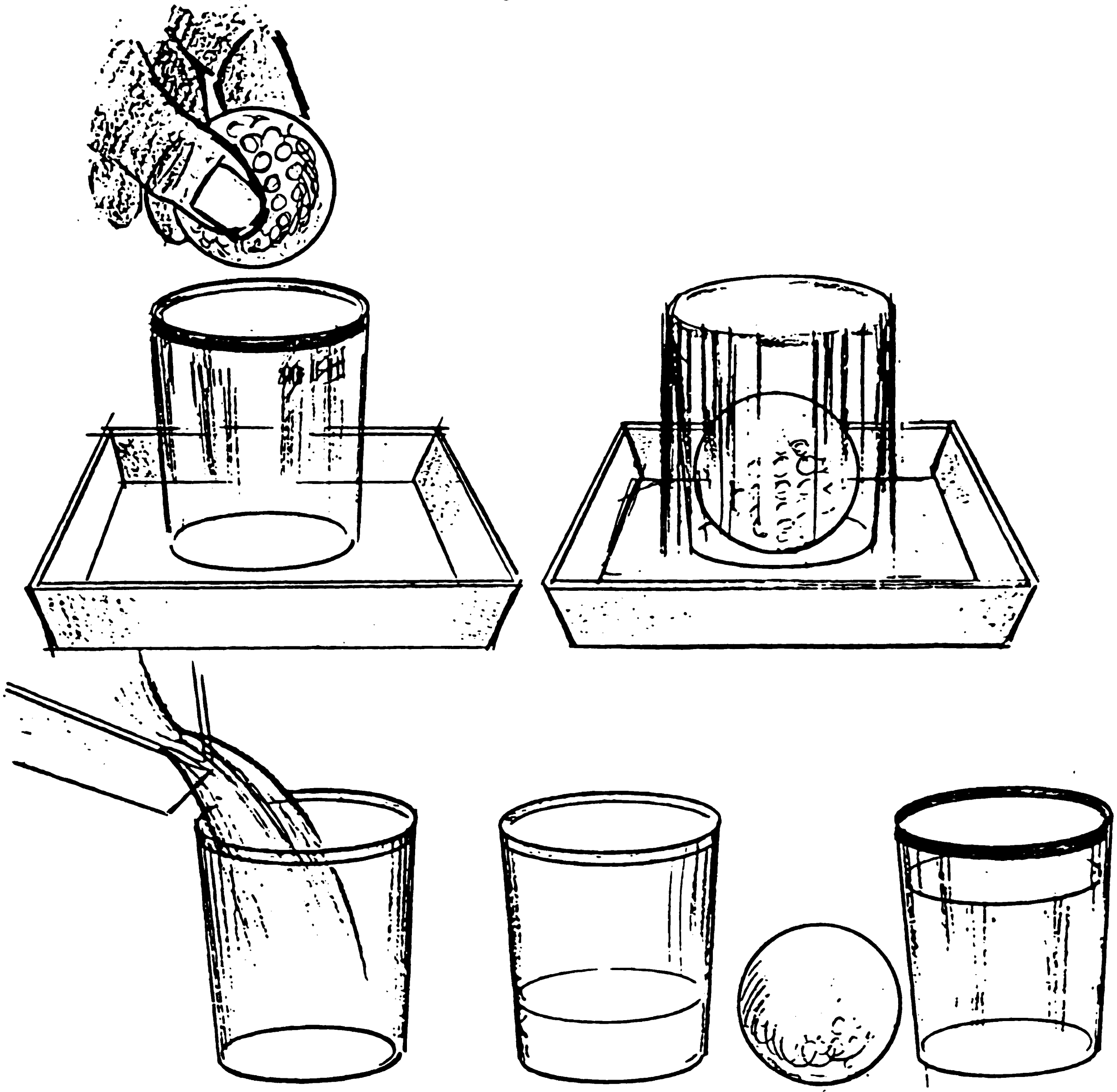
1.27 What are two important uses of plants?

a. ____________ b. ____________

____________ ____________

SCIENCE for Christian Schools: Grade2
Bob Jones University Press, Inc.
Greenville, South Carolina 29614

Solids fill space. What do you think this means?



Something you can do

Fill a glass of water and set it in a pan. Place a golf ball in the filled glass. Pour the overflowed water from the pan into another glass. Take the ball out of the glass. What do you observe?

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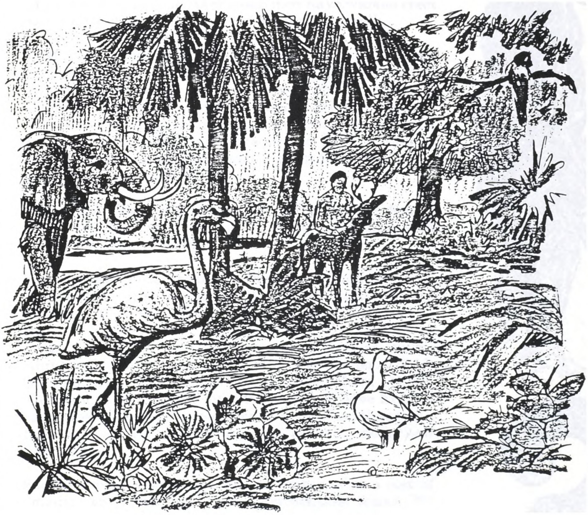
Living Things



The Bible tells us that God created life on the earth. All the living things that are now on the earth came from what God created in the beginning.

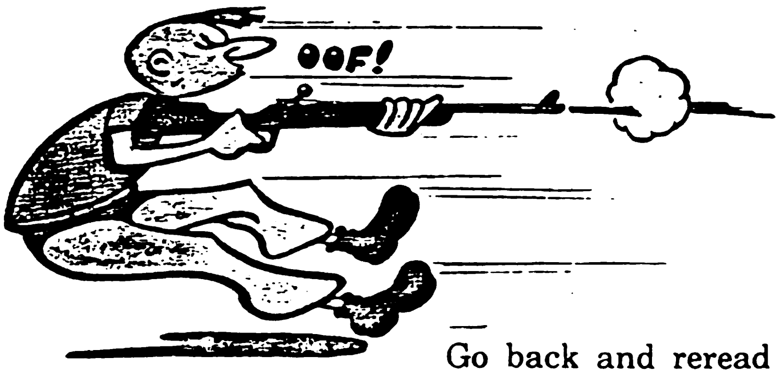
this as evidence that early man shuffled along, hunched over like the apes. More thorough examination of the Neanderthal man showed he suffered from arthritis. His stooped appearance was normal for a man of his age with this bone disease. The other fossil men have walked erect as we do, but artists still favor the ape-like walk.

small head At one time scientists thought that a person's brain size indicated how smart he was. They have since learned this is usually not true. Because no one knows the actual brain size of most early men (usually only pieces of skull were found) artists have chosen to draw men with a small brain and large jaw—like an ape! In fact, some of the Cro-Magnon men have a *larger* brain capacity in their skull than does modern man.

stupid look There is no evidence for this, only the ideas of the artist. We cannot tell what the muscles and skin looked like from the bones.

live in a cave Fossil remains have been found in caves. This is not surprising since the Bible tells us that Lot lived in a cave (Genesis 19:30). David and his men lived in caves (I Samuel 22:1; 24:1-13). It was the custom in ancient times for people to bury their dead in caves. Abraham's family was buried in a cave (Genesis 23:17-20). Lazarus was buried in a cave (John 11:38). Throughout history and even today people have lived in caves. Because *some* people lived in caves, does that mean that *everyone* did? No, some people probably built their own shelter.

huddle around a small fire Fire is spoken of as a sort of "magic" early man must have accidentally found. We know from the Bible that long before Noah, Tubal-cain was a worker in metal (Genesis 4:22). He had to have a thorough knowledge of fire and know some chemistry to do this. Occasionally someone will find some object made of metal or pottery that is buried so far underground we conclude that it must date to these people who lived before the great Flood. Because fire is used in making metal and most pottery, we know that some early men knew a lot about fire.

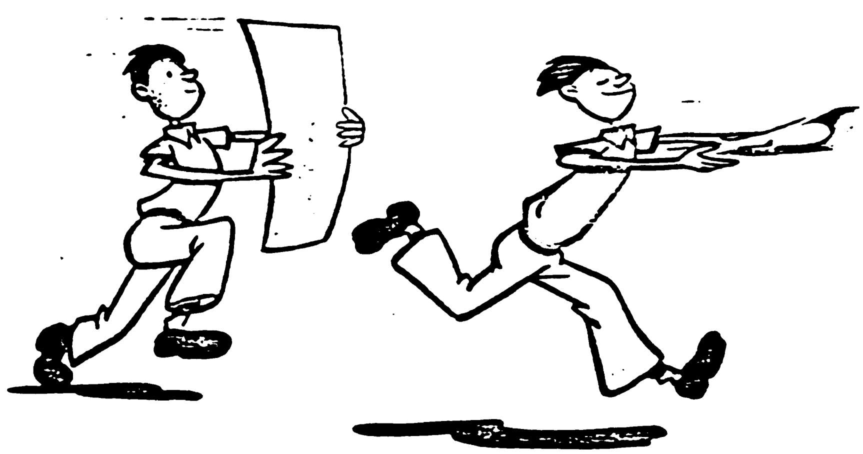


Go back and reread Newton's third law of motion. What was the action in the activities? What was the reaction?

Drag

Drag is a problem for aircraft designers. If an airplane has too much drag, a bigger engine will be needed for extra thrust. The bigger engine will weigh more and require extra lift. We have already learned that the more lift there is, the greater the drag will be. The best solution is to get rid of any unnecessary drag.

Activity 9: Get a large piece of stiff cardboard. Hold it in front of you and run into the wind. Get another piece of cardboard that can be bent and form it into a shape similar to the loop you made for the activity of page 171. Run into the wind holding this in front of you. Do you notice any difference in the "drag" as you run? Repeat these activities running at different speeds. Do you notice there is more drag when you run faster?



ACTIVITY 5

X-tra X-ercise for X-ceptional X-perts

235

Pretend that you are Noah and you are keeping a diary about the events of the Flood. Below are some months and days on which the Bible says things happened. Some dates have stars in front of them. We don't know exactly what happened on those days, but put down what may have happened. We don't know the names of the months so we will just call them Month 1, Month 2, etc. Write down what you think Noah would have written in his daily diary.

*Month 1 Day 30 — Believe it or not, I am nearly finished with the ark! There have been days I thought I'd never get done. But today I put up the and

Month 2 Day 10
Genesis 7:1-5 — God spoke again today. He gave me the big news and important instructions. He told me to

Month 2 Day 17
Genesis 7:11 — Well – today it started!

*Month 2 Day 30 — This is something else! For two weeks now it's been raining, pouring, and gushing.

Month 3 Day 27
Genesis 7:12 — It's been raining for . And today the rain actually . Just like that. I'll tell you, after hearing rain on the roof for nights, it surely seems .

*Month 4 Day 27

Today I tried to catch up on some work around here. Really, running this ark is no small task. Every day I have to

Month 7 Day 17
Genesis 8:4

Thumpety - crunch!

Month 10 Day 1
Genesis 8:5

Today, we truly saw something besides water.

Month 11 Day 11
Genesis 8:6-9

Today I opened a window! Fresh air! Did that ever seem good!

Creation and Providence
Student activity booklet F-1

National Union of Christian Schools,
now Christian Schools International
Grand Rapids, Mich. 49508

Month 11 Day 18
Genesis 8:10
and 11

Month 11 Day 25
Genesis 8:12

We learned something exciting today.

Month 1 Day 1
Genesis 8:13

Month 2 Day 27
Genesis 8:14-19

packet of seeds
tree cards

Trees; reading God's World
CSI Publications

Comparing how seeds travel.

Which seed would the wind move?
a. acorn b. cherry c. maple d. walnut

11 THE GREAT ESCAPE

In Lesson 9 you listed the ways people use trees. God made trees for people to use. Enough new trees should grow to take the place of the ones that die or are cut down. People can plant new trees, but trees must make the seeds to start new trees.

God made all living things to *reproduce,* or make more of themselves. Trees reproduce by making seeds. But seeds must get to places with the right conditions in order to grow. They need good soil and the right amount of light and water.

How do seeds travel to places with the proper conditions for growth? Different seeds travel in different ways. Some seeds are carried by the wind. Other seeds are carried on animals, people's clothing or in animals' mouths. Still others are eaten by birds and those seeds pass right through the animal's digestive system and can be dropped on the ground many miles from their tree. There are even seeds that are hollow inside and can float.

You can often tell how a seed gets away from its tree by looking at it. Take out the seeds you collected in chapter 3. Spread the out on the top of your desk.

Look closely at each seed. Cut open the fruit to get its seeds. Decide how each seed escapes from its tree. Group the seeds according to the way they travel.

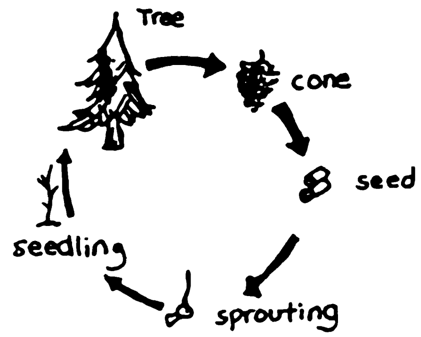
Make a chart like this in your record book:

By Wind	By People or Animals		By Water
	Outside	Inside (Eaten)	

Draw each seed in the proper space. Leave some room below each drawing.

1. How are the seeds that travel by wind different from the others?
2. Write down other differences between the seeds.
3. Do you know what trees any of these seeds come from? Write the names of the trees in the space you left in your chart.

Group the tree cards from the back of the book by the way their seeds travel. List those in each group.



Trees reproduce in different ways. They use different kinds of fruits and seeds. God allows each kind of tree to grow on the earth. We glorify God by the way we use trees and care for them.

Choice 11a CATCHING ESCAPEES

Dropped, eaten, blown away—seeds escape from trees in strange ways. Some of the fruits they escape in are even stranger! Let's capture some of them.

A fruit is not just something you eat. All the material around a seed is fruit. Collect as many different fruits as you can find.

Keep your collection going. You can find different fruits at different times of the year. Some fruits drop in the spring. Others drop in the summer or fall.

Some fruit may rot. A fruit like an apple or cherry will rot in a short time. Cut this kind of fruit in half. Then take out the seeds. Let them dry. Fruits like walnuts and acorns will not rot very quickly.

Draw a picture of each fruit. Keep the fruit and the seeds in your collection. The fruit and the tree it comes from usually have the same name. Find the name of the fruit. Use your tree cards or other books to help you find its name. Write it under your drawing.

National Union of Christian Schools,
now Christian Schools International
Grand Rapids, Mich. 49508

Appendix B

SURVEY SOLICITATION EXAMPLES AND DATA ENCODING VARIABLES

Nov. 1, 1980

Dear Administrator,

This is a request for your help in improving the quality of science teaching in Christian Schools.

As a part of my doctoral studies, I will be sending to participating schools copies of a survey instrument designed to provide a basis for improving science textbooks, developing effective science activities, and assisting classroom teachers. The survey will involve the elementary school principal and two teachers he will select.

Survey forms and information will be sent to participating schools in February, 1981. It is estimated that completing the survey forms will take less than one hour of your time.

If you will assist me in this study, please return this sheet with the information requested below.

Your assistance is appreciated,

Charles A. Joss

Charles A. Joss
Professor of Science Education
Bob Jones University

name of your school: ______________________________

school address: ______________________________

name of administrator: ______________________________

February 5, 1981

Dear Christian School Administrator,

A few weeks ago I received from your school a confirmation of your willingness to take part in a SURVEY OF SCIENCE TEACHING PRACTICES IN CHRISTIAN ELEMENTARY SCHOOLS. Thank you for saying "yes" to assisting me in this effort.

This project will establish a data base of information concerning science curriculum and instructional practices in Christian Schools. To the best of my knowledge a study of this type that involves a nation-wide geographic sampling of over 5300 Christian Schools has not been attempted before. (Please let me know if there is a similar study available.) The opportunity to develop improved curriculum materials and responsive teacher training programs will come as a result of the cooperation you and others provide in completing these questionnaires. The next few minutes of your time are very important to insure proper follow-through.

HOW TO PROCEED WITH THE SURVEY FORMS:

1. Select a teacher of grades 1, 2, or 3 and a different teacher of grades 4, 5, or 6 who will be able to provide the most accurate information on the questionnaires.

2. Discuss with the teachers the importance of the information in relation to improving science teaching in the Christian Elementary School. Let them know that the information is confidential and will be treated by normal statistical procedures that insure anonymity along with all the other schools participating in this study.

3. Set a reasonable deadline for the completion of their part (about one week or less) and collect the two questionnaires from the teachers.

4. Complete the Principal's form.

5. Mail the three forms in the stamped envelope provided for this purpose. The number appearing on the forms is the only identification required.

I am looking forward to hearing from you as one very important part of this project. Upon the receipt of your school's three completed survey forms (before my data processing deadline on March 5) I will send to you a copy of one of the Bob Jones University publications dealing with <u>Christian Philosophy of Education</u> or <u>Teaching Methodology</u>. Your exercise of good stewardship in making a prompt reply will avoid the expense of additional postage and data handling delays.

Sincerely yours in His service,

Charles A. Joss

Charles A. Joss
Professor of Science Education
Bob Jones University

Dear Christian School Administrator,

This is a request for your help in improving the quality of Science teaching in Christian Schools.

As a part of my Doctoral studies, I will be sending to participating schools a survey instrument designed to provide a basis for improving Science textbooks, Science activities, and assisting classroom teachers. The survey will involve the elementary school principal and two teachers whom he will select.

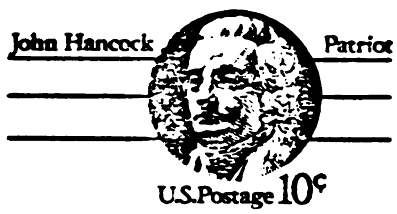
Survey forms and information will be sent to participating schools in February, 1981. It is estimated that completing the survey forms will take about a half hour of your time. A gift pamphlet will be mailed upon receipt of the completed forms.

If you will assist me in this important study, please sign and return the self-addressed portion of the post card.

Your assistance is appreciated,

Charles A. Joss

Professor of Science Education
Bob Jones University



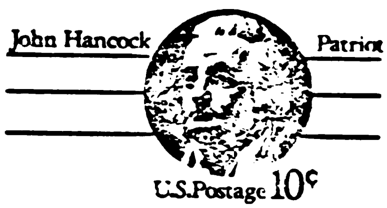
CHARLES A. JOSS
405 Collegiate Curve
GREENVILLE, SOUTH CAROLINA
29609

○ Yes, I will be able to help you.

○ No, I won't be able to help you.

(signature)

~~00029~~



Coding for Christian School Survey Data

PRINCIPALS' RESPONSES

Variable	label	Values	Column
	Geographic area	2=Great Lakes 3=Far West 4=New England 5=Mid East 6=Southwest 7=Rocky Mtns. 8=Plains 9=Southeast	1
	School identification in area		2, 3
	Respondent	1=Principal 2=Superintendent 3=Pastor 4=Other ministerial 5=Teacher/Supervisor 6=Principal-Pastor comb. 7=Teacher/Administrator 8=Teacher 1, 2, or 3 9=Teacher 4, 5, or 6	4
1	School organization type	1=Part of local church 2=Several local churches, independent 3=Denominational affiliation 4=Not church-related	5
2	Years in operation		6,7
3-9	Enrollment of school by grades	Kindergarten	8,9
		First grade	10,11
		Second grade	12,13
		Third grade	14,15
		Fourth grade	16,17
		Fifth grade	18,19
		Sixth grade	20,21
10	Number of other schools 10 miles	0=none 1=1 school, etc., through 8 9=9 or more schools within 10-mile radius	22

11	Number of miles to public science facility (museum, planetarium, etc.)	0=less than 6 miles 1=6 to 10 miles 2=11 to 15 miles 3=16 to 20 miles 4=21 to 25 miles 5=26 to 30 miles 6=31 to 35 miles 7=36 to 40 miles 8=41 to 45 miles 9=46 or more miles	23
12	Population of school's city	1=under 1,000 2=1,001 to 5,000 3=5,001 to 25,000 4=25,001 to 50,000 5=50,001 to 100,000 6=100,000 and up	24
13-19	Grade levels teaching science	0=science is not taught at grade level 1=science is taught at grade level	Grades K=25 1=26 2=27 3=28 4=29 5=30 6=31
20-26	Frequency of science teaching at specified grade level	0=1 day per week for half year 1=2 days per week for half year 2=3 days per week for half year 3=4 days per week for half year 4=5 days per week for half year 5=1 day per week for full year 6=2 days per week for full year 7=3 days per week for full year 8=4 days per week for full year 9=5 days per week for full year	Grades K=32 1=33 2=34 3=35 4=36 5=37 6=38
27-32	Number of minutes of science instruction required	0=none 1=1 to 30 minutes 2=31 to 60 minutes 3=61 to 90 minutes	Grades 1=39 2=40 3=41 4=42

		4=91 to 120 minutes	5=43
		5=121 to 150 minutes	6=44
		6=151 to 180 minutes	
		7=181 to 210 minutes	
		8=211 to 240 minutes	
		9=241 and up minutes	
33	Pattern of departmentalization	0=not departmentalized for science instruction	45
		1=all grades are departmentalized	
		2=grades 2 through 6 are departmentalized	
		3=grades 3 through 6 are departmentalized	
		4=grades 4 through 6 are departmentalized	
		5=grades 5 through 6 are departmentalized	
		6=grade 6 is only grade departmentalized	
		7=selected upper elementary grades are departmentalized	
		8=selected lower elementary grades are departmentalized	
		9=departmentalization is carpricious	
34-38	Number of teachers ranked		
	SUPERIOR	(9=9 or more teachers)	46
	GOOD	"	47
	FAIR	"	48
	POOR	"	49
	NO PREPARATION TO TEACH SCI.	"	50
39	Number of teachers on faculty K-6		51,52
40	Science consultant status	0=no consultant	53
		1=teacher in grades K-6, formal	
		2=teacher in grades 7-12 formal	
		3=teacher in grades K-6, informal	
		4=principal, administrator, supervisor	
		5=someone outside organization	
		6=multiple responses	
		7=teacher in grades 7-12, informal	

			Grades
41-47	Science textbook adoption status	0=no textbook series adopted 1=a single textbook series is adopted 2=two or more textbook series are adopted	K=54 1=55 2=56 3=57 4=58 5=59 6=60
48	Science textbook publishers	1=Accelerated Christian Education 2=Addison Wesley 3=Alpha Omega 4=Benefic Press 5=Bob Jones Press 6=California State Series 7=Cambridge Press 8=Charles E. Merrill 9=Christian Schools International 10=D.C. Heath 11=Beka Books 12=Grolier Press 13=Harcourt-Brace-Jovanovich 14=Harper & Row 15=Holt, Rinehart & Winston 16=Houghton-Mifflin 17=Jack Huston 18=Laidlaw 19=MacMillan 20=Millikin 21=National Union of Christian Schools 22=Rand McNally 23=Rod and Staff 24=Scott Foresman 25=Silver Burdett 26=Steck-Vaughn 27=A.O.P. Science Series	61,62
			Grades
49-55	Room type for science	1=regular classroom, no facilities 2=regular classroom, temporary/portable facilities 3=regular classroom, special facilities 4=special room for science 5=other	K=63 1=64 2=65 3=66 4=67 5=68 6=69

56	Supplies for grades 1 to 3 (Administrator's opinion)	1=completely lacking 2=inadequate 3=adequate 4=good 5=very good	70
57	Supplies for grades 4 to 6 (Administrator's opinion)	(same code as 56)	71
58	Eqiupment for grades 1 to 3 (Administrator's opinion)	(same code as 56)	72
59	Equipment for grades 4 to 6 (Administrator's opinion)	(same code as 56)	73
60	Dollar estimate for science equipment and supplies for school year '80-'81	four digit (0=specified "none"; blank = "not given")	74 through 77
	Suggestions for improving the quality of science instruction (Administrator's opinion)	0=awareness of priorities of science instruction 1=text, reading materials 2=curriculum improvement 3=time for teaching or schedule problems	78
61	First reason given	4=need for expert help and/or workshops 5=equipment and/or supplies deficient or handled better 6=room for science, special lab area in school 7=audio-visual methods and materials incl. "hands-on," trips 8=teacher preparation in colleges and universities 9=affective areas incl. enthusiasm, dedication, need for science	

62	Second reason given	(same code as above for first reason)	79
63	Third reason given	(same code as above for first reason)	80

Coding for Christian School Survey Data

TEACHERS' RESPONSES

Variable	label	Values	Column
	Geographic area	2=Great Lakes 3=Far West 4=New England 5=Mid East 6=Southwest 7=Rocky Mtns. 8=Plains 9=Southeast	1
	School number in geographic area		2,3
	Respondent identification	8=teacher of grades 1, 2, or 3 9=teacher of grades 4, 5, or 6	4
1	Number of years teaching		5,6
2	Employment status	1=full time 2=part time	7
3	Degree attained (highest)	0=non-degree 1=BA/BS 2=MA/MS 3=PhD/EdD 4=a theological degree 5=honorary 6=other	8
4	Sex	1=female 2=male	9
5	Number of semester hours science		10,11
6	Number of quarter hours science		12,13
7	Graduate of Christian school	0=no, 1=yes	14
8	Christian school identification	(code list 1 through 99)	15,16
9	Status of state certification	0=no, 1=yes, 2=yes for state of current employment	17

10	State of current employment	(alphabetical list 1-51, incl. D.C.)	18,19
11	Status of Christian school certification	0=no 1=American Assoc. of Christian Schools 2=American Christian Schools International 3=C.E.A. 4=C.S.O. 5=A.C.E.A. 6=A.C.E. 7=a local state assoc. of Christian schools 8=not specified (marked only "yes") 9=membership in more than one organization	20
12	Number of students enrolled in first class		21,22
13	Grade level of class in variable 12	1=first grade 2=second grade 3=third grade 4=fourth grade 5=fifth grade 6=sixth grade 7=combination of lower and upper grades (1-6) 8=combination of lower grades (1, 2, 3) 9=combination of upper grades (4, 5, 6)	23
14	Number of minutes of science/wk. for class in variable 12		24,25,26
15	Number of weeks per year science for class in variable 12		27,28
16	Grade level of class #2 specified in variable 17 (code as in variable 13 above)		29
17	Number of students enrolled in second class		30,31
	empty column		32

18	Science teaching schedule for Mon.	1=before lunch	33
19	Science teaching schedule for Tues.	2=after lunch	34
20	Science teaching schedule for Wed.	3=variable	35
21	Science teaching schedule for Thurs.	4=before lunch and after lunch	36
22	Science teaching schedule for Fri.		37
23	Textbook(s) used for/by students	(coded list same as Principal's Survey)	38,39
24	Supplies' adequacy	1=completely lacking 2=inadequate 3=adequate 4=good 5=very good	40
25	Equipment adequacy	1=completely lacking 2=inadequate 3=adequate 4=good 5=very good	41
26	Percent annual instruction time for "hands-on" experiences for students	0=0% 1=25% or less 2=25 to 50% 3=50 to 75% 4=75% or more	42
	Science topic:		
27	HEALTH	1=is taught with own science	43
28	CAREERS	2=is taught with other subject by self	44
29	CREATION/EVOL.	3=is taught at another grade level by some-one else	45
30	OUTDOOR ED.	4=is not taught in school curriculum	46
31	CONSERVATION	5=combination of responses 1 and 2 above	47
32	SAFETY		48
33	DRUG ABUSE		49
34	METRIC SYSTEM		50
35	Attendance at in-service event	0=no, 1=yes	51

	Frequency of use of teaching tools		
36	MOTION PICTURE PROJECTOR	0=not available for teacher's use	52
37	SLIDE PROJECTOR	1=available but is	53
38	OVERHEAD PROJECTOR	not used for science	54
39	TAPE/RECORD PLAYER	2=used 1-2 times per	55
40	TV/VIDEO EQUIP.	year for science	56
41	CHARTS/MODELS	3=used 2-4 times per	57
42	BULLETIN BOARDS	semester for science	58
43	FLANNEL BOARD	4=used 1-3 times per	59
44	MICROSCOPE	month for science	60
45	SCIENCE PICTURE SET	5=used 1-2 times per week for science	61
		6=used more than twice per week for science	
46	First choice teaching method	1=science demonstration	62
		2=in-class written work	
		3=individual lab activities	
47	Second choice teaching method	4=group lab activites	
		5=individualized studies	
		6=projected visuals	
		7=lecture/discussion/ question-answer	
		8=field trips	
48	Third choice teaching method	9=programmed instruction	
	Opinion scale of teaching factors		
49	ROOM FACILITIES	1=inhibits greatly	65
50	SUPPLIES/EQUIP. for science	2=inhibits somewhat	66
		3=neutral	
51	CLASS SIZE	4=enhances somewhat	67
52	SCIENCE CONSULTANT	5=enhances greatly	68
53	TIME TO TEACH		69
54	PREPARATION TIME		70
55	KNOWLEDGE OF SCIENCE		71
56	IN-SERVICE/WORKSHOPS		72
57	OWN INTEREST IN SCIENCE		73
58	SCIENCE PRIORITY IN SCHOOL		74
59	TEACHER SATISFACTION SCALE	1=very dissatisfied	75
		2=dissatisfied	
		3=neutral	

	TEACHER SATISFACTION SCALE (continued)	4=satisfied 5=very satisfied	
60	First suggestion to improve science	0=awareness of priorities for science	76
61	Second suggestion to improve science	1=textbook, reading materials	77
62	Third suggestion to improve science	2=curriculum improvement	78
		3=time for teaching or schedule problems	
		4=need for expert help and/or workshops	
		5=equip./supplies deficient or better organized	
		6=room for science, special lab area	
		7=AV methods/materials incl. "hand-on"; trips	
		8=teacher preparation in colleges	
		9=affective; enthusiasm, dedication, interest	

Appendix C

IDENTIFICATION OF SOURCES FOR QUESTIONNAIRE ITEMS

Identification of Sources Employed in the Derivation of Individual Items on the Questionnaires (see code below)*

PRINCIPAL'S QUESTIONNAIRE

General Information	1*	2*	3*	4*
1. position of administrator		A*		
2. mode of school organizational authority			B*	+
3. affirmation of doctrinal position				+
4. years school in operation				+
5. school enrollment by grades K-6	A*	B*	C*	
6. a) estimate of number of other Christian schools in 10-mile radius				+
6. b) estimate of number of miles to nearest public science facility				+
7. estimate of population of city in school's address			C*	
School Organization for Teaching Science				
8. proportion of school year and days per week science is taught	A*	B*		
9. minimum number of minutes required for science instruction	D*			
10. departmentalization for science teaching	A*		B*	
Instructional Personnel				
11. number of classroom teachers K-6 full, part time		B*		
12. total number of teachers who teach science		B*		
13. administrative evaluation of teachers' preparation to teach science				+
14. status of availability of science consultant assistance			AB*	

PRINCIPAL'S QUESTIONNAIRE (continued)

Science Teaching Resources and Materials	1*	2*	3*	4*
15. textbook adoption practices	AB*			
16. title and publisher of textbooks employed in school for science		C*		
17. frequency of room type for science instruction		B*	A*	
18. status of availability of supplies and equipment for science		A*	B*	
20. administrator's opinion of means for improvement of science instruction				+

*A = Blackwood, 1961
*B = Howe, et al., 1971
*C = Weiss, 1977
*D = Fitch/Fisher

*1 = adopted in toto
*2 = appropriated substantially
*3 = adapted
*4 = unique

Identification of Sources Employed in the Derivation of Individual Items on the Questionnaires (see code below)*

TEACHER'S QUESTIONNAIRE

Background Information	1*	2*	3*	4*
1. number of years teaching experience		C*	B*	
2. basis employed: full, part time	B*			
3. degree status			BC*	
4. sex: female, male			BC*	
5. number of hours (semester/quarter hours) of college science + science methods		B*		
6. identification of undergraduate Christian college, university				+
7. status of state teaching certification				+
8. status of Christian school certification				+
9. a) science class enrollment for each science class taught		BC*		
9. b) grade level of each science class taught in #9a above		BC*		
9. c) number of minutes per week for teaching class in science		BC*		
9. d) number of weeks per year for science teaching each class			B*	
10. schedule for teaching science; before lunch, after lunch, variable				+
Teaching Materials				
11. textbook title, publisher, date published, for grade level		BC*		
12. status of availability of supplies and equipment for science		B*	C*	
13. estimate of proportion of hands-on time in science instruction per year			C*	+
Selected Topics Taught in Science Curricula				
14. helath, science careers, creation/evolution, outdoor education, conservation/pollution, safety, drug abuse education, metric system		D*	C*	
15. in-service participation in science (frequency of)			B*	

TEACHER'S QUESTIONNAIRE (continued)

Science-Teaching Methods and Equipment	1*	2*	3*	4*
16. extent of availability and frequency of use of teaching tools (audio-visuals)		B*	C*	
17. extent of employment of methods in science teaching		B*		
18. frequency ranking of preferred science teaching methods identified in #17 above			C*	
Science-Teaching Concerns				
19. ranking of effect of teaching factors in science teaching		D*	BC*	
20. opinion of teacher satisfaction with teaching science	B*			
21. teacher's opinion of means for improvement of science instruction				+

*A = Blackwood, 1961
*B = Howe, et al., 1971
*C = Weiss, 1977
*D = Fitch/Fisher

*1 = adaopted in toto
*2 = appropriated substantially
*3 = adapted
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Appendix D

STATE BREAKDOWNS OF SURVEY RESPONSE

Number of Schools
On List by States

Alabama	150	Montana	31
Alaska	36	Nebraska	18
Arizona	88	Nevada	14
Arkansas	53	New Hampshire	29
California	742	New Jersey	98
Colorado	60	New Mexico	18
Connecticut	27	New York	161
Delaware	22	North Carolina	183
District of Columbia	0	North Dakota	1
Florida	452	Ohio	301
Georgia	161	Oklahoma	66
Hawaii	29	Oregon	103
Idaho	21	Pennsylvania	291
Illinois	191	Rhode Island	6
Indiana	160	South Carolina	111
Iowa	58	South Dakota	13
Kansas	60	Tennessee	136
Kentucky	49	Texas	635
Louisiana	73	Utah	8
Maine	28	Vermont	13
Maryland	94	Virginia	168
Massachusetts	34	Washington	131
Michigan	260	West Virginia	42
Minnesota	90	Wisconsin	103
Mississippi	54	Wyoming	15
Missouri	83		

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