Confidence Factors in Performing Science Related Tasks Among Students in a Teacher Preparation Program

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LOYOLA UNIVERSITY CHICAGO

CONFIDENCE FACTORS IN PERFORMING SCIENCE RELATED TASKS AMONG STUDENTS IN A TEACHER PREPARATION PROGRAM

A THESIS SUBMITTED TO
THE FACULTY OF THE GRADUATE SCHOOL
IN CANDIDACY FOR THE DEGREE OF
MASTER OF ARTS

DEPARTMENT OF
CURRICULUM, INSTRUCTION AND EDUCATIONAL PSYCHOLOGY

BY
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Science and technology are powerful forces that shape life on earth. They have the potential to improve the world and make society more productive. Many of the difficulties humankind faces today can also be attributed to science and technology, or humanity's abuse of these entities. Science education needs to help solve these problems and fulfill the enormous potential, by ensuring that science and technology are used effectively, creatively and wisely.

Today, most American adults are not scientifically literate. According to one recent poll, one-half of the public did not know that the earth revolves around the sun once a year, and one-half mistakenly believed that early humans lived at the same time as the dinosaurs (CEDAR, 1993).

Of particular concern are the students now moving through the educational system and into young adulthood.
Since young children formulate their attitudes at an early age, elementary science education is crucial in developing positive feelings toward science (Jewett, 1993). "The teacher plays the central role in communicating the essence of science to children" (Estes, 1990). As a result, teachers who do not like science will likely have students who do not like science.

Therefore, the lack of time spent on science in elementary schools is a major concern. Manning, et al. (1981) reported in his survey that 25% of teachers spent no time at all teaching science, and the remaining 75% spent less than two hours per week on science. The result is that only a slim percentage of young people graduate with the knowledge, skills, and motivation that constitute scientific literacy, let alone the background to successfully tackle college science or pursue science-related careers.

The Rationale

Practitioners have offered a wide variety of explanations for why science does not receive the attention it warrants. Most seem to fall into four main categories:

1) Lack of teacher content knowledge.
2) Lack of materials and equipment.

3) Lack of instructional time.

4) Negative teacher attitude toward science.

These four reasons are interrelated but seem to hinge on content knowledge which aids in shaping teacher attitude (Pedersen and McCurdy, 1992). Poor attitudes toward science stonewall efforts teachers may make to overcome material and time constraints.

In view of their preparation, the lack of teacher confidence in instructing science is not surprising. Considering that most teachers teach how they were taught, a rather frightening circle of instruction seems to be self-perpetuating. How can this cycle be broken and teachers' attitudes toward science instruction be altered? Increased teacher confidence impacts the level of content knowledge and shapes attitude (Jewett, 1993). The most apparent solution seems to be for further exploration into the factors influencing the confidence teachers bring to their science teaching.

Statement of the Problem

Many past educational reform efforts have attempted to
improve the level of science education for today's students. The primary focus has ranged from curriculum improvement projects to the development of science learning standards. The emphasis of these efforts have been placed on increasing the level of achievement among children and improving the instructional practices of in-service teachers. Although these approaches have a great deal of value and have shown some success, they disregard one major population, "preservice" teacher education students.

The teachers of tomorrow are the teacher education students of today. The responsibility for preparing these new educators lies heavily on institutions of higher education. While most teacher training programs prepare secondary education majors to teach one main content area, they expect elementary education majors to graduate as "experts" in all areas. At most teacher education institutions, reading, writing and arithmetic are the main focuses (Finson and Beaver, 1994). However, science has become an integral part of our everyday lives and is continually increasing its impact on society. Consequently, science instruction must be given equal emphasis in the elementary curriculum. As a result, teacher preparation
programs must offer its students not only the strategies and techniques to transfer scientific knowledge to their future students, but a significant level of confidence in their ability to teach this content area.

**Purpose of the Study**

This study was designed to determine the factors which influence the degree of confidence among students in a teacher education program. Specifically, the study investigated whether confidence indicators in performing scientific literacy related tasks encompass factors originating from within the academic program or student background. Academic program factors included class standing, number of science courses completed, current enrollment in a science course and participation in a science education internship. Gender, age and ethnic origin composed student background.

The framework for this study included the *Illinois State Goals for Learning in Biological and Physical Sciences* (ISBE, 1985). The four *State Goals* provide perspective into science education and were written to reinforce the importance of concepts, processes and principles that help
students gather, organize and apply information in all areas of science. These goals and the learning outcomes associated with each are the standards set forth by the Illinois State Board of Education for elementary and secondary students attending public schools in Illinois. It should be expected then, that the future teachers of these students ought to meet and exceed this level of competency.
CHAPTER II

REVIEW OF RELATED LITERATURE

This chapter is divided into several sections which influence the topic of preservice science education. These elements include information on trends in science education, science education standards, and the influence of science teacher attitude.

Trends in Science Education

While science education is not new, current reform efforts differ from earlier reforms, especially those of the sixties in some very specific ways. The current science education reforms have a different social and economic context, are informed by a better understanding of how students learn, and have different goals for science education. Nevertheless, the commonalities are significant enough to begin with an historical background.

From 1955 until 1974, a "Golden Age of Science
Education" (Kyle, 1985) spawned a generation of science reforms based on discipline-specific studies, designed primarily by scientists to produce more scientists and engineers. These Sputnik era efforts provided students with first-hand experience and understanding of the science inquiry process to students in a call for excellence in education (Blosser, 1989; Klopfer and Champagne, 1990). Examples of the "new" elementary curricula created during this period were the Elementary Science Study (ESS), Science Curriculum Improvement Study (SCIS), and Science: A Process Approach (SAPA).

The 1970's were a time of major change in society and culture. These transformations spawned educational reforms with particular attention to middle school science (Kyle, 1985). The major theme in this round of science education was science literacy for all students (Koballa, 1985). Psychologists and educational specialists were more often seen working alongside research scientists in these endeavors, and teachers were given more of an active role in developing curriculum.

The innovations of this period included the "inservice" training of teachers and the adaptation of centrally
produced curricula to meet the needs of a specific location. Many of the materials were of a modular structure instead of a single textbook. Therefore, the content and sequence of science classes became more flexible. Teacher preparation focused on classroom management as well as on content. Many schools introduced their own innovative programs during the period. Because of the many localized curricula, it became impossible for evaluators to keep track of the changes in schools and it became increasingly difficult for teacher preparation programs to train new teachers to meet these changing needs. The result was a shortage of qualified science teachers (Bethel, 1985).

A meta-analysis of data from 105 studies compared the curricula characteristics of the pre-1955 period with the "new" post-1955 curricula based on measures of achievement, attitudes, laboratory skills, problem-solving, creativity, and skills in communicating, reading and mathematics (Kyle, 1985). This comparison and related work indicated that, based on these criteria, the "new" curricula had a positive impact on student outcomes. Despite the significant increases in student performance, most of these "Golden Age" reforms were abandoned because the teachers considered
science teaching too difficult, and the teachers were not confident in their ability to master the inquiry or discovery style of teaching necessary to use the programs (Hurd, 1986).

Extensive case studies of actual school practice indicated that teaching science as inquiry and other aspects of the reforms were not part of common school practice (Stake and Easley, 1978). The projects were found to be effective when used, but teachers were more hesitant to put them to practice than anticipated. This difficulty has been attributed to a lack of performance confidence resulting from insufficient training in methodology and science content among teachers.

Following the height of science education reforms, a series of projects identified new concerns with science education. These concerns centered around the need for science literacy among all students, rather than simply the development of a scientific elite as in the case of many "Golden Age" reforms. In a synthesis of several of these critiques entitled What research says to the Science Teacher, Harms and Yager (1981) made several strong recommendations for science education. These included more
attention to career education, science topics related to technology and social issues, and science with personal applications to students.

In creating new reforms, recent efforts pay more attention to the integration of science knowledge and constructivist approaches to learning and teaching. The leading examples of such endeavors are Project 2061 from AAAS (Rutherford and Ahlgren, 1990) and the Scope, Sequence and Coordination (SS&C) Project of NSTA (Aldridge, 1991). More recently, a new endeavor has been established under the National Academy of Sciences to extend such work and produce science education goals somewhat analogous to the NCTM Standards in mathematics.

These current reforms are being pursued in the midst of continuing concern about the state of American science education. Students perform poorly on tests, are thought to be inadequately prepared for college, and become part of a work force said to be increasingly poorly prepared for competition in the world marketplace. The numerical indicators of these conditions are numerous, diverse, and often quoted. One study set the percentage of scientifically literate Americans at only 6%, based on their
knowledge of the processes of science, identification of science concepts and terms, and their understanding of the impact of science on society (Darling-Hammond and Hudson, 1990). While jobs in the fields of science and engineering increased at a rate three times the national rate of employment, college enrollment in these fields declined.

The need for changes in science instruction is quite clear. In international studies of education performance in science and mathematics, Americans rank near the bottom, and presently there are few signs of improvement (Lapointe et al., 1989). The latest NAEP study found "that despite some small recent gains, the average performance of 17-year-olds in 1986 remains substantially lower than it had been in 1969". (Rutherford and Ahlgren, 1990) While computation skills are adequate, NAEP reports, performance in problem solving is far below standard. Other studies concur. In assessing the challenge, Science for All Americans cites the lack of teacher education and an emphasis on bits and pieces of information over understanding in context as some of the reasons for our shortfall in scientific literacy.

If we are looking at this situation from a perspective of giving each citizen a basic knowledge of science
(scientific literacy), and not from a perspective of generating more scientists, then curriculum reform is for all students. It is generally accepted that each citizen should be literate, be able to read and write, and possess other skills necessary to function in our society. Because of the important role of science and technology in today's world, this view of literacy must be expanded to include basic knowledge of science and technology in the area of science. This has become the predominant theme among researchers and science educators.

While philosophically there may be a commitment to equity-based science literacy for all, recent history suggests that gender equity and equity for minorities and the physically challenged in American science education have not been the case in practice (Oakes, 1990). To correct this situation the time for intervention is in elementary school. By the time students reach high school, most of their values, interests, and ideas are already formed. An interest in science must be generated while children are young and receptive to new ideas; they need to gain confidence by experiencing success in science. Then it may be possible for all students to see themselves in the role
of a scientist.

In many ways all of these recent reform efforts encompass much of the same philosophy. They are sensitive to the necessity of science literacy for all students. These reforms embrace the emerging views of constructivist learning. They develop the interdependency and interaction of science, technology and societal issues. Whether they fulfill their promise on these and other conceptions of a "new science education" remains to be seen.

The Goals of Scientific Literacy

Recent educational reforms have brought about a discussion of the goals for science education. Over time, the goals for science education have shifted from meeting the need to produce elite scientists to a call for science for all citizens. In the face of the "information age," goals reflecting current social conditions are emerging. As agreement among educators and researchers concerning the basis of science education develops, it is important for schools to be responsive to society and change their practices to reflect this consensus.

In examining some of the current goals of science
education, the findings of the National Science Teachers Association Project Synthesis are of particular importance (Harms, 1981). The purpose of the project was to examine the status of science education at the elementary level in the 1970's and to make recommendations regarding future science educational practices. For the purposes of the project, science education goals were divided into four broad categories. Goals regarding individuals' preparation to use science to improve their own lives and to live in an increasingly technological world were grouped under the category of Personal Needs. Goals pertaining to preparing citizens to deal responsibly with science-related social issues were grouped under the category of Social Issues. Goals pertaining to acquiring academic knowledge of science required by individuals likely to pursue science academically and professionally were included in the third category, Academic Preparation. Goals pertaining to the acquisition of knowledge and utilization of knowledge regarding the nature and scope of scientific and technological careers were included in the fourth category, Career Education. The desired state was then compared with the actual state of science education resulting in a
description that could be used as a basis for improvement.

The most striking finding of Project Synthesis was that goals that could be included within the third category, academic preparation, were almost the exclusive focus of science teaching in our schools (Harms, 1981). Goals pertaining to personal needs, societal issues, and career education were largely ignored in classrooms and in textbooks. Harms states that the reasons for this are grounded in common school practices, the influence of textbooks, and lack of teacher preparation. As a result, the practices of science education found in most classrooms today reflect the outdated goals of training an elite group of students to pursue science careers.

However, the leadership of science education as a profession has consistently worked to overcome this perception of science as an elitist subject. While there is no definite unanimity of form or content in the goal statements being presented by various groups and individuals who represent the leadership, there seems to be growing consensus. Consider for example, this statement by Paul Hurd about the goals of science education. He identifies four large purposes of science education:
1) sensitizing students to expect and anticipate change;

2) recognizing that the future of human beings and the quality of life are not capricious;

3) enhancing students' self-concept so that, as individuals, students can use knowledge of science to make decisions that can lead to a more desirable world; and

4) helping students to acquire capacities to cope with changes, as well as to shape changes (Hurd, 1972).

Hurd wants to see science taught as preparation for life in a changing world. More specifically, he wants schools to prepare children for life in a democratic society in a changing world.

Simpson and Anderson, in a breakthrough textbook intended to be used to better prepare university students to be teachers of science, offer one of the first descriptions of the "scientifically literate person." It states that a scientifically literate person:

1) has knowledge of the major concepts, principles,
laws, and theories of science and applies them in appropriate ways;

2) uses the processes of science in solving problems, making decisions, and in other suitable ways;

3) understands the nature of science and scientific enterprise;

4) understands the partnership of science and technology and its interaction with society;

5) has developed science-related skills that enable him or her to function effectively in careers, leisure activities, and other roles;

6) possesses attitudes and values that are in harmony with science and free society;

7) has developed interests that will lead to a richer and more satisfying life and a life that will include science and life long learning (Simpson and Anderson, 1981).

This description of the scientifically literate person can be easily converted to goal statements congruent with those of Hurd.

With the trend of science education moving toward scientific literacy, the need for goals which all students
should be expected to achieve must be set forth. The American Association for the Advancement of Science began Project 2061 with the intent to do just that. This multi-phase effort, which began in 1985, emphasizes scientific literacy for all students. In its initial phase, the project outlined what every American should know in order to be scientifically literate (Rutherford and Ahlgren, 1990).

The basic dimensions of scientific literacy as recommended by a national council of advisors to the project are:

1) being familiar with the natural world and recognizing both its diversity and its unity;
2) understanding key concepts and principles of science;
3) being aware of some of the important ways in which science, mathematics and technology depend upon one another
4) knowing that science, mathematics and technology are human enterprises and knowing what that implies about their strengths and limitations;
5) having a capacity for scientific ways of thinking;
6) using scientific knowledge and ways of thinking
for individual and social purposes (AAAS, 1989).

The current object of Project 2061 is to transform "what every American should know" to alternate curriculum models. Each local project site will use these same general principles as the basis for its own curriculum, independent of the other sites. The next phase will consist of the actual curriculum development and implementation.

Besides outlining what all citizens should know in order to be scientifically literate, Project 2061 also enters the realm of how they should know. A departure from the traditional structure of teaching is advocated in two ways:

1) The boundaries between traditional subjects should "be softened" and more emphasis placed on the connections among the science disciplines, and science, technology and society.

2) The amount of detail or fact learning should be considerably less. Emphasis should be placed on ideas and thinking skills with details used as an enhancement for understanding a general idea (AAAS, 1989).
Although Project 2061 calls for learning fewer facts, it also suggests more emphasis on topics which are not included in the traditional science curriculum. These include the nature of scientific enterprise; the relationship of science, mathematics and technology to each other and the social system; and the major conceptual themes that are common throughout all the sciences.

Along with the development of scientific literacy goals, and new curricular models, improving the teaching of science, mathematics and technology is a major step to success. Teaching should be based on learning principles that are derived from "systematic research and from well tested craft experience" (AAAS, 1989). In keeping with the spirit of scientific inquiry and scientific values, teaching should begin with questions dealing with phenomena, not answers to be memorized or learned. Students should engage in the use of hypothesis, and the collection and use of evidence. The instructional activities in the classroom should include designing investigations, using the processes of science, and engaging in hands-on experiences. Student creativity and curiosity should be encouraged and rewarded, and the students should work together as a team when
possible.

The project is built on a commitment to science for all students with the equality of opportunity for all groups. There is a dedication to a process of reform that is long-term and involves the many parties who have stake in the process. They are convinced that collaborative action is needed on many fronts; administrators, university faculty, community, business, political and labor leaders must work together with teachers, parents and students to make reform a reality.

In the spirit of collaboration espoused by AAAS at the national level, there are many state and local curriculum reform endeavors underway which reflect much of the same philosophy and practices described earlier. It is an activity which is encouraged by the presence of the larger national programs. The reform of state testing programs, for example, is clearly part of the national movement toward scientific literacy for all students.

In 1985, The School Code of Illinois was amended to include for the first time, a definition of schooling and a requirement that goals for learning be identified and assessed. The result of this reform package was the
development of state goals for the six fundamental areas which specify what students should know and be able to do as a consequence of schooling. Along with the formation of state goals, local school districts were required to establish a school improvement plan, develop local learning objectives which meet or exceed the state goals for learning. Assessment at both the district level and the statewide level were to be phased in over several years, giving rise to the Illinois Goal Assessment Program (IGAP).

State Goals for Learning and Sample Learning Objectives: Biological and Physical Sciences was developed by the Illinois State Board of Education (ISBE) to meet the needs of the increasingly technological society. In the preamble, science is defined and the rationale for the study of science is explained. For the students of Illinois, science is:

"the quest for objective truth. It provides a conceptual framework for the understanding of natural phenomena and their causes and effects. The purposes of the study of science are to develop students who are scientifically literate, recognize that science is not value-free, are capable of making ethical judgements regarding science and social issues, and understand that technological growth is an outcome of the scientific enterprise" (ISBE, 1986, p. 3).
In order to become scientifically literate, students in Illinois are expected to know and be able to do specific science-related tasks. The State Goals for learning are broadly stated expressions of the terminal goals for the educational process for all students.

As a result of their schooling, students will have a working knowledge of:

1) the concepts and basic vocabulary of biological, physical and environmental sciences and their application to life and work in contemporary technological society;

2) the social and environmental implications and limitations of technological development;

3) the principles of scientific research and their applications in simple research projects; and

4) the processes, techniques, methods, equipment and available technology of science (ISBE, 1986).

The elementary and secondary schooling of students in Illinois is expected to provide this educational basis, resulting in the mastery of the State Goals for Learning. The state is less interested in how or when the desired knowledge and skills are acquired than on the ultimate
results in each of the local school districts.

The State Goals for Learning were deliberately stated in general terms so that districts would have a large degree of latitude in developing instructional strategies and having their objectives reflect the local considerations. ISBE provided sample district level objectives which are consistent with the State Goals for Learning. The sample objectives identify the expectations for students in grades 3, 6, 8, 10 and 12. It is these sample objectives which provide the basis for the IGAP test items.

Goal one objectives describe how fundamental concepts and laws of science apply to physical and biological systems. The first goal investigates how two or more natural phenomena interact, their properties, the effect each has on the other, and the principles that bound their interaction. The application of scientific knowledge and skill to solve problems in a technological society are also components of the goal one objectives.

The relationship between science and technology are explored under goal two. These objectives explore how technology selectively affects renewable and nonrenewable natural resources, human society, natural ecology, and the
environment. The historical progress of science and technology are incorporated into the second goal. Values essential to design, conduct, recording and reporting scientific experiments are important under goal three. This goal also emphasizes the importance for all citizens to understand the rights of human subjects, humaneness with respect to the consequences of science and technology, and the respect for life. The steps necessary to conduct a simple experiment are identified as components of the third goal.

The fourth goal for learning places an emphasis on the processes of science including observation, prediction, classification and inference. Laboratory procedures involving measurement and scientific instruments are examined along with the processes of data analysis, interpretation and presentation as part of scientific inquiry.

The Illinois State Goals for Learning and the related objectives do not cover all possible cognitive levels and the learning sequences necessary for effective instruction. The learning objectives are not intended to reflect measures of student achievement or to prescribe instructional
methods. However, they represent a broad picture of the knowledge and skills students are required to display as a result of curricular and instructional designs established by the local school districts.

From a national reform level to local school curriculum development, science education programs are under considerable pressure for a change in the direction of the utilization of knowledge. Analyses of existing school practices reveal that discrete knowledge, in and of itself, continues to be the emphasis of most programs. While advocates of the past have urged that science course content be revised and updated, it is now the basic goals of science education that are now being reassessed. Using the interdependence of science and society as a frame of reference, the goals of science education can be reformulated to meet the needs of our changing society. The new scientific literacy-based curriculum would be a demonstration of the realization that scientific knowledge is made concrete when it influences career choices, helps to solve social problems, and results in a richer life for the individual. It is the mixture of goals for academic, personal, social and career applications, that appears to
Science Teacher Confidence and Attitude

Attitudes and perceptions about science are powerful motivators working for or against students and teachers in the classroom. According to Bishop (1989), students who enjoy science are more apt to do well and take advanced courses. Similarly, students who dislike or fear science and doubt their own competencies are more likely to do poorly and boycott science all together by late high school.

Negative attitudes about science are learned, not inherited. Any parent can describe the delight little children take in observing the world around them and experimenting with its limits. Yet somewhere in the elementary grades, these positive attitudes wither or find outlets aside from the subject in school called "science." A recent survey showed that by the end of third grade, almost half of the students stated that they would not like to take science, and by the end of the eighth grade, only one-fifth had positive attitudes toward science (Shrigley, 1991). Enthusiasm about science, and with it confidence, tends to diminish as students progress through school.
It has been shown that young students develop their attitudes at an early age, elementary school science is central in fostering and maintaining positive feelings toward science (Jewett, 1993). Since teachers play a crucial role in formulating science attitudes among children (Estes, 1990), teachers who do not like science will likely have students who do not like science.

As stated previously, the lack of time spent on science in elementary schools is a major concern. In a survey, Manning, et al. (1981) reported that 25% of teachers spent no time at all teaching science, and the remaining 75% taught science for less than two hours per week. The result is that only a small percentage of students graduate with the elements of scientific literacy, and even fewer the background to pursue science-related careers.

The rationales given by practitioners for why science does not receive the attention it warrants are many and varied. Most explanations seem to rest on the relationship between content knowledge and the shaping teacher attitude (Pedersen and McCurdy, 1992). Poor attitudes toward science hinder efforts teachers may make to overcome material and time constraints.
Research regarding science teaching across Illinois supports this relationship between content knowledge and attitude (Finson and Beaver, 1994; Finson and Fitch, 1993; Morey, 1990; Fitch and Fisher, 1979). In a comparison between teachers surveyed in 1975 and in 1993, Finson and Beaver found inadequate teacher preparation to be the primary deterrent for teachers to teach science. Those teachers indicating fewer numbers of college science courses also expressed a significantly lower level of confidence in their ability to teach science. Closer examination of the survey results indicates that elementary school teachers are not taking the National Science Teachers Association recommended minimum number of 12 science content hours.

In a 1992 study conducted of preservice teachers in their senior year, 119 reported having an average of 2.34 science courses in high school and 2.94 science courses in college (Jewett, 1993). This coursework consisted of 58% life science, 21% earth sciences, 13% physical science, and 8% general science. These results are supported by the findings of Finson and Beaver (1994), indicating that elementary school teachers are largely prepared only to teach the biological sciences, and express a great
discomfort with physical sciences. Estes (1990), too, concurs by stating that most people teaching elementary school today didn't study physical science in college at all, and they last dealt with basic chemistry and physics when in high school, possibly as long as thirty years ago. She continues to say that many people who ultimately major in elementary education did not study physical sciences even in high school, and they are "nervous about the subject."

There seems to be a strong relationship between the number of college science courses completed, the teacher's knowledge base and teacher confidence. Then why have so many elementary school teachers not been exposed to the science classes necessary to be an effective science teacher? Tobias (1990), while working with graduate students, found that many students competent in science chose not to pursue science studies for several reasons directly related to the way science is taught at the university level. These reasons include a patronizing teaching style in which many professors serve as "keeper of the information" rather than the facilitator of student learning; the sense of competition which precludes collective problem solving, intellectual discussion, and
involvement with the subject matter; the resulting sense of isolation or lack of community; and a test focus on mathematical detail with little or no integration of concepts to illustrate the "big picture."

These conditions are the ones under which most of today's teachers were trained in college science. In addition to serving as a view of the science discipline, the university style of teaching has also served as a model of science teaching being replicated in elementary and secondary classrooms. The concerns of Tobias's graduate students concerning their undergraduate science classes may also be the concerns of young children in their science classes. Modelling elementary and secondary science teaching after college practices may alienate a portion of the interested students, contribute to a continued exodus of students from science, and add to the misconception that science is for an elite few.

The lack of teacher confidence in instructing science is not surprising, in view of their preparation. A circle of instruction has begun, which is fueled by the fact that most teachers teach the way they were taught. Increased teacher confidence impacts the level of content knowledge and shapes
attitude (Jewett, 1993). The most apparent solution for breaking the cycle seems to be for further exploration into the factors influencing the confidence teachers will bring into their classroom from the preservice level.
CHAPTER III
METHODOLOGY

This chapter describes the basis for the methodology and procedures followed in this study and includes: research methodology; selection of subjects; design of the questionnaire; and collection and analysis of data.

Research Methodology

The study utilized a descriptive research approach. This type of research has as its purpose "to describe systematically the facts and characteristics of a given population or area of interest, factually and accurately" (Isaac and Michael, 1989).

A survey questionnaire was the method chosen to collect data for the study. Among the purposes for the descriptive approach using survey studies are: "to identify problems or justify current conditions and practices; to make comparisons and evaluation; to determine what others are
doing with similar problems or situations; and to benefit from their experience in making future plans and decisions" (Isaac and Michael, 1989). Survey research serves to provide description, explanation and exploration (Backstrom and Hursh-Cesar, 1981).

The questionnaire format has both advantages and disadvantages. According to Backstrom and Hursh-Cesar (1981), ease of use is the primary advantage and covers much ground in terms of cost, contacting subjects, data collection, and subjects' understanding and completion of the instrument. In addition, the format is consistent in its method of obtaining information. Isaac and Michael (1989) add that the questionnaire surveys are self-administering and may be anonymous. Limitations include problems with response rates; reliability and validity; and the inability to follow up (Backstrom and Hursh-Cesar, 1981). There is no control over who actually completes the survey nor that the questions were understood (Isaac and Michael, 1989).

Theoretical Framework of the Survey Instrument

To measure the level of confidence students perceive
regarding the performance of science-based tasks, the concept of science must be explored. Science is the quest for objective truth. Science provides a conceptual framework for the understanding of natural phenomena and their causes and effects. Among the purposes of the study of science is the development of students who are scientifically knowledgeable, understand that modern technological growth is an outcome of the scientific enterprise, know the difference between objective fact and subjective value, and can apply scientific thinking and information in problem solving and decision making.

This view of science and science education is the basis of the Illinois State Goal for Learning in the Biological and Physical Sciences as set forth by the Illinois State Board of Education. The four State Goals as used in this study are presented as the following statements.

As a result of their schooling, students will have a working knowledge of:

1) the concepts and basic vocabulary of biological, physical, and environmental sciences and their application to life and work in contemporary technological society;
2) the social and environmental implications and limitations of technological development;
3) the principles of scientific research and their application in simple research projects; and
4) the processes, techniques, methods, equipment, and available technology of science (ISBE, 1986, p.3).

Science is often divided into two domains: content and process. The state goals in science comprise both. Goals 1 and 2 are rich in science content. In contrast, Goals 3 and 4 apply across traditional learning areas, such as physics, chemistry, geology, biology, etc. They are rich in process. Mastery of each goal requires that students, as a consequence of their elementary and secondary education, know and are able to perform specific elements of science.

The performance items used in the survey were designed from the Illinois State Goals for Learning in the Biological and Physical Sciences. Five sixth grade and five tenth grade learning objectives were selected for each goal. Each of these items was adapted and written to emphasize a task that demonstrates the general knowledge type and skills area related to each goal. These items served as the performance task dependent variables.
The independent variables were a combination of academic program factors and student background data. The student background variables included gender, age, and ethnic origin. Academic program factors consisted of class standing, number of science courses completed, current enrollment in a science course and participation in a science education internship. The number of science courses completed is based upon the core curriculum at Loyola University Chicago. All undergraduates are required to take three courses (nine credit hours) in the natural sciences. The variable of science education internship participation involves student participation in one of several programs offered at Loyola University, including SCIENCE 2001, Access 2000, and SMART Teams. These projects provide undergraduate education and science majors with the opportunity to work with inservice teachers and gain hands-on experience teaching science to elementary students in the Lakeshore Campus community.

**Instrumentation**

The survey instrument used in this study consisted of a questionnaire, a cover letter, and a self-addressed stamped
return envelope. The questionnaire was composed of 50 items printed in a five-page booklet. The first two items were screening questions to determine the respondent's eligibility of inclusion in the sample. Seven items sought demographic information to serve as the independent variables in the analysis. The forty main items of the survey instrument were developed from the Sample Learning Objectives associated with the Illinois State Goals for Learning in the Biological and Physical Sciences. These items present tasks addressing the general science knowledge and process skills necessary to meet the State Goals. A seven point equal appearing interval, or Likert-type, scale was employed allowing respondents to indicate the degree of confidence in performing each task (ranging from $1 = \text{Not at all Confident}$ to $7 = \text{Very Confident}$). Finally, blank space was provided for students to elaborate on their responses as they desired.

A cover letter was designed which explained the purpose of the study and how the resulting data would be used. Respondents were assured all data would be reported in aggregate form to maintain confidentiality.
Subject Selection

The population of interest for in this study was the 217 undergraduate, elementary education majors enrolled in the School of Education at Loyola University Chicago. This is the group to whom the results were generalized.

The sample population consisted of undergraduate, elementary education majors enrolled at Loyola University Chicago for the 1994-95 academic year. A systematic random sample was drawn from an alphabetical listing of students currently enrolled in the program provided by the Loyola University Chicago Office of Teacher Education. Using a sampling interval of three and beginning at a randomly selected point, seventy-two students, or 33% of the population, were selected to receive survey packets.

Survey Administration and Data Collection

Questionnaires were sent to all seventy-two students identified via first class mail. In addition, one mailing was also sent to the investigator in order to ensure the reliability of delivery. The cover letter and the final page of the questionnaire contained instructions regarding the mailing information and the desired return date.
In total, thirty-eight surveys were returned resulting in a 53% response rate. Provisions made for follow up included sending a second letter, although this plan was not carried out due to a sufficient initial response rate.

A list of students in the elementary education program was obtained from the Office of Teacher Education at Loyola University Chicago. This list was used for sample selection and for providing mailing addresses. Funding for producing, copying and mailing the survey was provided by the SCIENCE 2001 Project, an Illinois State Board of Education Scientific Literacy Grant awarded to the Alliance for Community Education at Loyola University Chicago.

**Data Analysis**

Respondents completed survey items were initially entered into a personal computer and analyzed to provide frequency data for each of the survey items. The Statistical Package for the Social Sciences for Windows version 6.1 (SPSS, 1993) was the program used to input and analyze the data for this study. Analysis included a scale reliability analysis to measure internal consistency via
Cronbach's alpha. Data was reduced to four aggregate dependent variables representing each of the four State Goals. To analyze significant differences between the interval dependent variables and nominal independent variables, a series of One-Way Analysis of Variance (F Test) procedures was conducted. The standardized mean scores of the four goals and total score were compared to the independent variables of class standing, number of college level science courses completed, science internship participation, current enrollment in science course, and ethnic origin. The Bonferroni modified test of least significant differences was used to identify significant differences between specific groups.
CHAPTER IV

FINDINGS; ANALYSIS AND EVALUATION

The findings from the survey questionnaire are presented in this chapter. To facilitate both presentation and interpretation of the data, the chapter is divided into two sections. The first section contains the research findings and includes: Sample Demographics; Reliability Analysis; Perceived Student Performance; and Confidence Factors. The second section presents the discussion of the general findings.

FINDINGS

Sample Demographics

The first two items of the survey instrument were screening questions to determine the respondent's eligibility of inclusion in the sample. These questions identified whether the respondents were undergraduate students at Loyola University Chicago and currently enrolled
as elementary education majors. 100% of the students met the specified criteria and were eligible to be included in the sample (N=38). These items were omitted from any further analysis.

Eight survey items asked for demographic data, including: gender, ethnic origin, class standing, age, number of college level science courses completed, current enrollment in a science course, interest in a science teaching endorsement, and participation in a science education internship.

The sample population was composed of nearly 68.4% European American students, 15.8% African American students, 10.5% Latino students, and 5.3% Asian American students. Table 1 summarizes these findings.

<table>
<thead>
<tr>
<th>ETHNIC ORIGIN</th>
<th>PERCENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>African American</td>
<td>15.8%</td>
</tr>
<tr>
<td>Asian American</td>
<td>5.3%</td>
</tr>
<tr>
<td>European American</td>
<td>68.4%</td>
</tr>
<tr>
<td>Latino</td>
<td>10.5%</td>
</tr>
</tbody>
</table>
Fifteen (39.5%) of students responding to the survey indicated their class standing as junior. Eleven (28.9%) students identified themselves as sophomores, nine (23.7%) as seniors and three (7.9%) were freshmen. These results are shown in Table 2.

<table>
<thead>
<tr>
<th>CLASS STANDING</th>
<th>PERCENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>freshman</td>
<td>7.9%</td>
</tr>
<tr>
<td>sophomore</td>
<td>28.9%</td>
</tr>
<tr>
<td>junior</td>
<td>39.5%</td>
</tr>
<tr>
<td>senior</td>
<td>23.7%</td>
</tr>
</tbody>
</table>

Among the students surveyed, 39.5% have taken two science courses. 23.7% of the sample indicated the completion of one science course and 23.7% also completed three science courses, as shown in Table 3.
TABLE 3

<table>
<thead>
<tr>
<th>NUMBER OF COURSES</th>
<th>PERCENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>none</td>
<td>7.9%</td>
</tr>
<tr>
<td>1 class</td>
<td>23.7%</td>
</tr>
<tr>
<td>2 classes</td>
<td>39.5%</td>
</tr>
<tr>
<td>3 classes</td>
<td>23.7%</td>
</tr>
<tr>
<td>4 or more classes</td>
<td>5.3%</td>
</tr>
</tbody>
</table>

34.2% of the students in the sample were currently enrolled in a science course at Loyola University Chicago. Six (15.8%) of the surveyed students have participated in a science education internship as part of their teacher preparation program.

With regard to age, the students ranged from eighteen to twenty-six with a mean age of twenty years old. Only one student indicated their age to be beyond traditional college age. As a result, further analysis between traditional and nontraditional age college students was excluded from the study.

Similarly, the independent variables of gender and science endorsement were eliminated from further analysis.
since 100% of the respondents were female and expressed no interest in seeking a science teaching endorsement.

Reliability Analysis

The analysis of the survey data included a scale reliability analysis to measure internal consistency via Cronbach's alpha (SPSS, 1993). A priori groups of items associated with each of the Illinois State Goals for Learning were selected for reliability analysis. An estimate of reliability was computed based upon the observed correlations and covariances of the items with each other. The resulting reliability coefficients (alpha) were as follows: Goal 1 = .9549; Goal 2 = .9054; Goal 3 = .8488; and Goal 4 = .9384. Based upon these results, data was reduced to four aggregate dependent variables representing each of the four State Goals. The reliability analysis is summarized in Table 4.
### Table 4

<table>
<thead>
<tr>
<th>AGGREGATE VARIABLE</th>
<th>ALPHA COEFFICIENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goal 1</td>
<td>.9549</td>
</tr>
<tr>
<td>Goal 2</td>
<td>.9054</td>
</tr>
<tr>
<td>Goal 3</td>
<td>.8488</td>
</tr>
<tr>
<td>Goal 4</td>
<td>.9384</td>
</tr>
</tbody>
</table>

**Perceived Student Performance**

Based upon the results of the reliability analysis, aggregate data was used in the analysis of perceived student performance items. The responses to items corresponding to the four Illinois State Goals for Learning were used to compute a mean score for each of the goals.

The first goal is grounded in the fundamental concepts and laws of science. The group mean for the goal one items was 3.732, exhibiting a poor to neutral level of confidence in performing the presented content-oriented tasks. Each task identified as goal two demonstrates the students' degree of confidence in completing an activity requiring knowledge of the social and/or environmental implications
and limitations of science. Responses expressed the highest level of confidence in performing these tasks. The group mean was 4.345, displaying a slight level confidence. The third goal addresses the principles of scientific research and their application in simple research projects. The mean level of confidence indicated by the respondents was 4.211. The tasks attributed to the fourth goal referred to the processes and methods used in the field of science. Goal four items showed the lowest level of confidence, with a mean of 3.300. The data regarding the mean confidence scores are displayed in Table 5.

<table>
<thead>
<tr>
<th>AGGREGATE VARIABLE</th>
<th>MEAN</th>
<th>STD. DEV.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goal 1</td>
<td>3.732</td>
<td>1.179</td>
</tr>
<tr>
<td>Goal 2</td>
<td>4.345</td>
<td>.991</td>
</tr>
<tr>
<td>Goal 3</td>
<td>4.211</td>
<td>.855</td>
</tr>
<tr>
<td>Goal 4</td>
<td>3.300</td>
<td>1.044</td>
</tr>
<tr>
<td>Total Score</td>
<td>3.897</td>
<td>.863</td>
</tr>
</tbody>
</table>

A total score was determined for each case by computing
the mean score of the items corresponding to all four State Goals for Learning. The mean for all cases reported was 3.897, as shown in Table 5. The scores ranged from a minimum of 2.5 to a maximum of 5.4. The total score also indicated that 55% of all students reported a general low degree of confidence in performing science related tasks.

Confidence Factors

A series of One-Way ANOVA tests (F Tests) was performed to analyze significant differences between interval data and nominal data. The procedures were conducted at the p < .05 level between standardized mean scores for each goal and the independent variables of class standing, number of science courses completed, science internship participation, current enrollment in a science course, and ethnic origin. The mean scores for each of the State Goals for Learning and the Total Scores were standardized to meet the assumption of normality by a z-transformation and a Levene's Test was performed to meet the assumption of homogeneity. Finally, a post hoc procedure, Bonferroni's modified Least Significant Difference test, was performed where applicable to determine the significant differences between specific groups.
Current enrollment in a science course and ethnic origin did not show any significant difference between groups. However, each of the other independent variables showed significant differences for some groups.

Class Standing indicated significant group differences in Goal 3 between seniors and freshmen and seniors and sophomores. Significant differences were also shown between seniors and freshmen for the Total Score. Data regarding the ANOVA for class standing is included in Table 6.

<table>
<thead>
<tr>
<th>TABLE 6</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CLASS STANDING</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Goal 1</td>
</tr>
<tr>
<td>Goal 2</td>
</tr>
<tr>
<td>Goal 3</td>
</tr>
<tr>
<td>Goal 4</td>
</tr>
<tr>
<td>Total Score</td>
</tr>
</tbody>
</table>

*Note: p < .05

The number of college level science courses completed presented significant differences for students who took more
than two science classes and those enrolled in one or less classes. This was evident in Goal 1, Goal 3, Goal 4, and the Total Score, as shown in Table 7.

**TABLE 7**

<table>
<thead>
<tr>
<th>NUMBER OF SCIENCE COURSES COMPLETED</th>
</tr>
</thead>
<tbody>
<tr>
<td>D.F.</td>
</tr>
<tr>
<td>------</td>
</tr>
<tr>
<td>Goal 1</td>
</tr>
<tr>
<td>Goal 2</td>
</tr>
<tr>
<td>Goal 3</td>
</tr>
<tr>
<td>Goal 4</td>
</tr>
<tr>
<td>Total Score</td>
</tr>
</tbody>
</table>

*Note: p<.05

Those students participating in a science education internship showed significantly higher scores with regard to Goal 1, Goal 2, and the Total Score. Table 8 displays the ANOVA data regarding participation in a science education internship.
### TABLE 8

<table>
<thead>
<tr>
<th>PARTICIPATION IN A SCIENCE EDUCATION INTERNSHIP</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>D.F.</strong></td>
</tr>
<tr>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>Goal 1</td>
</tr>
<tr>
<td>Goal 2</td>
</tr>
<tr>
<td>Goal 3</td>
</tr>
<tr>
<td>Goal 4</td>
</tr>
<tr>
<td>Total Score</td>
</tr>
</tbody>
</table>

*Note: p<.05

**ANALYSIS AND EVALUATION**

The results of the study were based upon the sample of undergraduate students enrolled in the elementary education program at Loyola University Chicago. This program consists of only 7% male students, consequently the sample reflected the large number of women in the population. The sample ranged in age from 18 to 23 years old in all but one case. This indicates that the sample was representative of traditional age college students.

The survey results also provided information about the level of science/science education background for each respondent. Overall, the students indicated a low level of
confidence on all levels of performing science related tasks. Most notably, none of the students indicated interest in seeking a science teaching endorsement. Students also identified the number of science courses they had completed. All undergraduate students enrolled at Loyola University Chicago are required to successfully complete three courses (nine credit hours) in the natural sciences as part of the core curriculum. Of the respondents, only 2 students reported that they had completed more than the required three courses. These two factors may be a result of the lack of interest many students have in pursuing the field of science. It may also be due to the current state of education that does not emphasize the importance of science as equal to that of reading, writing, and arithmetic.

The students surveyed reported that they feel the lowest level of confidence in performing tasks related to the fourth Illinois State Goal for Learning. These tasks are related to the process skills and methods central to the study of science. This is the area that is most important in elementary science education. When children acquire the basic science process skills early in their education, they
grasp science content at a much more sophisticated level when it is explored in the same way scientists discover new knowledge. A current trend in elementary science education is to place equal emphasis on process and content. The results of the study indicate that this may be as important for college level students as it is for young children.

Responding students identified the highest level of confidence in performing tasks associated with goal two. These tasks relate to the social and environmental implications of science. Proficiency in this area may stem from the real world connection these items have for many people. Prior research shows that children and adults alike learn science principles more effectively when they are placed in a context familiar to the learner (Rutherford and Ahlgren, 1990).

The survey identified the number of science courses completed, class standing and participation in a science education internship program as influences on the degree of confidence students display in performing various science related tasks. As the number of college level science courses increased, the level of confidence among students increased. This direct relationship leads one to believe
that if the number of courses to be successfully completed by elementary education majors is increased, their confidence relating to science performance will increase.

The difference shown as an effect of the class standing of the responding students seems to be related to the number of science courses the student has completed. As they progress through their college education in terms of time, they are more likely to enroll in more science classes to meet their degree requirements. Consequently this supports the previous notion that the greater the number of science courses completed, the higher the confidence level in performing science related tasks.

Participation in a science education internship was also an indicator of higher science performance confidence. Many of the science education internships offered at Loyola University Chicago are affiliated with inservice teacher staff development programs. These programs offer undergraduate students science education support on all levels. They are supplied with the content, methods and materials to teach elementary science. The students are provided hands-on clinical experience to "practice" teaching science to children and receive support from University
faculty and staff, as well as from inservice teachers learning along with them. The science education internships not only increase the level of confidence in performing science related tasks, but they have also been shown to be effective in increasing the desire to teach science (D'Agostino, et. al., 1995).
CHAPTER V

SUMMARY, CONCLUSION AND RECOMMENDATIONS

Summary

Chapter I structures the problem, explains the rationale for the study and poses the questions to be answered. The current state of science education indicates that students in the American educational system are not receiving the instruction necessary to provide them with the knowledge, skills and motivation which constitutes scientific literacy. As a result, few students are prepared to progress in our technologically advancing world.

This lack of science instructional practice centers on the lack of science content knowledge and poor attitude toward science among teachers. In addition, teachers' confidence in their ability to understand scientific concepts and conduct basic scientific procedures has been identified as a central influence in science teacher competence (Jewett, 1993). While many attempts have been
made to increase teacher knowledge and confidence through staff development, few efforts have focused on improving the quality of science education students enrolled in preservice teacher preparation programs.

The purpose of this study was to determine the factors which influence the degree of confidence among students in a teacher education program. Certain factors originating from within the academic program and student background were investigated. The study aimed to determine the impact each element has when students are asked to identify their perceived confidence in performing specific scientific literacy related tasks. Class standing, number of science courses completed, current enrollment in a science course and participation in a science education internship were included as academic program factors. Student background was composed of gender, age and ethnic origin.

The Illinois State Goals for Learning in the Biological and Physical Sciences (ISBE, 1985) served as theoretical framework for the study. These goals and the learning outcomes associated with each are the standards set forth by the Illinois State Board of Education for elementary and secondary students attending public schools in Illinois.
Since preservice teachers will be expected to help their students achieve these goals, they too should be competent in these areas.

Chapter II drew upon three distinct areas to provide a background for the study: trends in science education; the goals of science education; and science teacher attitude and confidence.

The review of trends in science education included selections from past and current literature. The impetus for improved science education began in the 1950's following the launching of Sputnik I by the Soviet Union. This event drew attention to the difference between the existing science courses and the rapid advances of science and technology. As a result, public interest was aroused, and some of the most innovative changes in American education were sparked.

The demand for more scientists who could meet the needs of society was the focus of the new reforms. Emphasis was placed on learning by doing while focusing on current concepts in science. Much time and effort was devoted to identifying central themes and unifying ideas to link the science disciplines.
Although these changes in science education met the goal of producing more scientists and engineers, science was not meaningful and useful for all students. It is generally accepted in current literature that each citizen should be literate and possess other skills necessary to be a functioning member of society. This view of literacy must be expanded to include basic knowledge of science and technology in the area of science because of the important role of science and technology in today's world.

The goals of science education have changed over time and the reforms in science education have attempted to meet these goals. The goal of the "Golden Age of Science Education" was to produce a greater number of scientists and engineers to meet the advances of society. Current changes in education have included an emphasis on redefining the goals of science education. The generally accepted purpose of school science in recent years has been to help all students achieve higher levels of scientific literacy. The strength of recent national reforms is the widespread acceptance of the objectives associated with this goal of science for all citizens.

Local and regional efforts have also been developed to
help individual school districts meet this new goal of scientific literacy. Statewide goals have been established in Illinois to facilitate the application of scientific literacy to curriculum development, teaching, and student learning.

In order for the goals of science education to be achieved, factors influencing classroom teaching must be investigated. Teachers indicate a reluctance to teaching science. This finding can be attributed to the lack of science content knowledge and poor attitude toward science. It has also been shown that as teachers confidence in performing science is increased, their willingness to teach science increases and teacher attitude toward science is improved.

The lack of teacher confidence can be traced to their own education. Many teachers have only been exposed to the elitist an intimidating conditions of traditional college science. In addition to serving as a view of the science discipline, the university style of teaching has also served as a model of science teaching being replicated in elementary and secondary classrooms. The result is an ongoing cycle which can only serve to alienate more students
from the study of science. In order for change to occur, the factors which influence teacher must be explored.

The methodology chosen for this descriptive study was a questionnaire as discussed in Chapter III. The advantages of such a format (ease of use; facility in contacting subjects; and cost containment) were felt to outweigh the disadvantages (response rates; reliability; validity; and follow up).

The population to which the results of the study will be generalized consisted of elementary education majors enrolled in the School of Education at Loyola University Chicago. A systematic random sample from this population was selected to receive the survey instrument.

The learning objectives associated with the Illinois State Goals for Learning in the Biological and Physical Sciences (ISBE, 1985) served as the framework for the survey. Select sixth and tenth grade learning objectives were used as dependant variable performance tasks on the survey instrument. Student background and academic program questions produced data to serve as independent variables and identify demographics.

Initial examination of the resulting data consisted of
descriptive statistical analyses and a scale reliability analysis to reduce data to aggregate variables for further investigation. Additional procedures were performed to compare differences between interval dependant and nominal independent variables.

The findings in Chapter IV identified demographic data concerning the population under consideration. The majority of respondents were traditional age, European-American, female college students. More students surveyed stated that they were in their junior year, having completed two college level science courses. None of the respondents expressed interest in pursuing a teaching endorsement in science and few had participated in a science education internship.

The reliability analysis showed agreement with a priori groups for each of the State Goals. As a result of this high reliability, aggregate data for each goal was used for further analysis.

Respondents expressed a general low level of confidence in all performance tasks. The students surveyed indicated their highest level of confidence related to the environmental and societal of science. On the other hand, students indicated the processes and methods central to the
study of science as the area in which confidence is lowest. Several factors were found to have significant influence on the confidence students' perceived when asked to respond to the performance task items. As the number of science courses completed increased, student confidence increased. Similarly, class standing had an effect upon the overall confidence of preservice teachers. Participation in a science education internship as a component of preservice training also influences the level of confidence among education students.

**Conclusions and Recommendations**

The findings of this study provided information that has implications for science educators working in teacher preparation programs. It has been shown that the number of science courses completed and the class standing have a significant impact on the degree of confidence displayed by students performing science related tasks. As a result, teacher preparation program administrators may wish to consider increasing the number of science courses required as part of the curriculum.

Yet, the findings suggest that there is more to
developing preservice teacher confidence than simply providing them with more science courses. The method in which teachers are instructed seems to be a crucial factor also. College level science courses which are taken by elementary education teachers, preservice and inservice alike, must be designed to address the needs and learning styles of the teachers. This includes courses having many "hands-on" components along with good "minds-on" linkages. The traditional courses designed as lectures with laboratory sections are primarily for preparing scientists not science educators. The course provided for education students should also have strong connections with methods courses so that teachers can learn more effectively how to teach the content they learn in their science courses.

The participation in science education internships was established as an indicator of science performance confidence. These internship programs offer the setting conducive for teachers to learn content, process, and instructional methods. When presented with a combination of science content instruction, modelled process approach and hands-on pedagogy, confidence can be positively affected. Students develop a science knowledge base while being
provided the experience to develop instructional strategies other than the standard lecture model. The students are then able to utilize their new found content and teaching techniques in a clinical experience. By receiving the opportunity to learn how to teach by practicing under supervision may be the most effective training available for preservice teachers. These opportunities should be made available to all elementary education majors, and not just select interns.

With this information providing a foundation of the needs of preservice science education, further research may help to bring about some of the recommended changes. It seems that an integration of science coursework with educational methods coursework is a successful way to attack the problem of knowledge base, confidence, and attitude toward teaching science in the elementary classroom.

Research is currently under way to provide more direct measurements of the status of science education among preservice elementary teachers. Achievement testing data has been collected to assess the science knowledge base of elementary education majors and to identify any correlation between perceived performance and achievement.
Performance assessment consisting of hands-on science activities is another area for further consideration. An investigation into any relationship between perceived student performance and actual performance may add validity to the indirect measurement approach used in this study.

Similar studies in settings other than private, urban, liberal arts institutions may be helpful in determining whether the results can be generalized to larger populations. Further study will involve other universities within the Chicagoland area, throughout the state of Illinois, and eventually on a national scale.

The findings of this study agree with previous research regarding low confidence among inservice teachers. As a result, it seems reasonable to believe that the preservice level would provide the best opportunity for intervention. Rather than placing teachers in the field, only to recall and retrain them, colleges of teacher education can better prepare their students to become more effective science teachers on the first day they arrive in the classroom. If it is hoped to improve the science education for elementary school students, it is the duty of science educators and researchers to provide them with teachers ready to face the
challenge of preparing the next generation for a changing future.
REFERENCES


APPENDIX A
# Science Experience Survey

**PLEASE MARK ON THIS SURVEY -- THERE IS NO OTHER RESPONSE SHEET**

1. Are you currently enrolled as a full-time undergraduate student at Loyola University Chicago? (circle one)  
   - Yes  
   - No

2. Are you currently an elementary education major? (circle one)  
   - Yes  
   - No

***If you answered no to either of the above questions, kindly return this survey form in the return envelope provided. Thank you for your time.

The following statements address your science knowledge to date. For each statement, please rate your degree of confidence in understanding the concepts and/or performing the scientific tasks indicated. Using the scale provided, answer by circling one response which best describes your confidence level.

<table>
<thead>
<tr>
<th></th>
<th>Not at all Confident</th>
<th>Very Confident</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 2 3 4 5 6 7</td>
<td></td>
</tr>
</tbody>
</table>

Please circle the number (1 - 7) which indicates your degree of confidence in performing the following tasks:

3. Construct a device with unique units of measurement for measuring length, volume, mass and time.  
   - 1 2 3 4 5 6 7

4. Identify some of Illinois' natural resources as renewable or nonrenewable.  
   - 1 2 3 4 5 6 7

5. Recognize conflicting data resulting from an investigation.  
   - 1 2 3 4 5 6 7

6. Use a classification key to place objects or events within a scheme.  
   - 1 2 3 4 5 6 7

7. Observe changes in matter and decide whether they are chemical or physical in nature.  
   - 1 2 3 4 5 6 7

8. Evaluate data collected by scientists and others to demonstrate changes in the atmosphere.  
   - 1 2 3 4 5 6 7

9. Replicate the results of an experiment.  
   - 1 2 3 4 5 6 7

10. Distinguish between independent and dependent variables.  
    - 1 2 3 4 5 6 7
<table>
<thead>
<tr>
<th>Task</th>
<th>Not at all Confident</th>
<th>Very Confident</th>
</tr>
</thead>
<tbody>
<tr>
<td>11. Identify the components of a simple electrical system.</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
</tr>
<tr>
<td>12. Understand how living organisms are affected by pollution.</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
</tr>
<tr>
<td>13. Compare experimental data with those obtained by others.</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
</tr>
<tr>
<td>14. Confirm a prediction through experimentation.</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
</tr>
<tr>
<td>15. Understand the interactions among populations of plants, herbivores and carnivores.</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
</tr>
<tr>
<td>16. Formulate positions on environmental issues after consideration of available scientific information.</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
</tr>
<tr>
<td>17. Relate alternatives to using animals in scientific research.</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
</tr>
<tr>
<td>18. Identify possible sources of error in measuring instruments.</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
</tr>
<tr>
<td>19. Demonstrate a procedure for separating a mixture into its components.</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
</tr>
<tr>
<td>20. Identify materials as biodegradable and nonbiodegradable.</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
</tr>
<tr>
<td>21. Relate accurately the findings and conclusions of laboratory investigations.</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
</tr>
<tr>
<td>22. Test an inference by collecting data.</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
</tr>
<tr>
<td>23. Identify how sound travels and identify its properties.</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
</tr>
<tr>
<td>24. Predict the effect of new technologies on human ecosystems.</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
</tr>
<tr>
<td>Task</td>
<td>Not at all Confident</td>
<td>Very Confident</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
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</tr>
<tr>
<td>25. Demonstrate various ways to display the same data.</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>26. Use direct observation to develop a question to be answered in a laboratory.</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>27. Relate seasons to the revolution of the earth around the sun.</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>28. Relate the contents of selected products from the supermarket to their use.</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>29. Contrast relevant with irrelevant information.</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>30. Recognize an operational definition.</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>31. Relate air masses and fronts to storms.</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>32. Understand how scientific inquiry is influenced by beliefs, traditions, views and actions of society.</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>33. Develop an experimental procedure which another student can follow.</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>34. Distinguish between precision and accuracy.</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>35. Compare the structures common to all living cells.</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>36. Recognize the changes in the physical environment resulting from human activity.</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>37. Develop alternative procedures for solving a problem.</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>38. Distinguish between an observation and an experiment.</td>
<td>1</td>
<td>7</td>
</tr>
</tbody>
</table>
Please circle the number (1 - 7) which indicates your degree of confidence in performing the following tasks:

<table>
<thead>
<tr>
<th>Task</th>
<th>Not at all Confident</th>
<th>Very Confident</th>
</tr>
</thead>
<tbody>
<tr>
<td>39. Relate how natural selection can serve as a model for change in organisms.</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
</tr>
<tr>
<td>40. Use the scientific method in consumer decision making.</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
</tr>
<tr>
<td>41. Evaluate reasons for obtaining conflicting data.</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
</tr>
<tr>
<td>42. Analyze an operation definition based upon a simple experiment.</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
</tr>
</tbody>
</table>

Please indicate the answer to the following questions by checking/writing the response that best describes yourself.

43. What is your gender?
   - [ ] Female
   - [ ] Male

44. What is your ethnic origin?
   - [ ] African American/Black
   - [ ] Asian American/Pacific Islander
   - [ ] European American/White
   - [ ] Latino
   - [ ] Native American
   - [ ] Other: ____________________________

45. What is your class standing?
   - [ ] Freshman
   - [ ] Sophomore
   - [ ] Junior
   - [ ] Senior
Please indicate the answer to the following questions by checking/writing the response that best describes yourself.

46. What is your age? __________

47. How many college level science courses have you taken to date?  
   (Include any present courses in your total.)
   ______ None
   ______ One course
   ______ Two courses
   ______ Three courses
   ______ Four or more courses

48. Are you currently enrolled in a science course?
   ______ Yes
   ______ No

49. Are you seeking a science endorsement?
   ______ Yes
   ______ No

50. Have you participated in a science or science education internship (SCIENCE 2001, Access 2000, SMART Teams, etc.)?
   ______ Yes
   ______ No

If you have any additional comments to share containing the contents of this survey, please do so in the space that is provided.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

Thank you for taking the time to complete this survey!
VITA

The author, Bryan William Wunar, is the son of Joseph and Dorothy Wunar. He was born September 4, 1970 in Princeton, Illinois. He obtained his elementary education in the Troy Consolidated District 30-C schools in Joliet, Illinois. His secondary education was completed in 1988 at Joliet Catholic High School. Mr. Wunar pursued his undergraduate education at Loyola University Chicago. In May 1993, he graduated with the degree of Bachelor of Science, Honors in Biology.

He has served as a project manager of the Alliance for Community Education at Loyola University Chicago, since 1993. His work has focused on providing educational opportunities for children, families and teachers in the Loyola Lakeshore Campus community. In 1994, he was named project director of SCIENCE 2001, a Scientific Literacy Grant Project funded by the Illinois State Board of Education, Chicago Archdiocese Office of Catholic Education,
and Loyola University Chicago. In August 1995, he was appointed to the faculty rank of Lecturer in the Department of Curriculum, Instruction and Educational Psychology at Loyola University Chicago.

He has made professional presentations regarding the Alliance for Community Education and SCIENCE 2001 at the annual meetings of the National Science Teachers Association (NSTA), the American Association for the Advancement of Science (AAAS), and various regional, state, and local conferences. Mr. Wunar is also a coauthor of "SCIENCE 2001: A Community-Based Model for Promoting Scientific Literacy," a case study to be published in The Collaborative Community: New Models for Social Research (Pine Forge Press, 1996).

Mr. Wunar holds membership in the National Science Teachers Association, the American Association for the Advancement of Science, and the Association for Supervision and Curriculum Development, for which he is currently serving as the facilitator for the ASCD Math and Science Network.
THESIS APPROVAL SHEET

The thesis submitted by Bryan William Wunar has been read and approved by the following committee:

Diane Schiller, Ph.D.
Professor, Education
Loyola University Chicago

Stephen Freedman, Ph.D.
Dean, Mundelein College
Loyola University Chicago

The final copies have been examined by the director of the thesis and the signature which appears below verifies the fact that any necessary changes have been incorporated and that the thesis is now given final approval by the committee with reference to its content and form.

The thesis is, therefore, accepted in partial fulfillment of the requirements for the degree of Master of Arts.

12-8-95
Date

Director's Signature