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An evaluation of the use of hands-on science activity homework assignments for sixth-grade children and their parents

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The Ohio State University, 1994
AN EVALUATION OF THE USE OF HANDS-ON SCIENCE ACTIVITY HOMEWORK ASSIGNMENTS FOR SIXTH GRADE CHILDREN AND THEIR PARENTS

DISSERTATION

Presented in Partial Fulfillment of the Requirements for the Degree Doctor of Philosophy in the Graduate School of The Ohio State University

By
Peter Rillero, B.A, M.A., M.A.

* * * * *

The Ohio State University
1994

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Approved by
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To my parents and my siblings for all their support and encouragement.
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CHAPTER I
INTRODUCTION

Introduction

Riding the subway on a warm autumn night, I reflected on my first parent-teacher conference as a teacher in a Bronx, NY public high school. Frequently during the conferences I told parents things like "your child always comes to class," "your child always completes homework assignments and participates in discussions," and "your child gets good marks on the exams." These statements did characterize the children of the parents I spoke with, however, these were not the characteristics of the majority of students I taught. From that moment, I became convinced of the importance of involving parents in their children's science education.

In my Regents Biology classes I had students bring home a science laboratory to conduct with their parents. From this idea grew the Student Parent Laboratories Achieving Science at Home (SPLASH) program. The SPLASH program features parents and their children working together on hands-on science homework activities. This study reports an evaluation of this program implemented with sixth grade students. The program was evaluated in many areas including: rates of
completion of activities, parent involvement, parent and student attitudes toward the program, effect on student attitude toward science, and student science process skill achievement.

The SPLASH program was implemented in a middle school—an important but often neglected level of schooling. Based on National Assessment of Educational Progress (NAEP) data, Anrig and Lapointe concluded that “each year, unless things change, one and a half million young Americans will leave the middle school experience unprepared for secondary school science courses” (1989, p. 7). The 1990 NAEP data indicate that fourth graders like science more than ninth graders (National Center for Educational Statistics, 1992). Middle school science is turning students off to science rather than exciting them.

"For many youth 10 to 15 years old, early adolescence offers opportunities to choose a path toward a productive and fulfilling life. For many others it represents their last best chance to avoid a diminished future" (Carnegie Council on Adolescent Development, 1989, p. 8). During the middle school years, students form attitudes which influence their science course selection in high school and college (Gennaro, Hereid, & Ostlund, 1986; Misiti, Shrigley, & Hanson, 1991). "For many students, it is during these years that a desire to learn and understand the scientific world is lost" (Meichtry, 1992, p. 441). “Adolescents, seeking to identify their own interests and abilities, are acutely affected by experiences both in and out of school. The degree of success in coping with the transition to middle school, a bridge between preadolescent and adolescent development, influences students’ attitudes and their academic progress” (Reynolds, 1991, p. 133).
To improve middle school students' attitudes towards science there needs to be a reformation of the middle school science experience. From an analysis of reviews of research, Towsley and Voss (1988) concluded that "many teachers and parents consider the primary purpose of science education to be the preparation for the next level of schooling: this means content not process skills" (p. 172). Many educators are developing programs to increase students' factual understanding of science (for example Rutherford & Ahlgren, 1990; Aldridge, 1992). However, the problem in middle school is not with fact knowing but scientific reasoning. The 1986 NAEP data (Mullis & Jenkins, 1988) indicated that 99.8% of 13 year-old students were proficient at knowing everyday science facts; however, the percentage of students that were proficient at analyzing scientific data and procedures was only 9.4.

The SPLASH program was implemented with middle school students and had the goals of providing more opportunities for hands-on science experiences and involving the parents in these experiences. The experiences and increased parental involvement were expected to improve student science process skills and improve student attitudes toward science.

**Historical Perspectives on Parent Involvement**

The value of parental involvement in education has been long recognized. Pestalozzi in the eighteenth century indicated this importance: (a) "For children, the teachings of their parents will always be the core, and as for the schoolmaster, we can give thanks to God if he
is able to put a decent shell about the core” (Pestalozzi, 1951, p. 26) and (b) “In my opinion, school instruction... that ignores the circumstances in the home in their entirety, is little more than a method for shriveling up our generation” (p. 35).

The home, church, and school were the educational institutions of early American colonists, and of the three, the school was the most marginal (Goodlad, 1984). "Although half of the child population attended no schools, reading was a significant part of the culture. There were books, almanacs, newspapers, the Bible, letters to be read and to be written. School was not the only place for learning to read. Older brothers and sisters, uncles, aunts and parents nurtured all aspects of life" (Goodlad, 1984, p. 40).

Following the American Revolution, it was no longer considered appropriate to transmit the European ways. A new national character was being developed and it needed to be taught. Since parents were assumed ill equipped for this task, schools assumed the responsibility. The desire to "Americanize" the many newly arriving immigrants in the nineteenth century made schools even more important. The balance of educational influence fell toward the school in the twentieth century (Goodlad, 1984).

Interest in parent involvement in education started to increase in the middle 1800s (Stout & Langdon, 1968). Kindergartens were being established during this time, and these new schools stressed the importance of the teacher knowing the students' home and parents. Home visits and visits to Mothers' Clubs were common practices of well-established kindergartens (Stout & Langdon, 1968). In the late 1880s the
importance of involving parents gained impetus and the National Congress of Parents and Teachers was formed.

In a 1902 article entitled "Can we interest the parents?", Morris explained that in the early days of the United States the teacher knew the parents well because of the policy of "boarding around." During the school year the teacher lived with families in the community. Urbanization changed society and it made it more difficult for parents and teachers to cooperate.

The value to the pupil and the teacher of all the coöperation which teachers and parents can give to each other has never been questioned. The fact that it has lessened, due to general trend of circumstances, is none the less patent. The question which confronts us is how may the old-time benefits of coöperation be enjoyed under the present circumstances of so widely diversified interests. (Morris, 1902)

Thorndike (1920) also recognized the importance of parents in education. "Teachers—that is, human beings whose special work in the world is formally recognized as education—are, of course, only a small fraction of the human means of education. Parents and friends are perhaps surer means" (Thorndike, 1920, p. 119).

With the increased popularity of television and greater numbers of mothers working outside the home, educators became concerned about diminished parent-child interactions. "Concern about the quantity and quality of learning in the home environment has been expressed during the past decade because the amount of interaction and learning between American parents and their children has decreased" (Bobbitt & Paolucci, 1975, p. 19).
In the 1960s came Federal legislation of parental involvement. "The stimulus of parental involvement was the 1965 Elementary and Secondary Education Act, which specified that parents were expected to assume a more direct role in their children's formal education" (Hart, 1988, p. 4). Legislation for programs such as Head Start also mandated parental involvement (Flaxman & Inger, 1991).

Reports in the 1980s called for increased parental involvement. Turning Points, the report of the Task Force on Education of Young Adolescents, stressed the need to "reengage families in the education of young adolescents by giving families meaningful roles in school governance, communicating with families about the school program and student's progress, and offering families opportunities to support the learning process at home and at the school" (National Center for Educational Statistics, 1992, p. 9).

Recent education reform movements such as Project 2061 (Rutherford & Ahlgren, 1990) and America 2000 (U.S. Department of Education, 1991) are calling for more parental involvement in education. Programs are being developed and propagated that have their principal focus on parental involvement. The Home Instruction Program for Preschool Youngsters (HIPPY) is in 17 states and the Parents As Teachers program is in 34 states (Hayes, 1992). Both of these programs are targeted at children below age five. However, factors such as the single-parent family, the increase in dual income families, the power of television, and increased commuting distances all have had a part in reducing the effectiveness of the parent as a teacher (Ostlund, Gennaro, & Dobbert, 1985, p. 723).
**Parent Uninvolvement**

During the difficult years of adolescence, many parents begin to lose touch with their children and their children’s school (Carnegie Council on Adolescent Development, 1989; Epstein & Conners, 1992). "In these changed times, when young people face unprecedented choices and pressures, all too often the guidance they needed as children and need no less as adolescents is withdrawn. Freed from the dependency of childhood, but not yet able to find their own path to adulthood, many young people feel a desperate sense of isolation" (Carnegie Council on Adolescent Development, 1989, p. 8).

Many parents have the belief that as their child becomes older they should disengage from them and their education (Carnegie Council on Adolescent Development, 1989). Adolescent youths are at the same time working towards independence from their parents (Berla, 1991). While increased autonomy may be necessary, the rift between adult and adolescent can leave the adolescent to turn to equally confused peers and make "too many poor decisions with harmful or lethal consequences" (Carnegie Council on Adolescent Development, 1989, p. 8). In justifying his school’s family involvement programs, Principal Nick Pike of the Desert View Middle School in El Paso, Texas, stated: "The largest number of dropouts occurs in the 9th grade, but the decision to drop out comes in the 7th or 8th grade" (as quoted by Hill, 1993, p. 26).

Seeley (1989) calls the factor that limits parental involvement in education the “delegation model.” Citizens pay taxes for government services including fire and police protection, sanitation, and public
health and therefore it is not their responsibility. Over the years the delegation model has been extended to schools resulting in a fundamental gap between families and schools. "Parents often signal, subconsciously and overtly, that they do not have to be involved because the job has been delegated to the schools, just as they don't have to be involved in putting out fires once the fire department has been given that job" (Seeley, 1989, p. 46). This role has been institutionalized by parents, school staffs, and citizens.

Mannan and Blackwell (1992) feel that our society has put more faith in social institutions, such as schools, than families for protecting and nurturing children. There is a propensity for social institutions to work without parents and families. Other barriers to involvement include parents not being sure of how much involvement is necessary and parents not knowing if they have the needed skills for involvement (Mannan & Blackwell, 1992).

The transition from elementary to middle school makes being an involved parent more difficult (Berla, 1991). Instead of one main teacher at the elementary school level there are five to six teachers at the middle school level, which makes it more difficult for the parent to find out how their child is doing. A middle school teacher can be responsible for about 150 students, which makes it more difficult for middle school teachers to keep or make contact with all parents. "By middle grade school, the home-school connection has been significantly reduced, and in some cases is nonexistent" (Carnegie Council on Adolescent Development, 1989, p. 66).
School administrators are unfamiliar with involving parents in their children's education and may feel that it is not their responsibility (Coleman, 1991). Middle/junior high schools seldom seek to involve parents and may even discourage it (Berla, 1991; Carnegie Council on Adolescent Development, 1989). Middle schools in disadvantaged areas are less likely than other middle schools to seek parental involvement (Lewis, 1992). "There are presently dramatic declines in schools' practices of partnership with families at each grade level, with big drops at the points of transitions to the middle and high school grades" (Epstein & Conners, 1992).

While there are many types of parent involvement in education, one of the most important and arguably easiest is parents helping and monitoring their children's homework. "One area in which schools can act concerns homework. Schools demand homework, and assume that parents will reinforce the school's demands and provide a setting in which the children can meet the demands" (Coleman, 1991, p. 18). These assumptions are often serious errors. Schools need to assist parents in helping their children succeed in school. Methods need to be explored and more research conducted on increasing parental involvement in education (Berla, 1991; Epstein & Conners, 1992; Heller, Padilla, Hertel, & Olstad, 1988).

**Perspectives on the importance of parental involvement in science**

There are many positive outcomes posited by educators about the advantages of involving parents in science education. This section presents a sampling of these viewpoints.
Students working with parents will allow the parents to become more powerful motivators in a cooperative learning venture (Gennaro, Hereid, & Ostlund, 1986). The premise of *A Parent's Guide to Great Explorations in Math & Science* (GEMS, 1991) is that parents and/or adult role models for children can make a crucial difference in a child's science and mathematics achievement and attitude. "Whether your children are preschoolers or high schoolers, exposure to activity-based science and mathematics, and working cooperatively with parents, other family members, or peers, can be of great value" (GEMS, 1991, p. 5).

It is becoming recognized that involving parents in science education is important for improving students' achievement and attitude toward science.

Parental influence can be a vital force in scientific literacy. We cannot depend solely on schools to teach our children science. We are asking our schools to do more and more with less and less. Japanese students have the highest math and science test scores in the world. Research has indicated that one reason may be that parents play a key role in education.... Children's questions don't stop when they leave the classroom. When parents help children explore their questions, children realize that science is something important and something they can do. Families who do science activities together, at home, demystify science and make it a part of everyday life. Both parents and children benefit: children gain enthusiasm for learning and parents gain satisfaction as participants in their children's education. (Bosak, Bosak, & Puppa, 1991, p. 15).

Additional benefits of parental involvement in science education are expressed by Williams-Norton, Residorf, and Specs (1990, p. 13):

Families who do science together, at home, demystify the subject and identify the everydayness of science processes. Both parents and children benefit. The children gain enthusiasm for learning,
and the parents gain confidence as supporters of their children's education. Just as reading at home strengthens reading skills and encourages an appreciation of literature, doing science experiments at home makes science relevant to children's lives and develops the entire family's awareness of science and technology.

Gennaro adds another argument for having students learn science with their parents: "Good things seem to happen when children and their parents are taught together. Not only do the parents learn science (as do their children) but they seem to come to better appreciate the problems, joys, and excitement of contemporary science teaching" (1982, p. 129). Gennaro selected middle school students to work with because of difficulties in having elementary students and their parents simultaneously learning something in a way that would be interesting and profitable to both. High school students were not selected because of their many outside school activities and because many have been exposed to more specialized sciences in their high schools. Moreover, science interventions in the middle school years are important for building an understanding of science and possibly influencing career decisions (Gennaro, 1982).

Another advantage of doing science with a parent is the parent can become a role model for doing science. "Family members teach primarily through modeling. Family members learn from one another primarily through imitating and identifying with one another" (Bobbitt & Paolucci, 1975, p. 198).

"One of the overarching objectives of most new science and technology syllabuses is parent and community participation" (Geake, 1993). "A partnership between home and school enhances the concept
that both partners share an important self-interest in the success of the child. Involving parents with their children's science education provides an opportunity for parents to discuss school expectations in science" (Rhoton, 1989, p. 10). Schools that are using a hands-on approach probably have parents who were educated in a different manner when they went to school. Having parents do hands-on activities with their children may help them better understand how their children are being taught, thus improving their effectiveness when they help their children.

Orman (1993), a fifth grade teacher in Wisconsin, used mathematics take-home activities to help the parents understand the use of mathematics manipulatives in the education of their children. "I realized that parents lacked knowledge of current instructional techniques in mathematics. Even though I had displayed objects at our open house and had demonstrated their use when holding conferences with parents, the parents needed more experience with this way of learning" (p. 306). The benefit according to Orman was that "if parents became actively involved in their children's learning, then both the parents and students would benefit" (p. 306).

After examining studies from a variety of content areas, Epstein (1992) concluded "research is needed on school and family connections in early and late adolescence in order to understand better how to help more students succeed and to prevent or reduce serious problems that may interfere with student success in school" (Epstein, 1992, p. 1114).
Learning Theory Perspectives

The SPLASH Program was developed based on ideas from different theories of learning. The program was further refined by analyzing other programs and educational research. This section discusses the learning theory components of SPLASH. In Chapter 2, science programs similar to SPLASH are described and the relevant research presented.

One important criterion of the SPLASH activities is learning by doing. Working with a parent, the student will learn skills, solve problems, and make discoveries. The importance of this type of active learning is supported by learning theories.

In Rousseau’s classic work Emile, the child learns about the world through discovery. This notion of learning through experience and discovery “was a major departure from the schooling that emphasized memorization and subordination to authority” (Spring, 1986, p. 25).

In America, the first major challenge to the prevailing education system that stressed rote memorization using the textbook came from the object teaching revolution (Rillero, 1993). The first tenet of the American version of the object teaching philosophy was “Activity is a law of childhood. Accustom the child to do—educate the hand” (Sheldon, 1869, p. 14).

John Dewey in the early part of the twentieth century stressed that children should learn by doing (Corin, 1980). According to Dewey, "Subject-Matter never can be got into the child from without. Learning is active. It involves reaching out of the mind. It involves organic assimilation starting from within" (1925, p. 13). Science or study is like a
map, not a substitute for experience but a way to organize and understand experiences.

The map is not a substitute for personal experience. The map does not take the place of an actual journey. The logically formulated materials of a science or branch of learning, of a study, is not substitute for the having of individual experiences. The mathematical formula for a falling body does not take the place of personal contact and immediate experience with the falling thing. (Dewey, 1925, p. 26-27)

Piaget stressed the importance of learning by doing, especially in science. According to Piaget,

a sufficient experimental training was believed to have been provided as long as the student had been introduced to the results of past experiments or had been allowed to watch demonstration experiments conducted by his teacher, as though it were possible to sit in rows on a wharf and learn to swim merely by watching grown-up swimmers in the water. It is true that this form of instruction by lecture and demonstration has often been supplemented by laboratory work by the students, but the repetition of past experiments is still a long way from being the best way of exciting the spirit of invention, and even of training students in the necessity for checking for verification. (Piaget, 1986, p. 705)

While the idea of discovery learning has been around for some time, Bruner’s work in the 1960s did much to popularize it. The term discovery need not be limited to finding out information that no one knew before; in fact, Bruner points out that these discoveries are rare and described discovery to “include all forms of obtaining knowledge for oneself by the use of one’s own mind” (1961, p. 22). The common element in all forms of discovery is the transforming of evidence into additional new insights. The advantages of discovery learning are “(1)
The increase in intellectual potency, (2) the shift from extrinsic to intrinsic motivation, (3) learning from the heuristics of discovering, and (4) the aid to memory processing" (Bruner, 1961, p. 23).

While all of the above benefits are important for science education, learning the heuristics of inquiry is extremely important in mastering science process skills. "The school boy learning physics is a physicist, and it is easier for him to learn physics behaving like a physicist than doing something else" (Bruner, 1960, p.14).

Discovery learning requires active learning on the part of the student. Bruner stated, "Of only one thing I am convinced. I have never seen anybody improve in the art and technique of inquiry by any means other than engaging in inquiry" (1961, p. 31). Through the development of inquiry processes, the student is better able to make future discoveries. Bruner points out the quick rate of change in our world and indicated that "the principal emphasis in education should be placed on skills—skills in handling, in seeing, and imaging, and in symbolic operations" (Bruner, 1983, p. 138). Discovery learning not only teaches skills of learning and thinking, but it produces excitement about learning.

To help children learn, it is important to get children to reflect on what they are doing. According to Bruner, "It is not so much that the teacher provides a model to imitate. Rather, it is that the teacher can become a part of the student's internal dialogue—somebody whose respect he wants, someone whose standards he wishes to make his own" (as quoted by Lawrence, 1969, p. 21). Bruner warns against the teacher's temptation to "get across" part of the subject simply to impart information (Lawrence, 1969). Succumbing to this temptation will erode
many of the distinct advantages of this type of learning. For Bruner, "Knowing is a process, not a product" (1975, p. 72).

Vygotsky's "Zone of Proximal Development" is becoming a topic of interest to educators. This zone was defined by Vygotsky as "the distance between the actual developmental level [of the child] as determined by independent problem solving and the potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (Vygotsky, 1979, p. 86). The zone is created by both the child's level of development and the type of instruction received by the child (Wertsch, 1985). "Children do not 'possess' zones, varying in dimension, but rather a zone may be created in the course of their collaboration with a more competent partner" (Tudge, 1991, p. 1). "The zone of proximal development defines those functions that have not yet matured but are in the process of maturation, functions that will mature tomorrow but are currently in an embryonic state" (Vygotsky, 1979, p. 86). "What a child can do with assistance today she will be able to do by herself tomorrow" (Vygotsky, 1979, p. 87) and thus, Vygotsky concluded "The only instruction which is useful in childhood is that which moves ahead of development, that which leads it" (1987, p. 211). One of the most fundamental assumptions underlying Vygotsky's work was to understand the individual, one must understand the individual's social relations (Wertsch, 1985). Parents have the potential to help their child function first on the interpsychological plane and then on the higher intrapsychological plane (Wertsch, 1985).
Many teachers assume that what is taught by verbally "covering" material will be learnt as it has been heard. However, what learning is generated by an experience is tremendously variable (Freyburg & Osborne, 1985). From a constructivist perspective, learners must actively construct or generate knowledge based on sensory input (Freyburg & Osborne, 1985). Thus, the foundations of constructivist learning reside in hands-on and minds-on instructional techniques (Loucks-Horsley, et al., 1990). However, constructivist learning goes beyond the hands-on approach by including opportunities for students to engage in dialogue with others (Loucks-Horsley, et al., 1990). Learning is not passive, the student must be an active player (Loucks-Horsley, et al., 1990). Thus, activity is important for learning, but learning is enhanced when there is a chance for discussion.

This hands-on home science program involving parents is grounded in learning theories. The theories of Rousseau, Sheldon, Piaget, Bruner, and constructivists all support the active, hands-on experiences utilized in the SPLASH program. The child working with the more competent adult, in a mutually created zone of proximal development, should help the child develop. The discussion that results from this interaction is a key aspect of learning advocated by constructivists.

**Problem Statements**

This study was designed to evaluate a hands-on, home-science, parental involvement program implemented with sixth grade students.
The program being evaluated is Student Parent Laboratories Achieving Science at Home (SPLASH). The components of the SPLASH program are detailed in Chapter Three and all ten activities used in the SPLASH program are presented in Appendices H through R. The sub-components of the SPLASH evaluation are listed below as problem statements:

1. What percentage of families complete the hands-on, home-science activities and how does that vary over time?
2. Does the hands-on, home-science parental involvement program increase parental involvement?
3. What are parent and student perceptions about the hands-on, home-science parental involvement program?
4. Will the hands-on, home-science parental involvement program improve student science process skills as compared to students in a control group?
5. Will the hands-on, home-science parental involvement program improve student attitude toward science as compared to students in a control group?
Research Hypotheses

1. The percentage of students and parents doing hands-on, home-science parental involvement activities will increase each week. The percentage of activities completed will grow to match the percentage of traditional homework assignments completed by the control group.

2. As a result of hands-on, home-science parental involvement program implementation, parents will increase their involvement in their child’s education in the following three areas: (1) helping their child with SPLASH activities, (2) helping and monitoring their children’s homework, and (3) attendance at parent-teacher conferences. At the conclusion of SPLASH a majority of parents will report that being involved with SPLASH has made them more involved with their children’s education.

3. At the conclusion of SPLASH implementation, the majority of parents and students will report positive feelings in regard to conducting the SPLASH activities.

4. Students in the treatment group will achieve higher scores on the process skill instruments than the control group.

5. Students in the treatment group will report more positive attitudes toward science.
Chapter Summary

There are many calls and challenges for improving science education. A critical time for forming attitudes is in the adolescent years. The importance of active learning and parental involvement has been stressed by educational theorists for over 100 years. This hands-on, home-science parental involvement program (SPLASH) combines parental involvement with active learning to attempt to improve attitudes toward science and skills in science. The next chapter discusses research related to these areas.
CHAPTER II
REVIEW OF RELATED LITERATURE

The SPLASH program involves children learning science with their parents through hands-on science activities assigned as homework. This review of the literature primarily addressed research studies that involve these areas. The SPLASH program seeks to improve middle school students' science process skills and attitudes toward science. A review of research involving middle/junior high school students is also presented for these areas. This chapter begins with an examination of previous science education parental involvement programs.

Review of literature of parents and children learning science together

Research in the area of parents and children learning science together is limited and has primarily focused on parents and their children taking science classes together. Many of these classes were organized independent of schools. The other published articles reviewed in this section are descriptions and evaluations of programs where the parents and students work on science activities at home. Kellaghan, Sloane, Alvarez, and Bloom (1993) have found problems
with evaluating the effectiveness of parent involvement programs. Their research indicated that "many programs do not have formal evaluation components, or they collect only 'informal' data that cannot be readily interpreted outside the context of a particular study" (p. 103-104). This also applies to programs seeking parent involvement in science education. "Despite the fact that many researchers believe that parents are important in children's learning, only a few studies have been reported on methods used to involve parents in children's learning of science" (Gennaro & Lawrenz, 1989, p. 1031).

Another problem Kellaghan, et al. (1993) found is with the design of the studies.

It is extremely difficult to establish clear casual links between changes in parent variables and subsequent measures of children's performance or development. Many programs do not assess changes in parent variables at all, choosing to focus solely on measures of children's performance. Experimental studies (which would provide the strongest basis for making casual inferences), in which families are randomly assigned to "treatment" and "nontreatment" (or control) groups and relevant variables are controlled during the treatment period, are extremely difficult to implement in natural settings. Further, issues of equity and equal access may prevent researchers from withholding treatments from control-group families. (Kellaghan, et al., 1993, p. 104)

The majority of studies and projects reported in this section contain problems described by Kellaghan, et al. (1993). However, an analysis of the studies and projects can still provide useful information for the design and evaluation of other programs.
Science Enrichment Classes for Parents and their Children

Gins and Goodwin (1977) described a class for parents (without their children) designed to stimulate parental interest in the science education of their elementary school children. Five 90 minute seminars consisting of activities and discussion were held in the evening, one per week. The lecturers were satisfied with the level of parental interest and response during the sessions. "Solicited, unsigned responses from parents attending the final session were over-whelmingly favourable. Most commented on the interest that was created and how the material presented would help them understand their child's work in science" (p. 23).

Cohen (1979) described a program entitled "Chemistry for Parents and Children." Classes were held at Washburn University (Topeka, KS) for children in grades five through eight accompanied by a parent. Professors were encouraged not to lecture for long periods, and to use experiments, demonstrations, or classroom dialog wherever possible. After completing the six week program, parents and students completed an evaluation form. In the three years of the program, no negative evaluations of the program were received. There was no mandatory attendance policy, yet the average attendance was over 90%. One indicator of the elementary school children's enthusiasm for the program was the children's successful lobbying to have a subsequent course for junior high school students.

Gennaro, Bullock, and Alden (1980) reported a study of an animal behavior course for parents to take with their children. The course met
for three hours on five consecutive Saturdays and was held in a classroom at the Minnesota Zoological Gardens. Discussions, film viewing, observations, demonstrations, and activities were all part of the instructional process. After three families were deleted from the sample, the results of a posttest—a 15 item multiple choice content exam—showed statistically significant improvements over the pretest. In a questionnaire, all of the participants agreed that the home activity packets and class activities had increased their knowledge of animal behavior. All of the participants agreed that home communication had increased because of the home activity packets. The authors felt it would have been interesting to assess the students' attitudes toward science before and after the class. It was concluded by Gennaro, Bullock, and Alden that five weeks was a good length of time for the program, although the parents wished it was longer.

Five different science courses for parents and their sixth, seventh, or eighth grade children were used 35 times, mainly in the St. Paul, Minnesota area but also in Seattle, Washington; Athens, Georgia; and Milwaukee, Wisconsin (University of Minnesota, 1982). The content of the courses was designed to be different from the science taught in school. The courses duration was five weeks and they were held on Saturday mornings or evenings. Results of the field test indicate that 99% of the parents and children said they would recommend the program to a friend. Ninety-seven percent of the course participants liked taking the course with their parent/child. For these 97%, 48% explained that they liked it because it gave them an opportunity to work and learn together. For parents, the most useful part of the course was
the sharing of experiences with their children. Children tended to stress the content of the courses.

Ostlund, Gennaro, and Dobbert (1985) studied middle school children and their parents in family learning classes in science that was an expansion of the program described by Gennaro, Bullock, and Alden (1980). They found that the children indicated they signed up for the class due to subject matter interest. Parents indicated they signed up for the class due to a desire to help their child learn the material and to develop the child's interests. Comparing pretests and posttests, both parents and children made significant gains in content knowledge. Learning content was the most common response for both parents and students when asked for one particularly rewarding experience related to the course. When children were asked to list three things they liked about the program, 78% of the time they listed specific course activities. The most common source of frustration related to particular activities done; however, these same activities were listed by others as the most rewarding aspect of the course. Children's attitudes toward their parents and the course were significantly higher if the child perceived that the parents shared the in-class work with the child. From an analysis of verbal interactions between parent and child, children's learning was not based on the amount or type of verbal interaction between family members. There was no evidence that question asking by the parents promotes achievement.

Gennaro, Hereid, and Ostlund (1986) conducted a follow-up investigation to the study conducted by Ostlund, Gennaro, and Dobbert (1985). They collected data two to three years after the parents and
children had participated in a family learning in science class. Data were obtained from face-to-face interviews (6 focal pairs of parent and student interviewed together), telephone interviews (n= 25 parents and 25 children), and mail questionnaires (n=50 parents, 49 children). From all data sources, both parents and children reacted positively to the course.

Gennaro, Hereid, and Ostlund surveyed the influence of the course on learning behavior. Parents in the face-to-face interview reported little influence on their subsequent learning behavior. All of the children in the face-to-face interview reported participation in the course had influenced their subsequent learning behavior. A majority of parents and children in telephone interviews and mail questionnaires reported an influence on learning behavior. Parents in the face-to-face interview reported that the course experience did not influence their parent-child relationship; while half the children reported that it positively affected family relationships.

A majority of parents in telephone interviews and mail questionnaires reported participation in the course had increased communication within their family. Two-thirds of the children in the telephone interview also stated that communication had increased as a result of the course. The influence on parent-child relationships was not assessed on the child mail questionnaire.

Gennaro, Hereid, and Ostlund (1986) concluded that family learning courses in science were both enjoyable and challenging learning experiences. Both parents and students overwhelmingly stressed that they enjoyed the cooperative aspect of working together. Most parents and children said they would consider taking another family learning
course together. The parents' data from the parent-student, face-to-face interviews were different from parents' data from telephone interviews and mail questionnaires. The authors stated that it might have been better to interview the parents and children separately when conducting the face-to-face interviews.

Heller, Padilla, Hertel, and Olstad (1988) conducted two studies comparing middle school children learning about technology with their parents versus learning with their peers. In the first study, students and parents attended a class on communications technology. The course was held on five consecutive Saturdays and each class was approximately three hours long. For science activities done in the course, the treatment group had a parent-child pairing and the control group had a child-child pairing. All participants were pretested and posttested for content achievement. All participants were given a posttest for perceived skills and attitude. There were no significant differences between the treatment and control group in content achievement. "There were significant differences (p <0.05) between the two treatments in attitude toward working with a partner and attitude toward the course. Children in the child-child treatment had a more negative partner attitude, but a more positive attitude toward the course than children in the parent-child treatment" (Heller et al., 1988, p. 6).

In the second study by Heller et al., the participants enrolled in a microcomputer class. The structure of the class and experimental design was similar to the first study. The results of three analyses of covariance for the constructs attitudes towards computers, computer literacy, and content achievement revealed no significant interactions or main effects
for attitudes and achievement. For computer literacy there was a significant treatment effect favoring the parent-child pairings. There were no differences in content achievement or attitude towards the course for these groups; however, the authors indicated that this may be a self-selection problem, with highly motivated students signing up for the course. The majority of students who signed up for this course had yearly family incomes over $30,000, 59-63% of their parents described their occupations as professional or executive, and 94% of the students had grade averages of A or B.

The "Parents and Children for Terrific Science" (PACTS) program was supported by the American Chemical Society (Worthy, 1988). PACTS programs varied considerably based on where they were developed. One program had parents and children do field work testing of water samples on two Saturday mornings. Another PACTS program invited parents and children to meet on four evenings for science workshops. Approximately 15% of the students in one school's grades four through six participated in the program. No formal evaluation data were presented, however, one observed positive aspect of the program, as described by a program director, was: "How well the children and parents worked together and how they seemed to enjoy each other" (as quoted by Worthy, 1988, p. 26). Elementary teachers commented that some students who were discipline problems in school behaved appropriately during the PACTS workshops.

Rand and Gibb (1989) described Project Parity, a program to encourage more women to pursue scientific careers. The components of the program included parental involvement, hands-on investigations,
and female role models. Girls in grades 1-3 and 4-6 and their parents or
teachers participated in two 90 minute sessions held in the evenings.
Girls in grades 7-9 and their parents or teachers participated in two all
day sessions. At the beginning of each program, 30 minutes were used to
talk to parents about the goals of the program. "Parents, especially the
fathers, were instructed not to overhelp" (p. 146) the girls when doing
hands-on activities. In an evaluation of the program, Rand and Gibb
stated that more girls drew pictures of female scientists after the program
than before; however, the authors do not state if these differences are
statistically significant. A majority of girls indicated on a questionnaire
item that they liked science more after participating in the program.
Many parents expressed enjoyment in regard to working with their
daughters on the activities. "There was an overwhelming feeling that
the parents and daughters had fun during each session" (Rand & Gibb,

The Say Yes to a Youngsters Future Project utilized school-based
teams, staff development, and Saturday family math and science classes
to (a) improve the competence and confidence of elementary teachers in
mathematics and science, (b) involve parents and the community, and
(c) increase the mathematics and science interest and skills of elementary
school students of color (Beane, 1990). The parent and student classes
were held on eight Saturdays in one month intervals. These activity-
based classes were taught by the school's teachers; however, participating
students did not necessarily have their teachers involved. Activities
were given to the families to try at home. In the regular classroom,
teachers were encouraged to help students make connections between
the Saturday classes and the curriculum concepts. This two year program was carried out in Houston and New Orleans. Two schools had less than thirty families participating, 12 schools served between 30 and 60, and two schools had more than 60 families participating, with the upper range at 82 families. Beane was surprised by the number of grandparents that attended the sessions. In one district eight percent of the families were made up of children with their grandparents. Seven percent of the families had both the mother and father in attendance.

Participating students had greater gains in mathematics, reading, and science scores than did non-participating students. As a result of the program there was greater involvement in science fair projects. School principals reported that student attitudes and self-esteem had improved and the students were showing increased interest in science and math (Beane, 1990).

In conclusion, doing science with parents, guardians, or relatives appears to be a positive experience for children and the adults. Most courses did not tie the coursework to the curriculum the child was encountering in school. Most programs did not attempt to make program evaluation comparisons to equivalent groups. The comparisons between students in Beane's programs and non-participants are problematic because of selection problems. It would seem that the most involved parents and the most motivated students would be more likely to enter programs such as these. The aforementioned study by Heller et al. (1988) indicates that students who enter these programs are high achievers. Differences between program
participants and non-participants are not likely to be due to the programs alone.

Parents and Children doing Science Activities at Home.

The previous section focused on programs where the main emphasis was on science experiences for parents and students that took place outside of the home. This section describes projects and studies where the main component of the program was at-home science activities involving children and their parents.

Browne and Browne (1977) presented a plan called "Kitchen Science for Kids." In their plan students would be given voluntary science projects to do in their homes. Parents would act as research advisors, and a monthly meeting of the Research Advisors' Council would be held for the parents. During these hour-long meetings, the parents would receive information, conduct aspects of the investigations, and learn skills to help them advise their child on the research projects. The parent would also be given written material about the project in the "Advisor's Guide." Parents should also be told not to be a co-worker or supervisor, but to be an advisor. The authors did not state if this program was ever actually carried out, and there is no evaluation information presented.

Beisenherz (1980) discussed many ideas for getting parents involved in their children's science education. He recommended sending parents a letter prior to each unit asking parents for materials and offering the opportunity "for children to perform at-home activities related to the unit introduced in class." Beisenherz indicated that an
accompanying "For Parents" sheet might be necessary. No evaluative information on these ideas was presented.

Graika (1981) held a course for parents designed to get them to conduct and discuss science activities with their children. The course was held on five consecutive Saturdays. In the first class, Graika introduced parents to science and hands-on science activities for their children. The second class focused on science and creativity, and the third class explored ways to promote inquiry. Questioning was the focus on the fourth class, and the final session focused on measurement and nature study. Parents were given homework assignments that required them to work on activities at home with their children.

Graika observed that many of the parents' needs resembled the needs of pre-service and post-service elementary teachers that he had previously taught. From evaluation forms completed by parents, Graika concluded the course was a success. "Many parents reported their children's avid interest in the ideas they brought home each week. Moreover, the parents expressed appreciation for the chance to learn about science and to transmit their joy in learning to their children. The one regret mentioned was that children could not enroll in the parents' class, too" (Graika, 1981, p. 15). Graika found the courses reduced one parent's anxiety in working on science fair projects with her children. A large number of parents reported they made additional science discoveries with their children.

The School Partners Program has been used in grades three through six in Tennessee (Rhoton, 1989). Teachers prepared information packets and sent them to the students' homes early in the
school year. The packet provided an overview of the program, agreement forms, instructions for recording activities as they are completed, and a list of suggested activities and projects. If the parent and student agreed to participate they were expected to complete 15 activities or projects together. Students earned extra credit when they turned in written reports of the completed activities. While no formal evaluation of the program was presented, the author provided advantages of the program: (a) it promotes discussions between parent and child, (b) it is easy to implement and inexpensive, (c) there is less dependence on the teacher, (d) it encourages exploration of science, (e) it reinforces science taught in the classroom, (e) it is non-threatening, and (f) it increases student/parent interaction. "Not all students and parents will participate in the program. However, it is a valuable learning experience for those students who work with their parents to complete the activities" (Rhoton, 1989, p. 13).

Williams-Norton, Residorf, and Specs (1990) described a program to involve families in science. The Science: Parents and Children Explore (SPACE) program was designed to last one week. Students could earn points by working on science activities at home with their parents. The points awarded were used to help two imaginary creatures return to their “home galaxy.” Two activities per night were available for each student. Five points were given if the student returned a completed activity sheet with the parent's signature. One point was awarded if the activity sheet was signed by the parent but not completed, indicating the parent had no time to participate that evening. This program was reported in a non-research journal, however, some evaluation findings
are presented. From 24 elementary classrooms, over 95% of the parents participated. Out of 400 surveys mailed to parents, 140 evaluations were returned. Parental comments were overwhelmingly positive. Comments from the parents included the following: "It wouldn't hurt to have parent involvement-type programs more often.... It helps keep parents in touch with their children" (p. 15) and "the activities did not take too much time, so it was easy to incorporate them into our busy evening schedule" (p. 15). One suggestion expressed by several parents was the desire for more advance notification so that time and materials could be set aside.

Gennaro and Lawrenz (1989, 1992) investigated the effectiveness of take-home science kits at the elementary level. In the Hands Together Science program, students in first to fourth grades in a science magnet school were given the option of bringing science kits home to work on with a parent. The kits contained the materials and instructions for science activities. Six kits were available to first and third graders in the first year. Four kits were available to second and fourth graders in the second year. The participation rate was 87% of the students, with 75% bringing home five or more kits in the first year. In the second year the participation rate was 75% with 45% bringing home three or more kits. From examining activity booklets, Gennaro and Lawrenz determined "that most of the children completed most of the activities in the kits they took home" (1992, p. 989). Participation in the program was viewed as the treatment. "Because the treatment (working with the kits) is administered on an individual basis, the student is the appropriate unit of analysis" (p. 993).
Both parents and students expressed positive attitudes towards the program. Girls had more positive attitudes than boys, and the authors suggest this may be a way to keep girls in the science pipeline. Parents in the treatment group changed more in their attitudes about the importance of developing their children's science interests than did the control group. There were no consistent changes in science attitude for parents or students. There were no differences between students in the treatment and control groups on a curiosity scale.

In a journal for practitioners, Franklin and Krebill (1993) described a mathematics program that used take-home kits in their kindergarten classrooms. The program was expanded to include science and language arts. They developed 25 different kits so that all students could take home a kit, without one student feeling like he or she was stuck with the last one. So that one each of the four sessions of kindergarten would have kits, they created 100 kits. "In a given week, students can take home four different kits, the class average being two kits per student weekly" (Franklin & Krebill, 1993, p. 446). No formal evaluation of the program is presented, however, Franklin and Krebill indicated that parents and students were enthusiastic about the program. Other teachers started calling them to find out about using the kits. Students were excited to take home a new kit and often asked for ones they had done previously. "We have not yet had a student wanting not to take a kit home" (Franklin & Krebill, 1993, p. 446).

Major Conclusions From Research on Parent and Child Science Learning
The published studies in this area are limited, and few of the identified studies attempted to control for extraneous variables. Most of the work in this area has been done on having students and their parents attend out-of-school classes. In most of the projects, there was no attempt to integrate the out-of-school experiences with classroom experiences. However, the evidence indicates that parents and their children can learn science by taking science classes together and that they enjoy the experience. Fewer studies have been done on parents and children doing home science activities. These programs seem easier to implement for the classroom teacher and they can involve more parents. Descriptive data indicate that both students and parents express positive attitudes towards these programs. The only study that utilized a control group study found an "overall lack of change in parent and student data" (Gennaro & Lawrenz, 1992, p. 992) as a result of the program.

Review of research on benefits of hands-on science

There are many ideas about what constitutes hands-on learning. From an analysis of views from teachers, curriculum developers, researchers, and educational writers, Haury and Rillero (1994) in Perspectives of Hands-On Science Teaching and Learning define hands-on learning in science to be "any educational experience that actively involves people in manipulating objects to gain knowledge or understanding" (p. 11).

Constructivist perspectives make hands-on science a starting point for further learning. According to Loucks-Horsley et al. (1990), hands-on learning begins with students engaging in concrete activities
before exploring a topic abstractly. It involves the implication of teaching for depth rather than breadth (Loucks-Horsley et al., 1990).

However, most American schools only offer traditional instruction in science, with few tailoring their curricula for a hands-on approach (Howe, Blosser, Helgeson, & Warren, 1990).

Bredderman (1982) in a review and synthesis of 57 research studies involving 13,000 students, concluded that activity-based programs such as Elementary Science Study (ESS), Science—A Process Approach (SAPA), and the Science Curriculum Improvement Study (SCIS) are better than non- or partial-activity based programs in improving process skills, and that economically disadvantaged students benefit significantly more than average or advantaged students. Students in ESS, SAPA, and SCIS scored 20 percentile units higher on process skill exams than students in traditional programs. Comparing gains in learning science content, both types of programs are equivalent. Bredderman further concluded there was a modest advantage in improving science attitudes, creativity, language development, and reading for students in the activity-based programs.

Saunders and Shepardson (1984) compared a program which stressed hands-on instruction with another which did not involve any hands-on instruction. After a 9-month period, the hands-on instruction group (n=57) scored higher in science achievement and cognitive development than the formal instruction group (n=58).

Donnellan and Roberts (1985) found that adoption of an activities based elementary education program increased student learning and had the added benefit of enhancing integration of mixed race groups.
Kyle, Bonnstetter, McCloskey, and Fults (1985) reported a comparison of elementary school science programs comparing student and teacher attitudes toward the science of the Science Curriculum Improvement Study (SCIS) with those of students and teachers in non-SCIS classes. Students (n=456) preferred the SCIS process-approach to science, and SCIS teachers (n=109) spent more time teaching science.

Lloyd and Contreras (1987) reported that in instruction on the topic of the water cycle, groups which received hands-on instruction demonstrated a better understanding of the terms than groups which received traditional instruction.

Brooks (1988), in an intervention program for grades 4-6 used science manipulative materials and concept verbalization. He found that achievement scores rose as a result of the intervention.

Kyle, Bonnstetter, Gadsden, and Shymansky (1988), found that a hands-on program entitled "Science Through Discovery" in a Texas school district, improved students' attitudes towards science as well as their decision making skills regarding technological issues.

In conclusion, research on hands-on science indicates that students who do hands-on science have more positive attitudes toward science and greater confidence in their ability to learn science than students in conventional science classes (Kyle et al., 1988). Science achievement has been shown to increase for most students involved in hands-on programs (Shymansky, Kyle, & Alport, 1982). Students prefer hands-on science to conventional science (Kyle et al., 1988). Kotar (1988) describes an important outcome of hands-on science, students learn that science is fun. Despite the benefits of hands-on science, evidence
suggests that it is not widely used at the middle school level. Sixty percent of seventh graders indicated that they never had to write up the results of an experiment and only 46% of seventh grade teachers had access to a laboratory (Mullis & Jenkins, 1988).

Review of research on homework

Homework's dictionary definition is "schoolwork to be done outside of the classroom" (Guralnik, 1969) and "schoolwork assigned to be done outside the classroom (distinguished from classwork)" (Flexner, 1987, p. 94). In 1968, Strang concluded that the research on homework "is both limited and inadequate" (p. 3). Research on homework since then has produced conflicting outcomes (Cooper, 1989). Studies can be found that support the use of homework and other studies show homework is not effective for improving academic achievement. The best way to analyze this research is by examining syntheses of research.

Strang (1968) concluded that there were great variations in practices of homework. Most elementary schools had the view that school work should be done during the school day; although, some schools did give homework. Junior high schools give more work than elementary schools. This may be to bridge the gap between junior high school and high school, where a heavy load of homework is usually given to the students. "The majority (around 85 percent) of parents, teachers, and, to a lesser extent, students are in favor of homework of some kind, even in the elementary school" (Strang, 1968, p. 13).

Strang (1968) concluded that there was variation in the amount of time students in the same grade spent on homework. "It is not always
the less able learners who study the most. If the schoolwork is challenging, the bright students may spend a large amount of time in home study. Girls generally study more at home than boys” (p. 14). The standards of a school, the suitability of the curriculum, and quality of instruction can all influence how much homework is done by the students. Strang reported conflicting results in studies of the relationship between study time and achievement.

The types of homework that “able learners” like are writing research reports, finding arguments on both sides of a question, memorizing selections from great literature, reading books of their choice, and doing experiments with home equipment (Strang, 1968).

Cooper (1989) synthesized the research related to homework. He found 20 studies comparing student achievement for students doing homework to the achievement of students not given any homework. Of these studies, 14 produced effects favoring homework and 6 favored no homework. The benefits of homework in these studies depended on student age. In elementary school, there was no difference in achievement based on homework. High school students and middle school students both benefited from homework but high school students derive the most benefit.

Cooper (1989) analyzed another set of studies that were not experimental. These 50 studies correlated the amount of time spent on homework with student achievement. In 43 studies, students who did more homework had better achievement scores, while only seven studies showed the reverse. There was a grade-level interaction between homework and achievement. Students in grades three to five had a
correlation between homework and achievement of almost zero, for students in fifth grade through eighth grade the correlation was 0.07 and for high school students the correlation was 0.25.

The amount of time spent on homework may be reduced by watching television. The National Education Longitudinal Study of 1988 was a survey of 24,599 eighth grade students, parents, teachers, and school administrators (Rock, Pollack, & Hafner, 1991). The students in the study came from 1,035 selected schools from each of the fifty states and the district of Columbia. The science test used in this survey "consisted of 25 items testing the students' factual knowledge, conceptual understanding, and problem-solving skills in the areas of life science, earth science, and chemistry/physical science" (Rock, Pollack, & Hafner, 1992, p. 64). The lowest average science test scores (8.82) were recorded for students who reported watching 4-5 hours or more of television per week. The highest average scores (11.42) were recorded for students who watch between 1-2 hours of television per week. The effect size for this study was found by comparing the standard deviations of a group with the standard deviations of the group with the lowest score. The effect size for the 1-2 hours of television group was 0.32. The authors considered effect sizes in the range of 0.3 to 0.5 to be of medium effect and practically significant. Table 1 shows categories of student self reports of amount of time spent on science homework with the science scores and effect sizes. From the data, students who reported doing two or more hours of science homework did significantly better on the science tests.
TABLE 1
Time spent on homework by eighth grade students with science test means and effect sizes (n=24,599)

<table>
<thead>
<tr>
<th>Hours of Science Homework per Week</th>
<th>Test Mean</th>
<th>Effect Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>No homework per week</td>
<td>9.20</td>
<td>0.00</td>
</tr>
<tr>
<td>Less than one hour</td>
<td>10.00</td>
<td>0.14</td>
</tr>
<tr>
<td>One hour</td>
<td>9.89</td>
<td>0.12</td>
</tr>
<tr>
<td>Two hours</td>
<td>11.18</td>
<td>0.35</td>
</tr>
<tr>
<td>Three hours or more</td>
<td>11.37</td>
<td>0.38</td>
</tr>
</tbody>
</table>

Johnston and Schroer (1992) used take-home experiments in a college general education course entitled Energy and Environment. This course had no laboratory session and the rationale for the program was as follows:

Take-home experiments offer most of the benefits of laboratory sessions but cost much less; in some cases take-home experiments are the only opportunity for students to get hands-on experience doing experiments. Doing these experiments at home with materials borrowed from school is actually better in some ways than doing experiments during laboratory sessions. At home a student can work at his/her own pace and be completely responsible for the outcome, rather than being helped or hindered by lab instructors or lab partners. (Johnston and Schroer, 1992, p. 94).

The experiments were offered as a voluntary option to quizzes. Typically 25 students out of a class of 90 would do two experiments. Kits were available for students to check out for two days. Completed reports were
due one week after checking out the kits. Students usually worked in pairs on the kits, but wrote separate reports. Johnston and Schroeer (1992) concluded that such assignments may prove useful as supplements to college and high school classes that don't have laboratory sessions.

Quality research on homework appears limited and the studies available show conflicting results. However, reviews of research and meta-analyses suggest that there is a correlation between amount of time spent on homework and achievement. One project identified used hands-on science activities as a homework assignment (Johnston & Schroeer, 1992). In this university science class optional at-home science activities were offered and approximately 25% of the students opted for the at-home science activity. Research on parents helping with or monitoring homework is reported in the next section on parent involvement.

Review of research on parental involvement with implications for science education

The home environment is one of the most important factors affecting a student's academic achievement (Epstein, 1992; Sealey, 1985). Parents with positive attitudes toward school, typically have children who have higher academic achievement, social adjustment, and emotional stability (Sealey, 1985). Epstein (1992) concluded from her review of research on families and student learning, that students at all grade levels do better academic work, have better attitudes toward school, and higher aspirations when their parents are aware, knowledgeable, encouraging, and involved.
Strang (1968), in a summary of research discussed homework and family relations as a potential problem. She makes the following conclusions (without indicating the specific research that was used to form these conclusions): “The help a pupil gets from his parents or older brothers and sisters is often of doubtful educational value. Some parents mean well but confuse the child by using methods different from those used in school” (p. 18). Other problems include nagging, excessive pressure, and interruptions. Homework with no intrinsic value may produce conflict in the home. The adolescent may grow antagonistic toward his or her parents. “On the other hand, homework that consists of practical problems to work on at home, like those in the 4-H Clubs and Scout groups, may have value in bringing parents and children closer together through a common interest (Strang, 1968, p. 18).

Bobbitt and Paolucci (1975) in a survey of 108 blue-collar families found that all parents thought that some type of learning should occur in the home. The types of learning most mentioned were learning values, getting along with other family members, and caring for children. This study did not address the quality of home based learning, nor the effectiveness of support provided to families for home learning. Bobbitt and Paolucci made the following recommendations to educators based on his study:

Educators need to place emphasis upon helping learners acquire skill and competence in how to learn (process) rather than on what to learn (content). A major role of the education system should be to develop a favorable attitude about home learning and produce family members who are competent to direct their own and other family members' home-based learning activities. (1975, p. 161-62)
Louwerse (1981) administered a questionnaire to students in grades 9-12 (n=790). Among the reasons students take science are their enjoyment of science, the opportunity to do hands-on activities, and the influence of their parents. Students did not appear to take science because of counselor influence, effect of science on society, a desire to become scientists, or comparisons of science teachers to other teachers or science courses to other courses.

Stead (1982) conducted in depth interviews with New Zealand high school science students and their parents. He concluded that since students are influenced by their perceptions of other people's views, the parents' outlook on science needs to be developed. A comment by a mother illustrates a typical parent view of science. "My concept of science at school was where we had two periods a week and that was in the laboratory and that was it. You know—I sort of—I work in an office so, you know, I suppose I don't really know what field science covers really" (Stead, 1982, p. 22).

One program designed to involve parents by informing them of course content did not result in better student performance. Nelson (1988) randomly assigned 33 high school physical science students to an experimental and control group. The parents of students in the experimental group were informed of the objectives of the course. After one semester, there was no significant difference between the groups on grades achieved in the course.

Meyer, Linn and Hastings (1990) surveyed 650 parents of students in grades K-2 about the parents' out-of-school experiences with their
children. One category was involving the children with processes in the home, such as cooking. Another category of parent child interactions was parent-sponsored activities such as taking the child to museums, to the woods, and on nature walks. There were significant correlations (r=0.27 to r=0.61) between the number of educational activities done together and achievement on several science instruments.

The National Education Longitudinal Study of 1988 (Rock, Pollack, & Hafner, 1991) was described in the section on homework. Levels of parent involvement were ascertained and their effects on student achievement tests determined. The levels of parental involvement that were assessed were as follows: (a) parents check if homework was done, (b) parents limit TV watching time, (c) students discussed with parents: selecting courses/programs, (d) parents' educational aspirations for student, and (e) students planned high school program with Mother/Father. Parents checking homework produced effect sizes of 0.16 for rarely or never, 0.04 for often, and 0.00 for sometimes (the effect size of 0.00 indicates this group has the lowest average score and is therefore the referent). The variable—parents limiting television—produced effect sizes of 0.14 for sometimes, 0.12 for often, and 0.00 for rarely or never. The variable of discussing course or program selection with parents produced effect sizes of 0.57 for three or more times, 0.31 for once or twice, and 0.00 for not at all. For parent's educational aspirations for student, the effect size was 0.81 for college graduate or more, 0.35 for the don't know category, 0.25 for some post-high school, and 0.00 for high school or less.
The final measure of parental involvement on the National Education Longitudinal Study of 1988 (Rock, Pollack, & Hafner, 1991) was the variable of planning high school program with a parent. The effect sizes for this variable were 0.37 for three or more times, 0.22 for once or twice, and 0.00 for not at all. Maple and Stage (1991) found that parent involvement in planning a high school program and emphasizing college was a significant positive predictor for explaining college sophomore’s plans to take math and science courses.

The National Assessment of Educational Progress (NAEP) is a congressionally-mandated project to provide an on-going assessment of the American education system. NAEP data analyses have indicated that parental involvement is associated with student proficiency in various subject areas (Mullis & Jenkins, 1988). The 1986 data revealed that when asked if anyone at home talks to you about what you are learning, a majority of students in grades 3 and 7 responded yes, and a majority of students in grade 11 responded no. A majority of third and seventh graders and a minority of eleventh graders indicated that they had been helped with science homework and science projects by someone at home (Mullis & Jenkins, 1988). "Parents with higher levels of education are more involved in their children’s science learning by participating in projects, discussing ideas, and reading science books, and students with more of these experiences tend to have higher science proficiency scores” (Mullis & Jenkins, 1988, p. 119).

Williams and Chavkin (1989) identified and described the characteristics of promising parent involvement programs. They found seven essential elements of strong parent involvement programs: (a)
Written policies legitimized the importance of parental involvement and helped both staff and parents understand how the parents would be involved. (b) Administrative support was provided in three ways. First, funds were appropriated for the programs. Second, materials, space, and resources were made available for the programs. Third, people were designated who would carry out aspects of the program. (c) Training was provided for both staff and parents. (d) A partnership approach was used in areas such as planning, goal setting, definition of roles, and program assessment. (e) Two-way communication between home and school was an important part of these promising programs. "Parents felt comfortable coming to the schools, sharing ideas, and voicing concerns. School staff did not feel threatened by parent input, but welcomed it and used it to fashion relevant learning activities for students. Schools developed their own means of communication that best served parents" (Williams & Chavkin, 1989, p. 20). (f) Promising programs networked with other programs to share expertise, resources, and information. (g) Promising programs had evaluation activities at key phases and at the conclusion of a phase of the program.

From an assessment of the status of elementary science education in Illinois, Morey (1990) found parental participation in school science programs is very limited. One third of the teachers surveyed indicated that parents never get involved in their children's science programs. Only seven out of 105 teachers surveyed felt that parents are involved to a great extent. The most often cited ways parents help with science programs include: helping with science projects or homework, helping
with science fairs, being guest speakers in areas of expertise, supplying materials and helping chaperone field trips.

Fraser-Abder (1990) found that students whose parents were teachers did better academically than students whose parents were categorized as professional or managerial. She suggested this difference may be due to the out-of-school experiences provided by the parents whose occupation is teaching.

Reynolds (1991) conducted a longitudinal study of middle school student math and science learning and influences on that learning. Three waves of data were collected over a two-year period for a sample of 3,116 public school students. Science achievement was measured through the use of multiple choice, NAEP questions. For a measure of parental involvement, three dichotomous items were used from parents' self-reported information on whether they had visited school that year, did volunteer work, and attended school events. Parent expectations were determined by asking parents for the highest level of education they would like to see their children complete. A five point scale was used to code the responses. The results of this study indicated that parental expectations had moderate indirect effects on grade 8 achievement, especially through grade 7 achievement. Parent involvement in school had only modest effects on achievement. However, it did influence the students' perceptions of instructional quality in science and math.

Epstein and Herrick (1991) evaluated the use of Summer Home Learning Packets by 7th and 8th grade students in the summer of 1989. The 7th grade packet contained 16 math exercises and 11 English
exercises. The 8th grade packet contained 10 math exercises and 11 English exercises. The packets were sent by mail and contained a cover letter signed by the principal, the project director, and the parent liaison encouraging the parents to set aside thirty minutes per week assisting their children. After the summer, surveys were sent to parents about the program and students completed surveys at school. The survey return rate for parents was 21% (n=182) and for students it was 67% (n=591). Results indicated that approximately 25% of the families never received a packet. A majority of parent (91%) and student (72%) respondents indicated that they worked on at least one of the exercises. Whether or not parents worked outside of the home had no influence on the number of activities completed. A large proportion of students (43%) indicated that they worked on the activities by themselves. Another 32% indicated that they worked with a parent or adult at least some of the time. The remaining students did not complete any activities.

"Students who worked with someone at home or who said they had time for schoolwork in the summer were somewhat more likely to do more of the activities than those who worked alone or those who said they had no time" (p. 3).

A majority of parents completing the survey (93%) agreed that the packets showed them what their children had been learning in school. Almost all parents were enthusiastic about the packets and agreed that they should be sent home every summer. Parents of seventh graders were more positive than parents of eighth graders. Most parents (88%) reported they would like more information on how to help their children with schoolwork. Students were considerably less enthusiastic
about the program; 60% of them thought it was a good idea but only 24% agreed strongly with that statement. Seventh graders were more likely than eighth graders to like the program, enjoy the activities, and feel the program should continue. Girls completed more activities than boys, and were more likely to work with a parent on some of them. Many students (54%) reported that they did not think their teachers wanted them to talk about school at home. About an equal number indicated they did not like to talk about school at home. However, students who perceived that their teachers wanted them to talk at home about school were more likely to do so, were more likely to report there was a parent to help them, and had better attitudes toward the activities in the program.

Epstein and Herrick (1991) made some adjustments to the Summer Home Learning Packets and used them in the summer of 1990. This time more information on academic achievement was sought. Seventh graders were given a pretest using the California Achievement Test for reading and language arts. Course grades in English were also used as pretreatment indicators of the students' academic achievement. The posttest assessed some of the skills that appeared in the summer packets. There was a slight positive association between the number of activities completed and the overall posttest score (r=0.16). There was a positive association with spring grades and posttest results (r=0.33). There was no significant independent effect for program participation on posttest scores, after students' pretest scores were taken into account.

In The Learning Gap, Stevenson and Stigler (1992) reported the results of cross-cultural studies focusing on the roots of elementary
school academic achievement in East Asia and the U.S. They visited hundreds of classrooms, heard from thousands of parents and children, observed scores of teachers in Chicago, Sendai (Japan), Taipei (Taiwan), and Beijing. They found that first and fifth grade math achievement tests were lowest in Chicago. Comparing American education with Asian education, one major difference noted was in the pattern of parental involvement. When a child enters first grade the Asian parents start getting involved with the child’s learning activities, while U.S. parents begin to abdicate many of their responsibilities to their children’s teachers (American students hold their own or outperform Asian counterparts in achievement in kindergarten). An additional problem was found in American complacency.

One of the most sought-after goals in the world of marketing is a high degree of consumer satisfaction. But in the world of education, satisfaction by itself should not be the criterion for success. If both satisfaction and performance are high, we have cause for celebration. If satisfaction is high and performance is low, as is currently the case in the United States, we have cause for serious alarm. (Stevenson & Stigler, 1992, p. 128)

This review suggests that involving parents can influence students' enrollment in science courses and academic achievement. Epstein and Herrick (1991) concluded that “involving parents in learning activities at home is known to be the hardest type of involvement and the one that parents want most of all. It is, therefore, worth working to improve and extend home learning” (p. 6). However, Cooper (1989) in a review of research on homework that involved parents was not as optimistic: “The few (poorly designed) studies examining parent
involvement suggested that giving parents a formal role in homework had neither a positive or negative effect on its utility” (p. 89).

**Science Process Skills in Middle/Junior High School Science**

Science has been thought of by some as an organized body of knowledge. However, science is more than a product, it is a process; science is more than a collection of facts, science is what scientists do. In *Science—A Process Approach* (American Association for the Advancement of Science (AAAS), 1968) the basic process skills associated with science were listed as follows: observing, classifying, using space/time relationships, using numbers, communicating, measuring, inferring, and predicting. The basic process skills provide a foundation for higher integrated process skills. The integrated process skills are formulating hypothesis, controlling variables, interpreting data, defining operationally, and experimenting (AAAS, 1968).

“While the philosophical importance of the integrated science process skills is often unchallenged, there is a lack of research with middle and secondary school students to indicate how these skills might best be taught” (Padilla, Okey, & Garrard, 1984, p. 277). In the following section, a review of science process skill research at the middle school level is presented.

Padilla, Okey, and Garrard (1984) implemented a 14 week program designed to investigate integrating science process skill development lessons into an already existing middle school curriculum. They compared three treatments in improving process skills in sixth and eighth graders. The first treatment involved two weeks of instruction in
process skills and then one process skill activity per week for 14 weeks. Treatment two consisted only of the two weeks of process skill instruction. Treatment three was instruction with neither the two weeks of process skill instruction nor the process skill activities. Two sixth grade teachers and two eighth grade teachers in Georgia participated. Each teacher had four classes of students that were characterized as having a broad range of socioeconomic levels and academic achievements. The Test of Integrated Process Skills (TIPS) was used as an indicator of proficiency in process skills. Students were given a pretest and posttest.

The results of the study by Padilla, Okey, and Garrard (1984) indicated all groups increased in process skill achievement over the weeks of the treatment. No significant process skill differences were found among the sixth graders for the three treatments. There were significant differences in the eighth grade students, with scores from treatment one being significantly higher than the other groups. When the TIPS exam was broken into three subtests, there was a significant difference favoring treatment one for the hypothesizing and identifying variables subtest. No differences were found for any grade in the measuring and experimentation subtest or the graphing and interpreting subtest. Padilla, Okey, and Garrard suspect the low reliability of the TIPS for these two subcomponents may have resulted in insignificant differences. They question the practical significance of the statistically significant differences found because of the low proportion of explained variance due to the treatment (1% to 4%). Padilla, Okey, and Garrard concluded their article as follows:
Perhaps the most important finding from this study relates to how process skills should be integrated into the curriculum. Brief units devoted to integrated science skills were somewhat less beneficial than extended periods of instruction. It appears that integrated science process skills cannot best be taught as brief topics in the same way as volcanoes or density. Instead, greater benefit to students seems to result from integrating science content and process instruction over a longer period of time. (p. 286)

The authors also stated that more research is needed to shed light on this topic.

Berge (1990) investigated the effects of group size (individuals, pairs, and quads of student), gender, and ability groupings of 245 grade seven and eight students on science process skill achievement using microcomputers as tools. The Test of Integrated Process Skills (TIPS) and Test of Integrated Process Skills II (TIPS II) were used as a measure of process skill achievement. One was randomly selected and used as a pretest in all 12 classes and the other was used as a posttest. The intervention period consisted of 10, 50-minute lessons. Some of the major conclusions reached included the following: There was no significant difference in achievement based on the size of the group, there was no significant difference between males and females in learning the process skills, and low-ability students gained the most on the TIPS tests and high-ability students gained the least.

Rubin and Norman (1992) investigated the effect of three treatments, systematic modeling, learning cycle, and traditional science instruction, on the learning of the integrated science process skills of urban middle school students. The sample was composed of 327 sixth through ninth grade students, and characterized as having low
socioeconomic status and as exhibiting lower than average basic skill abilities. Students who experienced the systematic modeling demonstrated greater gains on the Middle Grades Integrated Process Skill Test (MIPT) than either of the other groups. The authors concluded "this would imply that students develop better process skills when given the opportunity to observe and imitate a person who has mastery of the skill, to practice the skill with the expert's guidance and, finally, to practice the skill independently" (p. 724). The learning cycle treatment also resulted in integrated process skill achievement which was superior to the traditional instruction. Another finding of the study was that students with higher cognitive reasoning ability can better achieve integrated science process skills; however, no significant increase in cognitive reasoning ability as measured by the Group Assessment of Logical Thinking was associated with the modeling instruction.

Kanis (1992) reported the American results of a hands-on problem-solving activities test used in the Second International Science Study. From an analysis of results from 3,000 students, Kanis indicated that "there is little difference between males and females in their overall correct responses to the activities. Also obvious from the data is the conclusion that students do reasonably well in manipulating equipment, observing, and describing but do poorly with generalizing, inferring, and drawing conclusions" (p. 30). The instrument that Kanis described, the Science Laboratory Practical Exam, is used as one of two science process instruments used in this study.

In conclusion, two studies using three different process skill instruments (Test of Integrated Process Skills, Test of Integrated Process
Skills II, and Science Laboratory Practical Exam) showed no differences between achievement for boys and girls. The research comparing different methods for teaching process skills to middle school students showed no significant differences for size of the learning group (Berge, 1990) and for type of instruction for sixth graders (Padilla, Okey, & Garrard, 1984). While there were no significant differences for sixth graders Padilla, Okey, and Garrard found some significant differences in eighth graders favoring the group that received two weeks of process skill instruction and then one activity a week for 14 weeks. This suggests that the acquisition of process skills in learning situations over an extended period of time is better than an intense, short learning period. Modeling can be effective in helping the student learn process skills (Rubin & Norman, 1992).

Science Attitudes and Middle/Junior High School Science

While there have been numerous science attitude studies, there have also been many criticisms of attitude research in science education (Haladyna, Olsen, & Shaughnessy, 1983; Munby, 1983; Shrigley & Koballa, 1992). Criticisms of science attitude research include: "(a) a frequent lack of theoretical perspective, (b) an insufficient representation of variables which might account for science attitude variance, (c) inconsistent definitions of attitude toward science, (d) inadequacy of instrumentation and data analysis, and (e) a general lack of integrative findings" (Haladyna, Olsen, & Shaughnessy, 1983, p. 311).

Much previous research investigated "The Scientific Attitude." In Science—A Process Approach (AAAS, 1968) scientific attitude is defined
as "the willingness to wait for a conclusive answer—the skepticism that requires intellectual restraint and the maintenance of doubt—is often-times difficult for adult and child alike.... The attitude of intelligent caution, the restraint of commitment, the belief that difficult problems are always susceptible to scientific analysis, and the courage to maintain doubt" (p. 2). Munby (1983) criticized the most popular instrument, the Science Attitude Inventory (SAI), as lacking in conceptual validity. From his review of research using the SAI, Munby concluded that "a bewildering set of varying results is seen" (p. 145). The SAI items represent habits of mind and mental processes of scientists. "Yet, an inspection of the instrument's subscales clearly demonstrates that the conception of attitude to science which underlies the instrument goes further than notions of critical and 'scientific' thinking" (Munby, 1983, p. 142).

Munby further concluded that "not only is the field of measuring attitudes replete with instruments, but that these instruments are used in a rather cavalier fashion, without heed of their reliability and validity" (1983, p. 157). After Munby's criticism of the SAI, the majority of attitude studies found for the middle/junior high school grades consider attitudes towards science rather than scientific attitudes. In this study, science attitude refers to students' general feelings about science and not to a particular way of thinking.

Haladyna, Olsen, and Shaughnessy (1983), used the Inventory of Affective Aspects of Schooling to research science attitudes in grades four, seven, and nine. A small number of factors showed consistent and high correlation with class attitude toward science. Student perception
of the importance of science was the most consistent of student variables. Next was student fatalism; the tendency to feel they have little control over their success in school. The biggest contributor to variance in all grades was the overall teacher quality. Within the learning environment, the enjoyment of classmates, school environment, and class environment were social-psychological factors that were highly related to science attitudes. The following factors in the classroom were highly related to science attitudes: satisfaction, attentiveness, goal direction, disorganization, apathy, material usage, and diversity. Parent involvement was only significantly correlated with attitude in the ninth grade.

From an analysis of NAEP data, Mullis and Jenkins (1988) concluded that a positive relationship exists between seventh and eleventh grade attitudes toward science and their proficiency in science. From reported positive attitudes toward science in the third grade, there was a decline to seventh grade and a further decline to eleventh grade.

Simpson and Oliver (1990) reported the results of a comprehensive study to "examine home, school and individual influences on attitude toward science and achievement in science among adolescent students" (p. 1). Variables related to self, school, and home were correlated to attitude toward science. Variables in school were most strongly related to attitude toward science. Of these variables, curriculum, class climate, friends, best friends, teacher, and physical environment showed the highest correlation. Home variables accounted for 39% of the total variance in attitude toward science. The highest correlations in the home section were for family science and
mother's attitude toward science. Variables affecting science achievement had lower correlation. The three variables—science self-concept, science anxiety, and attitude toward science accounted for 11% of the variance in achievement. Boys had consistently higher attitudes toward science than did girls. In this sample of students, attitudes declined from grades 6 to 10.

Rennie and Punch (1991) examined the relationship between affect and achievement for a sample of 390 Australian students in eighth grade. Using path analysis, they found the contribution made uniquely by affect to subsequent achievement to be small; the largest contribution in this study was 6%. This study found science-related affect to be more closely related to past achievement than to subsequent achievement.

Brunkhorst (1992) examined student outcomes and teacher characteristics in middle/junior high school programs labeled exemplary by the National Science Teachers Association's Search for Excellence in Science Education. Teachers in exemplary programs utilized hands-on experiences in their classes 91% of the time, and they lectured only 21% of the time. This constitutes a greater use of hands-on science for the exemplary teachers than the national average of 18% and lower use of lecture (36%) than the national average. Science attitude was assessed with the NAEP Preferences and Understandings instrument. Students in the exemplary programs had significantly better attitudes toward science than the NAEP national sample and had higher content achievement scores.

The research examined on attitude towards science suggests that this attitude is correlated with many other variables. Both school
variables and home variables can have an influence on attitude towards science. Only low correlations were found that relate attitude to achievement in science.
CHAPTER III
METHODS AND PROCEDURES

Design Overview

This study explored the effectiveness of a program which promoted parental involvement in hands-on activities assigned as homework to sixth grade students. The evaluation utilized a quasi-experimental, control-group design with classes randomly assigned to the control group and treatment group. Using the protocol of Rhoton (1989), "the term 'parent' can mean any adult in the home or outside the home responsible for the welfare of the child" (p. 11).

Participation in the SPLASH program was the independent variable. The dependent variables were students' general attitude toward science, students' science process skill achievement, and measures of the parents' involvement in their children's education. Additionally, data were collected on student and parent attitudes toward the SPLASH program. The percentage of SPLASH activities completed in the treatment group was recorded. Interviews with seven parents and six students were used to illustrate personal perspectives and experiences of people involved in the SPLASH program, as recommended by Patton (1990).
Two teachers and their four sixth grade classes participated in the study (N=203). Three students moved out of the school during the program. Following a model proposed by Slavin (1992), within-teacher random assignment of classes was undertaken.

In schools with departmentalization, where teachers have more than one class in the same subject, it is often possible to have teachers serve as their own controls by randomly assigning two or more of their classes to experimental and control conditions. A very good study can be done in such circumstances with as few as two teachers, where each teaches at least two experimental and control classes. (p. 29)

Besides being a practical way to conduct research, Slavin adds that this design largely solves the problem of teacher effects influencing the outcome of the experiment.

Three instruments were administered to students in the treatment and control groups of the study (see Table 2). These instruments were the Attitude Toward Science in School Assessment (ATSSA), the Science Process Assessment (SPA), and the Science Laboratory Practical Exam (SLPE). The ATSSA instrument was designed to measure general attitude toward science.

The SPA and SLPE were designed to measure science process skill achievement. The ATSSA and SPA were administered prior to and after the intervention period. The SLPE was administered after the intervention period. A fourth instrument, the Student SPLASH Questionnaire, designed to ascertain attitudes toward the SPLASH program, was administered after the intervention period to only the students in the treatment group. Data
### TABLE 2
Instruments Given to Students

<table>
<thead>
<tr>
<th>Group</th>
<th>Pretest</th>
<th>During Intervention</th>
<th>Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>ATSSA</td>
<td>ATSSA</td>
<td></td>
</tr>
<tr>
<td>Treatment</td>
<td>SPA</td>
<td>SPA</td>
<td></td>
</tr>
<tr>
<td>Treatment</td>
<td>SLPE</td>
<td>SPLASH Questionnaire</td>
<td></td>
</tr>
<tr>
<td>Treatment</td>
<td>Activity #2</td>
<td>Question</td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>ATSSA</td>
<td>ATSSA</td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>SPA</td>
<td>SPA</td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>SLPE</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### TABLE 3
Instruments Given to Parents

<table>
<thead>
<tr>
<th>Group</th>
<th>During Intervention</th>
<th>Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>Feedback on Activities</td>
<td></td>
</tr>
<tr>
<td>Treatment</td>
<td>Activity #3 Questionnaire</td>
<td></td>
</tr>
<tr>
<td>Treatment</td>
<td>Parent Questionnaire</td>
<td></td>
</tr>
<tr>
<td>Treatment</td>
<td>SPLASH Questionnaire</td>
<td></td>
</tr>
<tr>
<td>Treatment</td>
<td>Parent Interviews</td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>Parent Questionnaire</td>
<td></td>
</tr>
</tbody>
</table>
were also collected from SPLASH activity number two, which contained a request for students to write a few sentences explaining what they thought of the first two activities. Six student interviews were an additional source of data.

A source of data for the formative evaluation of SPLASH included the treatment group parents' evaluation of individual SPLASH assignments for their children's understanding and enjoyment of the activity, as well as the activity's usefulness in helping the parent understand what their children were learning in science class (see bottom of SPLASH activities in Appendix H through R). These questions were recommended by Epstein, Jackson, and Salinas (1992) in the Teachers Involve Parents in Schoolwork project. Evaluation data also came from SPLASH parents who answered the questionnaire in SPLASH activity number three. Parents in both the treatment and control groups provided descriptive data in the Parent Questionnaire (Appendix E). Parents in the treatment group had a subsection of items asking about the SPLASH program (see Table 3 and Appendix F). Seven parents in the SPLASH group were also interviewed as a part of the study.

Other data gathered were the number and percentage of SPLASH assignments completed and the number of parents attending parent-teacher conferences as recorded by one cooperating teacher.
Subjects

The students in this study were all sixth graders (n=203: treatment group=104, control group=99; males=95, females=108) in a central Ohio suburban middle school. Three students in the treatment group moved away during the study. The social-economic class of this suburb of Columbus, Ohio was characterized by the principal and cooperating teachers as middle to lower-middle class. Students from this middle school attend the same high school. Approximately 40% to 50% of the students in this high school attend college upon graduation. The majority of the students in the study were European-Americans. Approximately 15% of the students were from minority groups, the largest represented minority group was African-American.

Development of SPLASH materials

Ten SPLASH activities for each class were developed for this study. A three week SPLASH pilot program, conducted in a different Columbus, Ohio suburban school in 1992, provided useful insights into the design of SPLASH program and activities. The three activities used in the pilot study were modified and used in this study. Materials were also synthesized from other parent-involvement programs to arrive at criteria for the design of the SPLASH activities. These activities were designed to require the active participation of a parent, to help students learn process skills of science, and to complement the content of the classwork.
In addition to these criteria, the SPLASH activities used in this study were designed to: a) be appropriate for sixth grade students; b) involve the parent; c) take approximately 20 to 30 minutes to complete; d) be safe; e) stress hands-on learning; f) use readily available materials; g) produce meaningful learning; h) be enjoyable; i) require the parent's signature and have places for the parent to write comments; and k) indicate the date assigned and due date. Eleven SPLASH activities were custom-made according to the above criteria (see appendix H-R for actual activities). The two cooperating teachers were consulted about the appropriateness of topics and activities prior to their use in the class. The teachers used identical activities with one exception, activity six was different for the two teachers (Appendix M and N).

Implementation of SPLASH

SPLASH implementation began with a letter from the teachers notifying parents and guardians about the program (Appendix B). In that letter there was mention of an optional parents' night to help answer any questions parents have about SPLASH. During the parents night a hand-out explaining the program was given to attending parents (Appendix C). Parents were told about the program and allowed to ask questions. Students whose parents did not attend the parent night were given the hand-out to take home. After the parents' night, SPLASH implementation began.

For each week of regular school, students received a SPLASH assignment on Thursday. On Tuesday of the following week the assignment was due in class, however, the teacher also accepted the
assignment on Wednesday. Parents were encouraged to complete the assignment with their child. However, if a parent was not able or did not desire to complete the assignment with their child they were asked to sign the SPLASH assignment. Then the teacher would give the child an alternative homework assignment. Parents and children were instructed that the students should not do the SPLASH activities by themselves. SPLASH activities were graded in the same manner that the teacher graded other homework. For Teacher 2 this was in a check plus, check, check minus system. Teacher 1 used a percentage correct system.

Instrumentation

1. Attitude Toward Science in School Assessment

This Likert-scale instrument was developed by Germann (1988) to assess student attitude toward school science instruction rather than scientific attitudes. The term attitude was defined as “the affect for or against a psychological object” (p. 693). The Attitude Toward Science in School Assessment Instrument (ATSSA) used a unidimensional concept of attitude as opposed to multidimensional concepts. The ATSSA was designed to measure a single dimension of a general attitude toward science, specifically, how students feel toward science as a subject in school. Attitude, here, does not include such scientific attitudes that might motivate a person to become a scientist; that affect performance, competence, and success in science as a profession; that affect contributions to and acceptance of new knowledge; that deal with the foundations, interactions, and dynamics of science; or that apply to philosophy, ethics, or politics. Nor does it include other attitudes toward science, such as toward scientists, toward
methods of teaching science, toward scientific interests, or toward particular science courses. Another domain avoided was that of judgments of personal ability in science, the value of science to the individual, or the value of science to society. Science did not refer to specific courses in school or to specific activities that occur within science classes (i.e., lecture, discussion, lab, homework, field trips, etc.). (Germann, 1988, p. 694)

Thirty-four positive and negative items, many from other instruments, were evaluated for construct validity and clarity by a panel of three judges. As a result of the evaluation the number of items was reduced to 24. These items were used in a pilot test with 125 science student in grades 7 and 8. The Cronbach's alpha reliability was 0.93. From a factor analysis, 14 items were found that best fit the construct of general attitude toward science. These items were used in the ATSSA instrument.

Four field tests were used to determine the reliability and validity of the instrument. The field tests were conducted with students across the grades 7 to 12. The Cronbach's alpha estimates for reliability were all greater than 0.95. For the field test comprising seventh and eighth grade students, the Cronbach's alpha reliability was 0.96. The mean for this sample of seventh and eighth grade students (n=113) is 44.92 and the standard deviation is 12.70. In all four of the studies all of the 14 items loaded on only one factor and the percent of variation accounted for by this factor in the studies was 64.9, 69.8, 67.4, and 59.2, respectively. The discrimination of the instrument was demonstrated by item-total correlation, which ranged between 0.61 and 0.89. Attitude as measured by this instrument, correlated better with student lab scores and semester grades than it did with course and lab pretests or with summative SRA
achievement exams. The attitude toward science in school accounted for 16% of the total variation in achieved classwork, compared to 7% or less for pretest and summative scores.

2. Science Process Assessment

This multiple-choice test was designed to measure science process skills for students in grade four (Smith & Welliver, 1990). Specifically, the Science Process Assessment (SPA) measures the following process skills: a) observing, b) classifying, c) inferring, d) predicting, f) measuring, g) communicating, h) using space/time relations, i) defining operationally, j) formulating hypothesis, j) experimenting, k) recognizing variables, l) interpreting data, and m) formulating models. In developing the instrument, classroom teachers and science educators were invited to two workshops to generate items. Participants generated 65 test items which were comprehensively critiqued and narrowed down to 61 items.

To establish content validity, the 61 items were presented to a panel of science educators for the purpose of judging item acceptability. The 61 items were reduced to 55 items based on this analysis. These 55 items were piloted with 184 fourth-grade students. Students were given a copy of the test booklet and teachers were asked to read each item orally to the students. Data from the subsequent item analysis yielded a reliability coefficient of 0.73. From the analysis, the SPA was reduced to 40 items.

In the second pilot study, the test-retest method for ascertaining reliability was used. The sample size was 113 fourth grade students.
Reliability coefficients of 0.80 and 0.82 were ascertained for the first and second administration, respectively. The correlation between the two tests was 0.77. The means for test 1 and 2 were 30 and 31, respectively, the standard deviations were 5.26 and 5.30, respectively, and the standard error of the test means for both tests was 0.50 (Smith & Welliver, 1990).

3. Practical exam for Science Process Laboratory Skills

Kanis, Doran, and Jacobson (1990) participated in the development a *Science Laboratory Practical Exam* (SLPE) as a part of the Second International Association for the Evaluation of Educational Achievement (IEA) Science Study (SISS). The test was given to a representative sample of American fifth grade students (n=2,392) and ninth grade students (n=2,248). The following three main skill areas are assessed with this instrument: performing, investigating, and reasoning. The performing skill includes observing, measuring, and manipulating. The investigating skill includes planning and designing of experiments, and the reasoning skill includes interpreting data, formulating generalizations, building and revising models.

For this study, only the fifth grade form of the instrument was used, which Kanis (1992) indicated could be used in the fifth and sixth grades. There are two forms of the fifth grade instrument, Set A and Set B, both are meant to be used simultaneously. Set A contains five performing skill items, two reasoning skill items, and no investigation skill items. Set B contains five performing skill items, five reasoning skill items, and one investigation skill item.
The specific tasks for the instrument are as follows:

- Describe and explain color change of bromothymol blue solution after blowing through a straw.
- Cite at least three similarities and differences of two plastic animal specimens.
- Determine if four objects are electrical conductors by testing in a battery-bulb circuit.
- Predict and measure the temperature of the mixture of equal amounts of hot and cold water.
- Observe and explain the dissolving of coffee crystals in water.
- Determine which seeds contain oil by rubbing them on paper.

(Doran, 1990, p. 26)

The science items and procedures under consideration for the instruments for the international study were field tested. If 85% or more of the students answered an item correctly, it was eliminated for being too easy. If less than 35% of the students answered it correctly, it was removed for being too difficult. Items were also checked for discrimination, the extent to which they differentiate between strong and weak students. The content validity was checked by science educators from the National Committee of the Study and from faculty of the Department of Mathematics and Science Education at Teachers College, Columbia University (Jacobson & Doran, 1988). For SISS, six countries (Hungary, Israel, Japan, Korea, Singapore, and the U.S.A.) used the SLPE test for students in grades five and nine. The correlation of these scores with the standard paper-and-pencil assessment was \( r = 0.30 \) and \( r = 0.43 \) for Grade 5 sets A and B, respectively (Doran, 1987). "These values can be interpreted to mean that there is a moderate positive relationship with paper and pencil achievement tests, but that process tests are
substantively unique, separate measures of science performance" (Doran, 1987, p. 17).

4. Student SPLASH Questionnaire

The Attitude Toward Science in School Assessment instrument was designed to assess general science attitude and not attitude towards a specific type of instruction nor assignment (Germann, 1988). Thus, to determine students' attitudes toward the SPLASH activities, the Student SPLASH Questionnaire instrument was developed (please see Appendix D). This instrument contains Likert-style questions and free response questions.

5. Parent Questionnaire

Parents in the treatment and control group were administered the Parent Questionnaire consisting of Likert items and free-response items pertaining to aspects of the parents' involvement with their children's education and items requesting demographic information (Appendix E). Parents in the treatment group had additional questions concerning their views of the SPLASH program and the program's impact (Appendix F).

6. Interviews of Parents and Students in the SPLASH group

Seven parents and six students were purposefully selected for semi-structured interviews with open-ended questions. For each teacher, one student and his/her parent were selected from each of the following three groups: high SPLASH participation, moderate SPLASH participation, and low SPLASH participation. For Teacher 2, an
additional parent was selected for the high participation group. The researcher followed a protocol with listed questions to ask (please see Appendix G). Notes were taken during the interview, and with parental permission, the interviews were also audio tape recorded.

Procedures and Time Frame

The pretest Attitude Toward Science in School Assessment and pretest Science Process Assessment were administered during the last week of January and the first week of February in 1993. On January 26th, the two teachers involved in the SPLASH program gave their students a letter to take home to their parents explaining the program. A parents night was held on Thursday, February 4th at 7:00 PM. The following Thursday (February 11), the first SPLASH activity was assigned. It was due on Tuesday (February 16). Ten SPLASH activities were assigned, one per week of school. Because of a one week long vacation, a camping trip, and sex education instruction requiring the dividing of classes, the SPLASH intervention lasted 13 weeks; the last SPLASH assignment was given on April 29th and was due May 4th. That week and part of the next were used for three posttests: ATSSA (May 6), SPA (May 7 and 10), and SLPE (May 13 and 14). The school's regular parent-teacher conferences was held during two evenings in the first week in March. Data were collected on how many parents attended the conferences.

Data Entry and Statistical Analysis

Data from the instruments were entered into spreadsheets in Microsoft Excel. All data were double checked for accurate entry. The
SPSSx program for the Macintosh computer was used for the statistical analysis of the data. Means, standard deviations, and Cronbach alpha reliability measurements were calculated for the science attitude instrument (ATSSA) and the science process skill instruments (Science Process Assessment and the Science Laboratory Practical Exam). Descriptive statistics were reported for Parent Questionnaire, Student SPLASH Questionnaire, number of SPLASH activities completed, and levels of parent involvement.

Factor analyses were conducted on the ATSSA, SPA, Parent Questionnaire, and Student SPLASH Questionnaire. For the Parent Questionnaire, and Student SPLASH Questionnaire, the factor analyses were used to identify variables in these instruments.

Pretest and posttests were administered for the SPA and the ATSSA instrument. To compare the outcomes for the control group and the treatment group for the pretest and posttest, repeated measure analysis of variance was conducted. When significant interactions were found, the differences in the groups were explored using Fischer's least significant difference (LSD) method.

In comparing the treatment and control groups on levels of parental involvement, one source of data used was the number of parents attending Teacher 2's normal parent teacher conference. Differences between the treatment group and the control group on these parameters was investigated through a Chi-square analysis.

The data from the interviews were analyzed with the purpose of providing rich descriptions of participants' experiences, thoughts, and feelings associated with the SPLASH program. A secondary purpose of
the qualitative data was to compare families with different levels of SPLASH participation. In all the presentations of interview data and open-ended question results, the names of the students and other institutions were changed.
CHAPTER IV
RESULTS

Introduction

This study was designed to evaluate a hands-on science homework with parental involvement program called Student Parent Laboratories Achieving Science at Home (SPLASH). SPLASH was implemented with sixth grade students in a suburban area of central Ohio. In this chapter data pertaining to the following five problem statements will be presented:

1. What percentage of families complete the hands-on, home-science activities and how does that vary over time?
2. Does the hands-on, home-science parental involvement program increase parental involvement?
3. What are student and parent perceptions about the hands-on, home-science parental involvement program?
4. Will the hands-on, home-science parental involvement program improve student science process skills as compared to students in a control group?
5. Will the hands-on, home-science parental involvement program improve student attitude toward science as compared to students in a control group?
The research hypotheses (please see the end of Chapter 1) for each problem statement are used to organize the presentation of data.

**Analysis of Instruments**

Five instruments were used in the evaluation of the hands-on, home-science, parental involvement program. Reliabilities for these instruments or subsections of these instruments are presented in Table 4. These reliabilities are discussed in the section that describes the data from that particular instrument. The means, standard deviations (SD), and sample size for each instrument are also reported in Table 4. All Likert items contained a five point scale with 1, 2, 3, 4, and 5 representing strongly disagree, disagree, undecided, agree, and strongly agree, respectively.

**Research Question 1**

What percentage of families complete the hands-on, home-science activities and how does that vary over time? It was hypothesized that the percentage of students and parents doing the activities each week would increase, and that this percentage would grow to match the percentage of students completing a normal homework assignment.

The frequencies and percentages for the number of activities completed by students in the SPLASH classes are presented in Table 5. The largest frequency, 24 students or 11.8%, was for students who completed all ten activities. Only three students (1.5%) completed none of the activities.
TABLE 4
Descriptive Statistics and Reliabilities for Instruments Used in Study

<table>
<thead>
<tr>
<th>Instrument/Section</th>
<th>n=</th>
<th>Means</th>
<th>SD</th>
<th>Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Attitude (Germann)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pretest</td>
<td>190</td>
<td>4.04</td>
<td>0.75</td>
<td>0.95</td>
</tr>
<tr>
<td>Posttest</td>
<td>192</td>
<td>4.11</td>
<td>0.69</td>
<td>0.94</td>
</tr>
<tr>
<td>Sci. Process Assess. (Smith)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pretest</td>
<td>196</td>
<td>31.44</td>
<td>6.33</td>
<td>0.87</td>
</tr>
<tr>
<td>Posttest</td>
<td>193</td>
<td>32.35</td>
<td>6.54</td>
<td>0.89</td>
</tr>
<tr>
<td>Sci Lab Practical Exam A</td>
<td>102</td>
<td>11.32</td>
<td>2.18</td>
<td>0.96 (I.R.)</td>
</tr>
<tr>
<td>Sci Lab Practical Exam B</td>
<td>89</td>
<td>6.83</td>
<td>2.06</td>
<td>0.90 (I.R.)</td>
</tr>
<tr>
<td>Parent Data Likert Items</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parent Involvement</td>
<td>169</td>
<td>3.76</td>
<td>0.67</td>
<td>0.67</td>
</tr>
<tr>
<td>Parent Comfort</td>
<td>169</td>
<td>4.15</td>
<td>0.64</td>
<td>0.74</td>
</tr>
<tr>
<td>Homework</td>
<td>169</td>
<td>3.79</td>
<td>0.65</td>
<td>0.69</td>
</tr>
<tr>
<td>SPLASH Parent Data</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benefits</td>
<td>85</td>
<td>3.56</td>
<td>0.83</td>
<td>0.92</td>
</tr>
<tr>
<td>Problems</td>
<td>85</td>
<td>3.76</td>
<td>0.68</td>
<td>0.82</td>
</tr>
<tr>
<td>Student SPLASH Attitude</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benefits</td>
<td>97</td>
<td>3.30</td>
<td>0.97</td>
<td>0.91</td>
</tr>
<tr>
<td>SPLASH and Parents</td>
<td>97</td>
<td>2.81</td>
<td>1.02</td>
<td>0.77</td>
</tr>
<tr>
<td>Time and Homework</td>
<td>97</td>
<td>3.30</td>
<td>1.17</td>
<td>0.66</td>
</tr>
</tbody>
</table>

*Note. All reliabilities are Cronbach Alpha, except for the Science Laboratory Practical Exam which are interrater reliabilities.*
Figure 1 presents a graphical display of data for research question 1, what percentage of families complete the hands-on, home-science activities and how does that vary over time? During the SPLASH program, 57.1% of the assigned activities were completed by the students in Teacher 2's class compared to a 78.6% completion rate for students in Teacher 1's class. These different levels of activity completion are statistically significant (Table 6). Despite the differing levels, the variation of completion rates between the activities are similar for the two teachers (see Figure 1). The research hypothesis that the level of completion of the activities will increase throughout the program was not supported. The mean rate of completion of activities in the first week of SPLASH was 87.0% and 45.3% for the last week.
The second hypothesis was that the level of completion of the activities would grow to match the level of completion of normal homework assignments. The estimated completion rate of a normal homework assignment was between 70 to 75% for the two teachers. The SPLASH levels of completion started higher than this for both teachers. There was a gradual decline from the first activity to the last activity, with a sharp decline for activities four and five. Thus, there was no evidence to support the second hypothesis that the level of SPLASH participation would grow to match the

Figure 1. Activity Completion Percentages for Each Week by Teacher.
TABLE 6
Means, Standard Deviations, and T-Test for Number of Students Completing Activities by Teacher

<table>
<thead>
<tr>
<th>Teacher</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>T</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher 1</td>
<td>49</td>
<td>7.86</td>
<td>2.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teacher 2</td>
<td>52</td>
<td>5.71</td>
<td>3.39</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T-test Statistics</td>
<td>3.73</td>
<td>&lt;.001</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TABLE 7
Adult Reasons for Not Doing SPLASH Activity 4: Settle Down!

**Time Problems**

"Was unable to do this activity with Emily as her father & I had an appointment."

"We did not have time to do this activity and Mark will turn it in on Wednesday."

"We can't find the Splash activity sheet, I'm sorry to say. Please excuse Christie for the next 2 months from her Splash activities. I am currently working on my thesis and am at West Middle School (name changed) from 8 to 3, then I go to work until 8:00. By the time I come home there isn't time to do the exercise. Thanks."

"Didn't have time."

"Didn't realize this one took extra-time."

**Material Problems**

"Don't have these materials."

"We did not do this because we lacked the materials."

**Sickness Problems**

"I am sorry that we cannot do this Splash activity. With Anna being sick we did not have time to prepare."
level of normal homework completion. The SPLASH participation level was higher initially than the homework completion level and ended lower.

Activity four, five, nine, and ten had the lowest levels of completion.

For activities four and five there was a decline in the percentage of activities completed (Figure 1). When parents did not do an activity with their child they were asked to sign the activity. In addition to signing the activity some adults would provide reasons for not doing the activity. These reasons are categorized in Table 7 and Table 8 for activities four and five, respectively.

<table>
<thead>
<tr>
<th>Time Problems</th>
<th>Material Problems</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;I have been in evening meetings at work every night until late and didn’t have the extra time to do the project.&quot;</td>
<td>&quot;Could not complete—no materials.&quot;</td>
</tr>
<tr>
<td>&quot;This assignment given out too late for us to complete please substitute w/a homework paper. Thank you.&quot;</td>
<td>&quot;We did not do this because we lacked the materials.&quot;</td>
</tr>
<tr>
<td>&quot;Not enough time.&quot;</td>
<td>&quot;We did not have the materials for this activity.&quot;</td>
</tr>
<tr>
<td>&quot;Paper was not give to me until Tuesday morning 3/16.&quot;</td>
<td>&quot;Because of snowstorm couldn’t get out to the garden to dig up soil.&quot;</td>
</tr>
<tr>
<td>&quot;I’ve had to work the last five days so we have not been able to do this project.&quot;</td>
<td>&quot;We did not have access to the materials needed for this experiment.&quot;</td>
</tr>
<tr>
<td>&quot;Did not have time. Looked to long.&quot;</td>
<td>&quot;We did not have the materials to do this project.&quot;</td>
</tr>
<tr>
<td></td>
<td>&quot;Wrong time for soil projects!&quot;</td>
</tr>
<tr>
<td></td>
<td>&quot;No soil available—blizzard.&quot;</td>
</tr>
<tr>
<td></td>
<td><strong>Sickness Problems</strong></td>
</tr>
<tr>
<td></td>
<td>&quot;I am sorry but I had the flu this weekend and Monday and was unable to start this project with Valerie. Also I was unable to get materials required.&quot;</td>
</tr>
</tbody>
</table>
In conclusion, 98.5% of the families did at least one SPLASH activity. Rather than the hypothesized increase in participation levels, there was a decline. Reasons for lower participation levels for activities four and five appear to be the difficulty getting soil due to a snowstorm. A decline in the number of activities completed for activities nine and ten was observed. Possible reasons for this decline are presented in the section, Student and Parent Interviews, at the end of this chapter.

Research Question 2

Research question two asked if the program would increase parental involvement. The research hypotheses were that parents will increase their involvement in their child’s education in the following three areas: (1) helping their child with SPLASH activities, (2) helping and monitoring their children’s homework, and (3) attendance at the school’s parent-teacher conferences.

The instructions to parents in the SPLASH program were that students should not do the activities alone. The adult participating in the activity not only had to sign the activity upon completion, but also write answers on the activity itself. From Figure 1 and Table 5, it is evident that throughout the program a majority of students completed the activities. Approximately seventy percent of the parents indicated that they had helped their children learn science by doing the activities together (Table 14). This suggests that parents were involved in working on the activities.

The relation of the adult completing the activities to the child can be gleaned from the following three sources: The student’s answer to who helped them with specific activities they completed, the parent’s SPLASH
questionnaire that was to be completed by the adult who helped the most with the SPLASH activities, and a parent question on SPLASH activity four (see Appendix K). From an analysis of the student response data, the range of either one or both parents as the adults helping with specific activities ranged from a low of 93.2% to a high of 100%. The majority of adults helping with each activity were the mothers of the children. After mothers, fathers were the next most likely adult to help. From the SPLASH parent questionnaire, which was to be completed by the parent doing the most SPLASH activities, 81.1% of the forms were completed by mothers and 17.8% by fathers. SPLASH activity four contained a short questionnaire that was completed by the adult helping with the activity (n=58). Thirty mothers (51.7%), twenty-six fathers (44.8%), one uncle (1.7%), and one brother (1.7%) worked on the activities with students. Thus, from three different data sources it is concluded that the program did involve parents working with their children on the activities.

The second hypothesis stated that involvement in the SPLASH program would increase the amount of time parents spend helping and monitoring their children's homework. The Parent Questionnaire asked parents to indicate the time spent helping and monitoring their children's homework for all classes (item 1 in Table 9) and for science class (item 2 in Table 9). Parents in the SPLASH program were instructed not to count the time for SPLASH activities. The time for helping or monitoring homework reported for this question was 94.6 minutes a week (SD=104.2) for parents in the treatment group and 125.0 minutes a week (SD=142.1) for parents in the control group. From an analysis of variance (ANOVA), this was not a statistically significant difference (Table 10 item 1). For treatment group parents and control group parents, the weekly time reported for helping and
Table 9
Means and Standard Deviations of Parents Reported Time Spent Monitoring and Helping with Homework by Experimental Group

<table>
<thead>
<tr>
<th>Time Reported for Monitoring and Helping with Homework</th>
<th>Treatment Mean (SD)</th>
<th>Control Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. For all classes (not including SPLASH time)</td>
<td>94.6 (104.2)</td>
<td>125.0 (142.1)</td>
</tr>
<tr>
<td>2. For Science HW Time (not including SPLASH time)</td>
<td>21.1 (23.6)</td>
<td>32.3 (64.8)</td>
</tr>
<tr>
<td>3. For non-science classes</td>
<td>74.9 (90.7)</td>
<td>91.4 (110.5)</td>
</tr>
<tr>
<td>4. Total Time (includes SPLASH time)</td>
<td>122.8 (106.2)</td>
<td>125.0 (142.1)</td>
</tr>
<tr>
<td>5. Science Total (includes SPLASH time)</td>
<td>49.6 (32.0)</td>
<td>32.3 (64.8)</td>
</tr>
</tbody>
</table>

Table 10
Analysis of Variance of Time Spent Helping or Monitoring Homework by Experimental Group

<table>
<thead>
<tr>
<th>Time Reported for Monitoring and Helping with Homework</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. For all classes (not including SPLASH time)</td>
<td>1</td>
<td>24354.00</td>
<td>1.48</td>
<td>.225</td>
</tr>
<tr>
<td>2. For Science HW Time (not including SPLASH time)</td>
<td>1</td>
<td>4254.71</td>
<td>1.72</td>
<td>.192</td>
</tr>
<tr>
<td>3. For non-science classes</td>
<td>1</td>
<td>10127.46</td>
<td>0.80</td>
<td>.374</td>
</tr>
<tr>
<td>4. Total Time (includes SPLASH time)</td>
<td>1</td>
<td>282.95</td>
<td>0.02</td>
<td>.896</td>
</tr>
<tr>
<td>5. Science Total (includes SPLASH time)</td>
<td>1</td>
<td>11588.67</td>
<td>4.31</td>
<td>.040</td>
</tr>
</tbody>
</table>
monitoring science homework was 21.1 minutes (SD=23.6) and 32.3 minutes (SD=64.8), respectively, again not a statistically significant difference (Table 10 item 2). To arrive at the time spent by parents helping and monitoring homework for all classes except science class, the time spent helping and monitoring their child's science homework was subtracted from the time spent for all classes. The treatment group's time was 76.4 minutes (SD=90.7) and the control group's time was 91.4 minutes (SD=110.5). This was not a statistically significant difference (Table 10 item 3). It would appear that parents' self-report indicates SPLASH parents were spending less time helping and monitoring non-SPLASH related homework, however, these differences are not significant.

The mean time the parents reported for working on one SPLASH activity was added to the time they reported helping and monitoring homework. The total for the treatment group of 122.8 minutes per week (SD=106.2) helping and monitoring homework for all classes was almost equivalent to the time of 125 minutes (SD=142.1) for the control group (item 4, Table 9). This difference was not statistically significant (Table 10 item 4), and therefore, the hypothesis—that the amount of time parents spent helping and monitoring homework would increase—was not supported. The amount of time helping and monitoring science homework with the addition of the mean time for a SPLASH activity was 49.6 minutes per week (SD=32.0) for the treatment group. This was a larger value than the minutes per week reported spent by the parents in the control group (32.3) and the difference was statistically significant (F=4.31; df=1, 145; p=0.040; see Table 10, item 5).

On the Parent Questionnaire there was a statistically significant difference (F=6.37; df=1, 145; p=0.013) between the treatment and control group.
on the item "I frequently help my child with science homework." The mean scores on this item were 3.02 (SD=1.13) and 2.61 (SD=1.01) for the treatment and control groups, respectively. There was also a statistically significant difference (f=10.21; df=1, 145; p=0.002) on the parental questionnaire item "I have a good idea of what my child does in science class." The mean reported answer for the treatment group and the control group, was 3.76 (SD=0.77) and 3.31 (SD=1.06), respectively.

In a factor analysis of the Likert items on the Parent Questionnaire, three factors were distinguished (Table 11). One of the factors was a measure of parental involvement (question numbers 2, 3, 4, and 9, see Appendix D). The Cronbach's alpha reliability of this subsection, Parent Involvement, was 0.67. The correlation between Parent Involvement and time parents spent helping and monitoring homework (not including SPLASH activity time) was significant (r=0.20, p=0.012). The mean score on the variable Parent Involvement for the treatment group was 3.82 (SD=0.60) and for the control group was 3.71 (SD=0.73). Based upon an ANOVA this difference between groups was not statistically significant (Table 12).

Item nine and item three of this variable are straightforward indicators of a parent's overall feeling of involvement in their child's education and their knowledge of what their child was learning in science, respectively. Comparing responses on item nine, "I feel involved in my child's education," 93.0% of the parents in the treatment group and 85.7% of the parents in the control group agreed or strongly agreed with the statement. This difference was not statistically significant. Comparing responses on item three, "I have a good idea of what my child does in science class," 76.5% of the parents in the treatment group and 54.8% of the parents in the control group agreed or
<table>
<thead>
<tr>
<th>Item #</th>
<th>Item on Factor</th>
<th>Factor Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>I feel involved in my child's education.</td>
<td>0.79</td>
</tr>
<tr>
<td>2</td>
<td>I make sure my child has completed all homework assignments.</td>
<td>0.71</td>
</tr>
<tr>
<td>3</td>
<td>I have a good idea of what my child does in science class.</td>
<td>0.67</td>
</tr>
<tr>
<td>4</td>
<td>I frequently talk to my child about science.</td>
<td>0.60</td>
</tr>
</tbody>
</table>

**Factor 1: Parent Involvement**

Total Variance Explained=30.3%  Reliability of Factor=0.67

<table>
<thead>
<tr>
<th>Item #</th>
<th>Item on Factor</th>
<th>Factor Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>I would feel comfortable helping with science homework.</td>
<td>0.89</td>
</tr>
<tr>
<td>7</td>
<td>I would feel comfortable helping with a science fair project.</td>
<td>0.89</td>
</tr>
<tr>
<td>5</td>
<td>Hands-on Science activities are a good way to learn science.</td>
<td>0.58</td>
</tr>
</tbody>
</table>

**Factor 2: Parent Comfort With Science**

Total Variance Explained=18.7%  Reliability of Factor=0.74

<table>
<thead>
<tr>
<th>Item #</th>
<th>Item on Factor</th>
<th>Factor Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>My child does not usually ask for help with science homework.</td>
<td>0.88</td>
</tr>
<tr>
<td>6</td>
<td>I frequently help my child with science homework.</td>
<td>0.82</td>
</tr>
</tbody>
</table>

**Factor 3: Parent Helping With Homework**

Total Variance Explained=13.5%  Reliability of Factor=0.69
strongly agreed with the statement. Assuming parents in the treatment and control groups were equivalent at the beginning of the study, the statistically significant differences on this item (t= 3.19; df=167; p=0.002) may be an indication that SPLASH involvement helped increase parents' understanding of their child's science education.

The second factor on the Parent Questionnaire involved parents' comfort levels with involvement in science (question numbers 5, 6, and 8, see Table 11). The Cronbach's alpha reliability of this subsection, Parent Comfort With Science, was 0.74. The mean score on this variable for the treatment group was 4.06 (SD=0.67) and for the control group it was 4.25 (SD=0.59); the difference between groups was not statistically significant (F=3.86; df=1, 167; p=0.051; see Table 10). For parents in the treatment group, there was a significant correlation (r=0.43, p<0.001) between Parent Comfort With Science and the number of SPLASH activities completed.

The last factor of the Likert items of the Parent Questionnaire contained the following two items: Students asking for help with homework and parents helping with homework (item number 1 and 6, see Table 11). Question 1 was a negatively stated item, so the responses were reverse coded. Questions 1 and 6 constitute the variable Parent Helping With Homework. This variable was correlated significantly with the parents' reported time helping and monitoring homework (r=0.29, p<0.001). The Cronbach's alpha reliability of the items in this variable was 0.69. The treatment group mean for Parent Helping With Homework was 2.74 (SD=0.94) and the control group mean was 2.52 (SD=0.96), again not a statistically significant difference (see Table 12).
TABLE 12
Parent Questionnaire Variables for Treatment and Control Groups

<table>
<thead>
<tr>
<th>Variables</th>
<th>Treatment</th>
<th>Control</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>Mean (SD)</td>
<td>n</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td>Parent Involvement</td>
<td>85</td>
<td>3.82 (0.60)</td>
<td>84</td>
<td>3.71 (0.73)</td>
</tr>
<tr>
<td>Parent Comfort with Science</td>
<td>85</td>
<td>4.06 (0.67)</td>
<td>84</td>
<td>4.25 (0.59)</td>
</tr>
<tr>
<td>Parent Helping with Homework</td>
<td>85</td>
<td>2.74 (0.94)</td>
<td>84</td>
<td>2.52 (0.96)</td>
</tr>
</tbody>
</table>

Note. n=sample size; SD=standard deviation of sample.

The third hypothesis concerning parental involvement was that parents' attendance at a parent teacher conference would increase due to involvement in the SPLASH program. Data, available only from Teacher 2, show 26.5% of the treatment group parents and 27.1% of the control group parents attended parents night conferences. From a chi-square analysis of these data there was no significant difference between the treatment group and control group ($X^2=0.0003$, $p=0.985$) in parent attendance at the parent teacher conference. Thus, the third hypothesis was not supported by the data.

The final hypothesis stated that at the conclusion of SPLASH a majority of parents will report that being involved with the program has made them more involved with their children's education. Parents in the treatment group were asked if they felt more involved in their child's education as a
result of the SPLASH program. A mean score of 3.41 (SD=1.13) was obtained for this item with 58.8% of the parents agreeing or strongly agreeing (see Table 14). Thus, this hypothesis was supported. Only a minority of SPLASH students, however, perceived their parents as more involved. On the SPLASH questionnaire they were asked if they thought their parents were more involved as a result of SPLASH. A mean score of 2.74 (SD=1.26) on this item was obtained from the student data, with only 28.9% of the students agreeing or strongly agreeing (see Table 17).

In conclusion, SPLASH did involve the parents in doing science activities with their children. Mothers helped more than fathers. A majority of parents felt they were more involved in their children's education as a result of SPLASH, but only 28.9% of their children felt their parents were more involved. There was no evidence that parents were spending more time overall helping and monitoring their children's homework. It does appear that they were spending more time helping and monitoring science homework. Presumably, this was due to the time they spent helping with the SPLASH activities. There was no evidence that SPLASH increased parental attendance at parent teacher conferences.

Research Question 3

Research question three explored how students and parents feel about the SPLASH program. It was hypothesized that at the conclusion of SPLASH implementation, the majority of parents and students will report positive feelings in regard to conducting the SPLASH activities. In this section, results of the student and parent SPLASH questionnaire are presented. Later in this chapter, the results of interview data for this question are presented.
Two factors were revealed in a factor analysis of SPLASH evaluation items answered by parents in the treatment group (Table 13). The individual item descriptive statistics are reported in Table 14. The first factor (items 10-13, 15-17, and 24) was associated with positive outcomes of SPLASH (Cronbach's alpha reliability=0.92) and the second factor (items 14, 18-20, 22, 23) was associated with potential problems of the SPLASH activities (Cronbach's alpha reliability=0.82).

The mean score on the Parent Benefits of SPLASH was 3.56 (SD=0.83). This variable was significantly correlated with students' pretest science attitude scores ($r=0.32$, $p=0.004$), posttest attitude scores ($r=0.31$, $p=0.004$), and the number of SPLASH activities completed ($r=0.31$, $p=0.001$). Parents in general expressed positive attitudes toward the program, and a clear majority (83.5%) of parents agreed or strongly agreed that all parents should do at least one SPLASH activity (see Table 14).

The mean score for the variable Parent Problems With SPLASH (items 14, 18, 19, 20, 22, and 23) was 2.24 (SD=0.68). The low mean indicates that parents tended to disagree that the items were problems they encountered. The evaluation of potential problems of SPLASH revealed that only a minority of parents agreed or strongly agreed that time, money, or materials were problems (Table 14). A minority of parents agreed or strongly agreed that the SPLASH instructions were too confusing, that they did not know enough science to work effectively on the activities, or that the activities were too difficult. The biggest problem with SPLASH activities from the parents' perspectives were the confusing instructions. On the Parent Questionnaire, 27.4% of the parents agreed or strongly agreed that the instructions in the activities were confusing.
**TABLE 13**
Factor Analysis Results of Parent SPLASH Questionnaire Items

**Factor 1: Parent Benefits of SPLASH**
Total Variance Explained=48.8%  Reliability of Factor=0.92

<table>
<thead>
<tr>
<th>Item #</th>
<th>Item on Factor</th>
<th>Factor Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>17</td>
<td>I feel more involved in my child’s education as a result of SPLASH.</td>
<td>0.85</td>
</tr>
<tr>
<td>13</td>
<td>I would recommend SPLASH activities to my friends.</td>
<td>0.81</td>
</tr>
<tr>
<td>6</td>
<td>My child learned a lot from doing SPLASH.</td>
<td>0.81</td>
</tr>
<tr>
<td>15</td>
<td>SPLASH program should be done again next year.</td>
<td>0.79</td>
</tr>
<tr>
<td>10</td>
<td>I enjoyed the SPLASH activities.</td>
<td>0.76</td>
</tr>
<tr>
<td>12</td>
<td>The SPLASH activities helped me know my child better.</td>
<td>0.71</td>
</tr>
<tr>
<td>11</td>
<td>SPLASH helped me learn science.</td>
<td>0.71</td>
</tr>
<tr>
<td>24</td>
<td>All parents should do at least one SPLASH activity.</td>
<td>0.67</td>
</tr>
</tbody>
</table>

**Factor 2: Parent Comfort With Science**
Total Variance Explained=11.5%  Reliability of Factor=0.82

<table>
<thead>
<tr>
<th>Item #</th>
<th>Item on Factor</th>
<th>Factor Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>I did not know enough science to work effectively on SPLASH activities.</td>
<td>0.84</td>
</tr>
<tr>
<td>23</td>
<td>Materials for SPLASH were too hard to get.</td>
<td>0.74</td>
</tr>
<tr>
<td>22</td>
<td>Most activities were too difficult for my child.</td>
<td>0.72</td>
</tr>
<tr>
<td>18</td>
<td>Activities required too much money for materials.</td>
<td>0.71</td>
</tr>
<tr>
<td>19</td>
<td>Instructions in activities were confusing.</td>
<td>0.64</td>
</tr>
<tr>
<td>14</td>
<td>Activities required too much time.</td>
<td>0.45</td>
</tr>
</tbody>
</table>

Item did not load on either factor.

<table>
<thead>
<tr>
<th>Item #</th>
<th>Item on Factor</th>
<th>Factor Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>21</td>
<td>I helped increase my child’s understanding of the activities by working with him/her.</td>
<td>N/A</td>
</tr>
</tbody>
</table>
TABLE 14
Likert Items on Parent SPLASH Questionnaire with Percent Responses, Mean, And Standard Deviation Grouped by Factors

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Items</th>
<th>% of Answers</th>
<th>Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Parent Benefits of SPLASH</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>I enjoyed the SPLASH activities.</td>
<td>4.7</td>
<td>7.1</td>
</tr>
<tr>
<td>11</td>
<td>SPLASH helped me learn science.</td>
<td>6.0</td>
<td>16.7</td>
</tr>
<tr>
<td>12</td>
<td>The SPLASH activities helped me know my child better.</td>
<td>7.1</td>
<td>25.9</td>
</tr>
<tr>
<td>13</td>
<td>I would recommend SPLASH to my friends.</td>
<td>2.4</td>
<td>10.6</td>
</tr>
<tr>
<td>15</td>
<td>SPLASH should be done again next year.</td>
<td>3.5</td>
<td>7.1</td>
</tr>
<tr>
<td>16</td>
<td>My child learned a lot from doing SPLASH.</td>
<td>2.9</td>
<td>9.5</td>
</tr>
<tr>
<td>17</td>
<td>I feel more involved in my child's education as a result of the SPLASH.</td>
<td>7.1</td>
<td>16.5</td>
</tr>
<tr>
<td>24</td>
<td>All parents should do at least one SPLASH activity.</td>
<td>3.5</td>
<td>4.7</td>
</tr>
<tr>
<td></td>
<td><strong>Parent Problems with SPLASH</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>The SPLASH activities required too much time.</td>
<td>13.1</td>
<td>52.4</td>
</tr>
<tr>
<td>18</td>
<td>Activities required too much money.</td>
<td>33.3</td>
<td>47.6</td>
</tr>
<tr>
<td>19</td>
<td>Instructions too confusing.</td>
<td>11.9</td>
<td>36.9</td>
</tr>
<tr>
<td>20</td>
<td>I did not know enough science to work effectively.</td>
<td>22.4</td>
<td>47.1</td>
</tr>
<tr>
<td>22</td>
<td>Most activities were too difficult.</td>
<td>18.8</td>
<td>62.4</td>
</tr>
<tr>
<td>23</td>
<td>Materials too hard to get.</td>
<td>21.2</td>
<td>55.3</td>
</tr>
<tr>
<td>21</td>
<td>I helped increase my child's understanding of the activity by working together with him/her.</td>
<td>1.2</td>
<td>8.2</td>
</tr>
</tbody>
</table>

*Note.*  St D=strongly disagree (1); D=disagree (2); U=undecided (3); A=agree (4); St=strongly agree (5).
The scores on the problem dimension are negatively stated items that were not reverse coded; lower scores indicate the problems were perceived as not being severe. The problem dimension was significantly correlated with the number of SPLASH activities completed \((r=-0.44, p<0.001)\) and the values of the variable Parent Benefits of SPLASH \((r=-0.63, p<0.001)\), the variable Parent Comfort With Science \((r=-0.53, p<0.001)\), the variable Parent Involvement \((r=-0.22, p=0.045)\), *Science Laboratory Practical Exam Version A* \((r=-0.40, p=0.005)\), *Science Laboratory Practical Exam Version B* \((r=-0.41, p=0.011)\), *Science Process Assessment Pretest* \((r=-0.33, p=0.002)\), and *Science Process Assessment Posttest* \((r=-0.32, p=0.003)\).

Another indicator of parents' thoughts about the program comes from a small questionnaire contained at the end of SPLASH activity 4 (Appendix K). An open-response item asked the adult what could be done to make the activities better. The full range of responses are presented by clusters in Table 15.

The largest category of responses (12) was adults who expressed the idea that the program was okay as it was. The next largest category were adults (6) who felt more information could be given about the purpose of the SPLASH activities, either how they fit into the curriculum or why they were important for life. The problem with gathering materials for SPLASH activities was expressed by four adults. There are direct references to the difficulty of obtaining rocks and soil during the week of this SPLASH assignment, apparently because of the cold weather and snowstorms. Four adults commented on the difficulty of the activities. Of these four adults, one thought the instructions were confusing, two thought the activities were too difficult, and one thought the activities could be more challenging.
TABLE 15
Responses to Question in Activity Four:
What can we do to make the SPLASH activities better?

<table>
<thead>
<tr>
<th>No Suggestions for Change</th>
<th>Suggestions for Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;They are fine as they are.&quot;</td>
<td>&quot;More information up front for the adult so we can explain better why we are doing the activity and the purpose of the experiment.&quot;</td>
</tr>
<tr>
<td>&quot;OK the way they are.&quot;</td>
<td>&quot;I feel it would be beneficial to have a article or summary of what we are actually studying and how this activity relates to it.&quot;</td>
</tr>
<tr>
<td>&quot;Keep the activities fun.&quot;</td>
<td>&quot;Assign books on the theoretical part of the project to understand the significance.&quot;</td>
</tr>
<tr>
<td>&quot;Nothing—they are great.&quot;</td>
<td>&quot;The materials are easy to find and the activity doesn't take too long. I like the activities, but I'm not sure how they relate to the curriculum they are currently working on.&quot;</td>
</tr>
<tr>
<td>&quot;Can't think of anything at this point. Thank you.&quot;</td>
<td>&quot;Other real life activities that help us to understand why the subject might help us in everyday life.&quot;</td>
</tr>
<tr>
<td>&quot;They're fine.&quot;</td>
<td></td>
</tr>
<tr>
<td>&quot;Nothing, they are great!&quot;</td>
<td></td>
</tr>
<tr>
<td>&quot;I like question D on the previous pages—good way to apply the ideas from this activity.&quot;</td>
<td></td>
</tr>
<tr>
<td>&quot;Nothing really, they're already fun and good.&quot;</td>
<td></td>
</tr>
<tr>
<td>&quot;I have been pretty happy with the projects so far.&quot;</td>
<td></td>
</tr>
<tr>
<td>&quot;They are fine the way they are. Something different each week.&quot;</td>
<td></td>
</tr>
<tr>
<td>&quot;I like the fact we had to go and find the materials for this splash. I would like that incorporated into more of them. Also, I liked that we had to come back the next day and finish the experiment. I noticed that each week the experiments got more involved—I hope this holds true!&quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Material Suggestions</td>
<td></td>
</tr>
<tr>
<td>&quot;Supply the rocks—we had a hard time finding any.&quot;</td>
<td></td>
</tr>
<tr>
<td>&quot;Provide supplies if needed—not everyone can obtain soils in March.&quot;</td>
<td></td>
</tr>
<tr>
<td>&quot;It would be helpful to have a list of materials for this month in advance so we could pick things up if we need them when we're out. Gathering the materials seems to take a little more time than it should.&quot;</td>
<td></td>
</tr>
<tr>
<td>&quot;Fewer materials or more materials in season?&quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Time Suggestions</td>
<td></td>
</tr>
<tr>
<td>&quot;Perhaps allow more time for completion.&quot;</td>
<td></td>
</tr>
<tr>
<td>&quot;Encourage Joe to start earlier and not wait until the last day!&quot;</td>
<td></td>
</tr>
<tr>
<td>&quot;Do it in class.&quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Messy Suggestions</td>
<td></td>
</tr>
<tr>
<td>&quot;Less messy.&quot; ((With a drawn smiley face))</td>
<td></td>
</tr>
<tr>
<td>&quot;Not make them messy!&quot;</td>
<td></td>
</tr>
</tbody>
</table>

Parent provided a detailed answer written about extensions for settle down activities—deltas, natural filtration, etc.

Level of Difficulty Suggestions
"Make it easier."
"This activity was much more difficult. Since the rocks were big, the dirt settled around the rocks. Also, it was difficult to determine if the dirt had settled into layers and what the contents of the layers were."
"Some directions could be clearer—not specifically on this activity but some (especially the Superposition Lab on Craters) are difficult to follow."
"Make more challenging."

Interest Suggestions
"More interesting activities."
"I think the experiments would be more entertaining if chemistry were used. My son enjoys Mr. Wizard, especially when he makes 'magic' using chemical reactions."
"Know what they were taught in previous grades and come up with something different."
Student answers to questions about the program are presented in Table 16. Items 10-17 on the Parent SPLASH Questionnaire correspond to items 1-11 on the Student SPLASH Questionnaire. Although these items were not distinct factors on either the parent or student questionnaire, the Cronbach's alpha reliability for these items was 0.92 and 0.86 for the Parent Questionnaire and the student questionnaire, respectively. These two sections of the questionnaires were significantly correlated with each other ($r=0.44$, $p<0.001$). Comparing items 10-17 on the Parent SPLASH Questionnaire with the corresponding items on the Student SPLASH Questionnaire, the mean score for the parents was 3.50 (SD=0.83) and for the students it was 3.16 (SD=0.82). Student attitudes were positive, but not as positive as their parents, the differences were statistically significant ($t=3.50$, $df=83$, $p=.001$).

In a factor analysis of the Student SPLASH Questionnaire, three factors were found. The names and items of these factors are: (a) Student Benefits of SPLASH (items 1, 2, 4, 6, 9, and 11), (b) Student Views of SPLASH and Parents (items 3, 7, and 8), and (c) SPLASH Time/Homework (items 5 and 10) (see Table 16); the Cronbach alpha reliabilities and mean scores on these three sections are (a) 0.91 and 3.30 (SD=0.97), (b) 0.77 and 2.81 (SD=1.02), and (c) 0.66 and 3.30 (SD=1.17), respectively (see Table 4).

In the items for the variable Student Benefits of SPLASH, 45.5% of the students agreed or strongly agreed that they enjoyed the SPLASH activities and 61.9% of the students agreed or strongly agreed that the activities helped them learn science. A majority of students indicated that the SPLASH program should continue. Of the items in the variable Student Benefits of SPLASH, the item with the most student disagreement was "I like science more because
### TABLE 16
Factor Analysis of Student SPLASH Questionnaire

<table>
<thead>
<tr>
<th>Factor 1: Student Benefits of SPLASH</th>
<th>Total Variance Explained=53.4%</th>
<th>Reliability of Factor=0.91</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item #</td>
<td>Item on Factor</td>
<td>Factor Loading</td>
</tr>
<tr>
<td>9</td>
<td>Hands-on activities, like those used in SPLASH, are a good way to learn science.</td>
<td>0.85</td>
</tr>
<tr>
<td>1</td>
<td>I enjoyed the SPLASH activities.</td>
<td>0.79</td>
</tr>
<tr>
<td>11</td>
<td>I like science more because of SPLASH.</td>
<td>0.71</td>
</tr>
<tr>
<td>6</td>
<td>SPLASH program should continue.</td>
<td>0.71</td>
</tr>
<tr>
<td>4</td>
<td>I would recommend SPLASH activities to my friends.</td>
<td>0.70</td>
</tr>
<tr>
<td>2</td>
<td>SPLASH activities helped me to learn science.</td>
<td>0.69</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Factor 2: Student Views of SPLASH and Parents</th>
<th>Total Variance Explained=12.3%</th>
<th>Reliability of Factor=0.77</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item #</td>
<td>Item on Factor</td>
<td>Factor Loading</td>
</tr>
<tr>
<td>3</td>
<td>SPLASH activities helped me know my parents better.</td>
<td>0.81</td>
</tr>
<tr>
<td>8</td>
<td>My parents are more involved in my school work as a result of SPLASH.</td>
<td>0.81</td>
</tr>
<tr>
<td>7</td>
<td>My parents learned a lot from doing SPLASH.</td>
<td>0.72</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Factor 3: SPLASH Time /Homework</th>
<th>Total Variance Explained=7.3%</th>
<th>Reliability of Factor=0.66</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item #</td>
<td>Item on Factor</td>
<td>Factor Loading</td>
</tr>
<tr>
<td>5</td>
<td>SPLASH activities required too much time.</td>
<td>0.87</td>
</tr>
<tr>
<td>10</td>
<td>I would rather do SPLASH homework than do a regular homework assignment.</td>
<td>0.56</td>
</tr>
</tbody>
</table>
of SPLASH." Approximately 45% of the students disagreed or strongly disagreed with this statement. The variable Student Benefits of SPLASH was significantly correlated with scores on the following variables: Student Views of SPLASH and Parent \( (r=0.58, p<0.001) \), SPLASH Time/Homework \( (r=0.73, p<0.001) \), Total Number of SPLASH Activities Completed \( (r=0.38, p<0.001) \), Science Process Assessment Pretest \( (r=0.24, p=0.20) \), Parent Benefits of SPLASH \( (r=0.46, p<0.001) \), Parent Problems With SPLASH \( (r=-0.51, p<0.001) \), Parent Comfort With Science \( (r=0.34, p=0.001) \), Attitude Toward Science in School Assessment Pretest \( (r=0.51, p<0.001) \), and Attitude Toward Science in School Assessment Posttest \( (r=0.47, p<0.001) \).

The second variable of the Student SPLASH Questionnaire was Student Views of SPLASH and Parent. Only 21.6% of the students agreed or strongly agreed that SPLASH helped them know their parent better, with a majority of students disagreeing or strongly disagreeing. A low percentage of agreement was also reported for the item "My parents are more involved in my education as a result of SPLASH"; only 28.9% of the students agreed or strongly agreed with this statement. Many students (37.1%) were undecided if their parents had learned a lot from doing the SPLASH activities.

In a separate item, students were asked if they would rather have worked on SPLASH by themselves or with a parent. Almost three-quarters of the students (72.3%) indicated they would rather work with a parent than by themselves.

There were significant correlations between scores on the variable Student Views of SPLASH and Parent and the following variables: Student Benefits of SPLASH \( (r=0.58, p<0.001) \), SPLASH Time/Homework \( (r=0.37, p<0.001) \), Total Number of SPLASH Activities Completed \( (r=0.32, p=0.001) \),
TABLE 17
Likert Items on Student SPLASH Questionnaire with Percent Responses, Mean, and Standard Deviation, Grouped by Factors

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Item</th>
<th>% of Answers</th>
<th></th>
<th></th>
<th></th>
<th>Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>St D</td>
<td>D</td>
<td>U</td>
<td>A</td>
<td>St A</td>
</tr>
<tr>
<td>1</td>
<td>I enjoyed the SPLASH activities.</td>
<td>7.2</td>
<td>16.3</td>
<td>28.9</td>
<td>35.1</td>
<td>12.4</td>
</tr>
<tr>
<td>2</td>
<td>SPLASH activities helped me learn science.</td>
<td>4.1</td>
<td>12.4</td>
<td>21.6</td>
<td>52.6</td>
<td>9.3</td>
</tr>
<tr>
<td>4</td>
<td>I would recommend SPLASH to my friends.</td>
<td>13.5</td>
<td>16.7</td>
<td>32.3</td>
<td>25.0</td>
<td>12.5</td>
</tr>
<tr>
<td>6</td>
<td>SPLASH should continue.</td>
<td>17.5</td>
<td>9.3</td>
<td>22.7</td>
<td>29.9</td>
<td>20.6</td>
</tr>
<tr>
<td>9</td>
<td>Hands-on science activities, like those in SPLASH are a good way to learn science.</td>
<td>4.1</td>
<td>5.2</td>
<td>26.8</td>
<td>34.0</td>
<td>29.9</td>
</tr>
<tr>
<td>11</td>
<td>I like science more because of SPLASH.</td>
<td>19.6</td>
<td>25.8</td>
<td>25.8</td>
<td>20.6</td>
<td>8.2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Item</th>
<th>% of Answers</th>
<th></th>
<th></th>
<th></th>
<th>Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>The SPLASH activities helped me know my parent better.</td>
<td>23.7</td>
<td>29.9</td>
<td>24.7</td>
<td>11.3</td>
<td>10.3</td>
</tr>
<tr>
<td>7</td>
<td>My parent learned a lot from doing SPLASH.</td>
<td>12.4</td>
<td>11.3</td>
<td>37.1</td>
<td>26.8</td>
<td>12.4</td>
</tr>
<tr>
<td>8</td>
<td>My parents are more involved in my education as a result of the SPLASH.</td>
<td>19.6</td>
<td>25.8</td>
<td>25.8</td>
<td>18.6</td>
<td>10.3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Item</th>
<th>% of Answers</th>
<th></th>
<th></th>
<th></th>
<th>Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>The SPLASH activities required too much time.</td>
<td>14.4</td>
<td>34.0</td>
<td>17.5</td>
<td>19.6</td>
<td>14.4</td>
</tr>
<tr>
<td>10</td>
<td>I would rather do SPLASH HW than regular HW.</td>
<td>13.4</td>
<td>14.4</td>
<td>16.5</td>
<td>24.7</td>
<td>30.9</td>
</tr>
</tbody>
</table>

Note. St D=strongly disagree (1); D=disagree (2); U=undecided (3); A=agree (4); St A=strongly agree (5).
Parent Benefits of SPLASH ($r=0.37$, $p=0.001$), Parent Problems With SPLASH ($r=-0.27$, $p=0.014$), Parent Comfort With Science ($r=0.32$, $p=0.003$), and *Attitude Toward Science in School Assessment* Pretest ($r=0.22$, $p=0.032$).

The third variable from the *Student SPLASH Questionnaire*, SPLASH Time/Homework, contained two items. For item one, "The SPLASH activities required too much time," 48.4% of the students disagreed or strongly disagreed with this statement and 17.5% of the students were undecided. A majority of the students agreed or strongly agreed with the second item, "I would rather do SPLASH homework than regular homework" (Table 17). The variable SPLASH Time/Homework had significant correlations with scores on the following variables: Student Benefits of SPLASH ($r=0.73$, $p<0.001$), Student Views of SPLASH and Parent ($r=0.37$, $p<0.001$), Total Number of SPLASH Activities Completed ($r=0.28$, $p=0.005$), Parent Benefit of SPLASH ($r=0.37$, $p=0.001$), Parent Problems With SPLASH ($r=0.41$, $p<0.001$), Parent Comfort With Science ($r=0.28$, $p=0.010$), *Attitude Toward Science in School Assessment* Pretest ($r=0.40$, $p<0.001$), and *Attitude Toward Science in School Assessment* Posttest ($r=0.38$, $p<0.001$).

Girls had higher scores than boys on each of the three variables on the *Student SPLASH Questionnaire*. The means (and standard deviations) for the variable Student Benefits of SPLASH were 3.18 (SD=1.08) for boys and 3.38 (SD=0.88) for girls. For the variable Student Views of SPLASH and Parents the mean for boys was 2.79 (SD=1.04) and the mean for girls was 2.84 (SD=1.01). The means for the variable SPLASH Time/Homework were 3.27 (SD=1.26) for boys and 3.32 (SD=1.11) for girls. The mean number of SPLASH activities completed was 6.79 (SD=3.04) for girls and 6.71 (SD=3.14) for boys. From an ANOVA, none of these differences were statistically significant.
The data supports the hypothesis that the majority of parents and students had positive feelings toward aspects of the SPLASH program. A majority of parents and students thought the program should continue and a majority of both groups thought the students had learned from SPLASH. A majority of students preferred SPLASH homework over regular homework and would rather work with parents than work alone. The biggest problem for parents was the clarity of the activity directions.

**Research Question 4**

The hypothesis for research question 4 was that students in the treatment group would achieve higher scores on the science process skill instruments than the control group. Two instruments were used as measures of science process skills: The *Science Process Assessment* (Smith & Welliver, 1990) and the *Science Laboratory Practical Exam* (Kanis, Doran, & Jacobson, 1990) used in the Second International Study.

The *Science Process Assessment* (SPA), when converted into dichotomous answers (0=wrong, 1=right), had a Cronbach alpha reliability of 0.87 on the pretest and 0.89 on the posttest (Table 4). A factor analysis failed to provide the same grouping of questions as suggested by the 14 variables of the test makers. The items in the SPA were dealing with multiple skills rather than attitudes. Successful answering of skill questions is highly item dependent, and many variations can exist between individuals and groups.

Average scores on the SPA pretest for the treatment group and control group are 31.6 (SD=5.7) and 31.3 (SD=7.0), respectively. Average scores on the posttest for the treatment group and control group are 32.3 (SD=6.9) and 32.5 (SD=6.2), respectively. A repeated measures analysis of variance indicates
there were no significant primary differences between students based on experimental group (Table 18). Nor were there any primary effects based on sex or classroom teacher.

TABLE 18
Repeated Measures Analysis of Variance of Science Process Assessment Scores

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Subjects</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exper. Group (A)</td>
<td>1</td>
<td>1.01</td>
<td>0.01</td>
<td>0.904</td>
</tr>
<tr>
<td>Teacher (B)</td>
<td>1</td>
<td>135.48</td>
<td>1.95</td>
<td>0.165</td>
</tr>
<tr>
<td>Sex (C)</td>
<td>1</td>
<td>96.04</td>
<td>1.38</td>
<td>0.242</td>
</tr>
<tr>
<td>A x B</td>
<td>1</td>
<td>278.51</td>
<td>4.00</td>
<td>0.047</td>
</tr>
<tr>
<td>A x C</td>
<td>1</td>
<td>78.71</td>
<td>1.13</td>
<td>0.289</td>
</tr>
<tr>
<td>B x C</td>
<td>1</td>
<td>0.61</td>
<td>0.01</td>
<td>0.925</td>
</tr>
<tr>
<td>A x B x C</td>
<td>1</td>
<td>1.17</td>
<td>0.02</td>
<td>0.897</td>
</tr>
<tr>
<td>Within Subjects</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre/Post (P/P)</td>
<td>1</td>
<td>93.83</td>
<td>6.84</td>
<td>0.010</td>
</tr>
<tr>
<td>A x P/P</td>
<td>1</td>
<td>7.88</td>
<td>0.57</td>
<td>0.450</td>
</tr>
<tr>
<td>B x P/P</td>
<td>1</td>
<td>3.06</td>
<td>0.22</td>
<td>0.637</td>
</tr>
<tr>
<td>C x P/P</td>
<td>1</td>
<td>1.49</td>
<td>0.11</td>
<td>0.742</td>
</tr>
<tr>
<td>A x B x P/P</td>
<td>1</td>
<td>0.06</td>
<td>0.00</td>
<td>0.945</td>
</tr>
<tr>
<td>A x C x P/P</td>
<td>1</td>
<td>21.99</td>
<td>1.60</td>
<td>0.207</td>
</tr>
<tr>
<td>B x C x P/P</td>
<td>1</td>
<td>46.89</td>
<td>3.42</td>
<td>0.066</td>
</tr>
<tr>
<td>A x B x C x P/P</td>
<td>1</td>
<td>8.96</td>
<td>0.65</td>
<td>0.420</td>
</tr>
</tbody>
</table>
There was a significant interaction between experimental group and teacher (p=0.047). Figure 2 shows a graph of the four groups in the interaction of experimental group and teacher for the combined pretest and posttest results. Using Fischer's least significant difference (LSD) method (Collyer & Enns, 1986), the only significant difference was between Teacher 1's treatment group mean and Teacher 2's treatment group mean. From the analysis of the SPA data, there was no evidence that confirms the hypothesis that the treatment group did better on this instrument than did the control group.

![Figure 2. Interaction of Experimental Group and Teacher on the Science Process Assessment.](image)
There was a significant difference between pretest and posttest scores on the SPA ($F=6.84; \text{df}=1,178; p=0.010$; See Table 18). The SPA pretest mean for all classes was 31.4 ($\text{SD}=6.33$) and the SPA posttest mean was 32.4 ($\text{SD}=6.54$). This indicates that the group mean for all students improved from the pretest to the posttest.

The SPA scores had statistically significant negative correlations with parents' self report of time spent helping and monitoring non-SPLASH homework (pretest: $r=-0.18$, $p=0.023$; posttest: $r=-0.19$, $p=0.017$). There were also statistically significant negative correlations when the time for SPLASH was added to the time parents reported helping and monitoring homework on the SPA pretest ($r=-0.17$, $p=0.039$) and posttest ($r=-0.17$, $p=0.040$). Negative correlations also existed between the SPA scores and the time reported by parents helping with and monitoring their children's science homework, however, these correlations were not statistically significant. The SPA had statistically significant negative correlations with the variable Parent Helping With Homework (pretest: $r=-0.22$, $p=0.006$; posttest: $r=-0.16$, $p=0.044$), and Parent Problems with SPLASH scores (pretest: $r=-0.33$, $p<0.002$; posttest: $r=-0.32$, $p=0.003$).

The SPA scores had statistically significant positive correlations with Parent Comfort in Science (pretest: $r=0.21$, $p=0.008$; posttest: $r=0.22$, $p=0.004$), the scores on the pretest Attitude Toward Science in School Assessment (pretest: $r=0.23$, $p=0.001$; posttest: $r=0.17$, $p=0.023$), and the scores on the posttest Attitude Toward Science in School Assessment (pretest: $r=0.28$, $p<0.001$; posttest: $r=0.16$, $p=0.029$). The following items had values with statistically significant correlations with the pretest of the SPA but not the posttest: the variable Parent Involvement (pretest: $r=0.18$, $p=0.019$), the number of SPLASH
activities completed (pretest: $r=0.24$, $p=0.018$), and the variable Student Benefits of SPLASH (pretest: $r=0.24$, $p=0.020$). The SPA pretest scores and posttest scores were significantly correlated ($r=0.67$, $p<0.001$).

The *Science Laboratory Practical Exam* (SLPE) was the other measure of science process skills. This instrument was given as a posttest. Mean scores are reported for the two non-equivalent versions of the SLPE and their corresponding subscores (Table 19). The two sub-components of version A (SLPEA) were Performing and Reasoning. The three sub-components of version B (SLPEB) were Performing, Reasoning, and Investigating. From an ANOVA there were no significant differences between groups on either version of the SLPE or its sub-components based on the students' experimental group, sex, or teacher.

The SLPE had statistically significant correlations with the *Science Process Assessment* (SPA). The correlations of the posttest SPA with the overall results of the SLPE version A and SLPE version B were $r=0.37$ ($p<0.001$) and $r=0.39$ ($p<0.001$), respectively. The SLPE version B, like the SPA was significantly correlated with the variable Parent Comfort in Science ($r=0.30$, $p=0.009$). The correlation of Parent Comfort in Science with SLPE version A was not statistically significant.

The SLPE scores, like the SPA scores, had small negative correlations on some indicators of parents helping or monitoring their children's work. The scores on the *Science Laboratory Practical Exam* version A (SLPEA) and version B (SLPEB) had correlations of $r=-0.08$ and $r=-0.07$ with the parent's report of time they spent helping or monitoring homework, however, these correlations were not statistically significant. For the variable Parent Helping
<table>
<thead>
<tr>
<th>Exam/Section</th>
<th>Treatment</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td>SLPE A/Total</td>
<td>54</td>
<td>11.5 (2.16)</td>
</tr>
<tr>
<td>Performing A</td>
<td>54</td>
<td>9.44 (1.64)</td>
</tr>
<tr>
<td>Reasoning A</td>
<td>54</td>
<td>2.06 (0.94)</td>
</tr>
<tr>
<td>SLPE B/Total</td>
<td>45</td>
<td>6.60 (1.91)</td>
</tr>
<tr>
<td>Performing B</td>
<td>45</td>
<td>4.09 (1.06)</td>
</tr>
<tr>
<td>Reasoning B</td>
<td>45</td>
<td>1.87 (1.20)</td>
</tr>
<tr>
<td>Investigat. B</td>
<td>45</td>
<td>0.64 (0.48)</td>
</tr>
</tbody>
</table>

*Note.* n=sample size; SD=standard deviation of sample.

With Homework the correlations with SLPE A and SLPE B were both $r=-0.21$; the correlation with SLPE A was statistically significant ($p=0.046$), the correlation with SLPE B was not statistically significant.

Students in the SPLASH program were asked if they thought the SPLASH activities had helped them learn science. The mean answer to this item was 3.51 (SD=0.97) with 61.9% of the students agreeing or strongly agreeing (see Table 17). When parents were asked if their children learned a lot from the SPLASH activities a mean score of 3.61 (SD=0.89) was obtained with 64.3% agreeing or strongly agreeing (see Table 12). A majority of parents also agree that they had helped their children by working on the SPLASH activities with them.
In conclusion, there was no support for the hypothesis that students in the treatment group would achieve higher scores on the science process skill instruments than the control group. While a majority of parents and students thought the student had learned from participating in the SPLASH program, there were no statistically significant differences between the treatment group and the control group on either of the two science process instruments used in this study.

Research Question 5

It was hypothesized that students in the treatment group would report more positive attitudes toward science than the control group. The *Attitude Toward Science in School Assessment* (ATSSA) instrument (Germann, 1988) loaded on one factor and had a Cronbach alpha reliability of 0.95 on the pretest and 0.94 on the posttest (Table 4). The instrument loading on one factor was consistent with the findings of Germann (1988).

The mean pretest scores on the ATSSA of the treatment group and the control group were 3.99 (SD=0.84) and 4.11 (SD=0.66), respectively. The mean posttest scores for the treatment group and the control group were 4.05 (SD=0.75) and 4.13 (SD=0.65), respectively. A repeated measures analysis of variance was used to analyze between group and within group differences on the pretest and posttest scores (Table 20).

On the ATSSA, there were no significant main effects due to experimental group or sex (Table 20). There was a significant main effect for teacher, with Teacher 1’s students scoring higher than Teacher 2’s students (F=9.99; df=1, 173; p=0.002). A significant interaction was found between
TABLE 20
Repeated Measures Analysis of Variance of *Attitude Toward Science in School Assessment* Scores

<table>
<thead>
<tr>
<th>Source</th>
<th>Within Cells</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>p</th>
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<tr>
<td></td>
<td></td>
<td>173</td>
<td>0.85</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between Subjects</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Exper. Group (A)</td>
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<td>1</td>
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<td>Sex (C)</td>
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<td>1</td>
<td>1.96</td>
<td>2.32</td>
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<tr>
<td>A x B</td>
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<td>0.180</td>
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<tr>
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<td>1</td>
<td>2.07</td>
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</tr>
<tr>
<td>B x C</td>
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<td>0.47</td>
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<td>0.456</td>
</tr>
<tr>
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<tr>
<td>Within Subjects</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre/Post (P/P)</td>
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<td>1</td>
<td>0.12</td>
<td>0.82</td>
<td>0.365</td>
</tr>
<tr>
<td>A x P/P</td>
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<td>1</td>
<td>0.00</td>
<td>0.02</td>
<td>0.879</td>
</tr>
<tr>
<td>B x P/P</td>
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<td>1</td>
<td>1.28</td>
<td>8.90</td>
<td>0.003</td>
</tr>
<tr>
<td>C x P/P</td>
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<td>1</td>
<td>0.06</td>
<td>0.41</td>
<td>0.525</td>
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<tr>
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<td>1</td>
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<td>1.44</td>
<td>0.232</td>
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<tr>
<td>A x C x P/P</td>
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<td>1</td>
<td>0.57</td>
<td>3.96</td>
<td>0.048</td>
</tr>
<tr>
<td>B x C x P/P</td>
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<td>1</td>
<td>0.02</td>
<td>0.12</td>
<td>0.728</td>
</tr>
<tr>
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<td>1</td>
<td>1</td>
<td>0.23</td>
<td>1.61</td>
<td>0.206</td>
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</table>
teacher and the pretest and posttest ATSSA ($F=8.90; df=1, 173; p=0.003$). The mean scores of Teacher 1's classes fell from the pretest of 4.25 (SD=0.59) to a posttest mean of 4.21 (SD=0.64). The mean scores of Teacher 2's classes rose from 3.85 (SD=0.83) to 4.00 (SD=0.73). An interaction between sex, experimental group, and the pretest and posttest ATSSA ($F=3.96; df=1, 173; p=0.048$) was also found. Figure 3 displays the eight points involved in this interaction.

From a post hoc analysis using Fischer's least significant difference (LSD) method (Collyer & Enns, 1986), it was determined that both points for the males/treatment group were significantly different from all other points, but not different from each other. The other significant differences were between (a) the pretest scores of the males in the control group and the posttest scores of the females in the treatment group and (b) the posttest scores of the female treatment group and female control group.

There was a disordinal interaction between girls in the experimental and treatment groups. Girls in the treatment group started with lower ATSSA scores than did girls in the control group. This difference was not statistically different. Girls in the treatment group had higher posttest scores than girls in the treatment group. These differences were statistically significant. The significant difference between the groups was due to the treatment group girls' scores rising and the control group girls' scores falling.
Figure 3. Interaction of Sex, Experimental Group, and Pretest-Posttest Scores on Science Attitude Instrument.
One item in the *Student SPLASH Questionnaire* asked students if they liked science more because of SPLASH. Students tended to disagree with this statement. The mean score on this item was 2.72 (SD=1.23) with 45.4% of the students answering the questionnaire disagreeing or strongly disagreeing with this statement (see Table 16).

In conclusion, the hypothesis that students in the treatment group would report more positive attitudes than students in the control group was not supported. As a group there were no significant differences. However, girls in the treatment group reported more positive attitudes than girls in the control group on the posttest.

**Parent and Student Interview Results**

This section consists of interview answers from seven parents and six children in the SPLASH program. All interviews were performed before any data analysis had taken place. One student for each teacher was selected from each of the following groups: high participation (HP) in SPLASH, medium participation (MP) in SPLASH, and low participation (LP) in SPLASH. Students and their parents were interviewed separately. One additional parent from Teacher 2's high participation group was chosen. Table 21 presents the children interviewed, the number of SPLASH activities completed, and the exact relationship of the parent who was also interviewed. The percentages of class completion of SPLASH activities for Teacher 1 was greater than Teacher 2, so the amount of participation was teacher dependent.
The interview followed a protocol of questions (see Appendix G). The reported responses are clustered around the problem statements to which they apply.

**TABLE 21**
Parents and Children Interviewed and Number of Activities Completed

<table>
<thead>
<tr>
<th>Parent</th>
<th>Child</th>
<th>Number of Activities Completed by Child</th>
</tr>
</thead>
<tbody>
<tr>
<td>HP.T2.Father</td>
<td>HP.T2.Boy</td>
<td>10</td>
</tr>
<tr>
<td>HP.T2.Mother</td>
<td>n/a</td>
<td>10</td>
</tr>
<tr>
<td>MP.T2.Mother</td>
<td>HP.T2.Boy</td>
<td>4</td>
</tr>
<tr>
<td>LP.T2.Mother</td>
<td>LP.T2.Boy</td>
<td>1</td>
</tr>
<tr>
<td>HP.T1.Father</td>
<td>HP.T1.Boy</td>
<td>10</td>
</tr>
<tr>
<td>MP.T1.Mother</td>
<td>HP.T1.Girl</td>
<td>6</td>
</tr>
<tr>
<td>LP.T1.Mother</td>
<td>LP.T1.Girl</td>
<td>4</td>
</tr>
</tbody>
</table>

1. What percentage of families complete the hands-on, home-science activities and how does that vary over time?

There was an observed decline in the level of participation near the end of the SPLASH program. The following comments related to a decline in level of enthusiasm:

There was a couple of them [SPLASH activities] as the program continued and continued and continued he said "Gee Dad do we really have to do it?" I said, "We made a commitment. You made a commitment. We've had fun at it so far. Let's finish it up."
And we got through it that way. (HP.T1.Father)

Interviewer: How did you feel about the program in the end?
Boy: I just kind of felt the same about getting the homework part, but I also felt that it was kind of getting hard to umm, it was getting even harder, and I was finding a harder time finding general interest in some of them cause I had other things in for a while [inaudible] I liked it most of the time. (HP.T2.Boy)
The last SPLASH activity was totally open ended. The students with their adult helpers needed to choose a problem, design an investigation, and conduct the investigation. Some participants indicated that this assignment was difficult.

The last experiment was not intimidating to me but it might have been to others.... I predict that there will be a drop at the end, for the last activity. (HP.T2.Father)

Interviewer: What was your least favorite activity?
Boy: Number 10.
Interviewer: The activity "Hey What's Your Problem?"
Boy: Yeah.
Interviewer: Why?
Boy: I found it kind of hard to make up your own project. (HP.T1.Boy)

In comparing high participation parents with low participation parents, there seemed to be a difference in their perceived roles as parents in regards to schools. High participating parents expressed the importance of parental involvement. A high participating father indicated his involvement with his son's homework in the following passage:

[The father would say] "What's your homework log got written down?" [His son would say] "I've got this, this and this." So I say "Well lets get to it." And then you have to sit there and push him because of what ever the days events were to get him to get the homework done or you have to say "Tom you've got math, you've got science, you've got some reading to do, what do you want me to help you with, if anything?" And he'll come up with, lets go over science. Or lets go over the math, or something he wants a little bit of help or a little bit of back-up to say what's right or what's wrong before he puts the answer down. (HP.T1.Father)

Low participating parents said statements that seemed to reflect their conscious or unconscious thoughts that schoolwork was something that
should be between child and school, a factor that Sealey (1989) calls the
"delegation model."

Mother: I guess, you know bottom line, what is your purposes of doing
it outside of school instead of having them do it in school?
Interviewer: Is it fair to say that you basically feel they could do it at
school and not at home?
Mother: Right. I'm just wondering what the purpose was to have the
child to do it separately as homework. The main reason for it.
(LP.T1.Mother)

What the children do at school is why I pay tax dollars. If I am going to
be the teacher let them stay home. I will teach them all day. But you
know you keep sending—your class might send one thing then
another class sends something, before you know it I'm back in school. I
graduated, I'm a mother now. I have other children to take care of and
help with homework, so these time consuming projects just don't
work for me. (LP.T2.Mother)

For one family, the delegation view of the mother coupled with the
child's lack of enthusiasm for this type of homework created a situation
where only one activity was done.

I asked him if he liked them and he said no. If he said he doesn't want
to do them then why should I bother? Fine. Send it back and get the
homework. (LP.T2.Mother)

2. Does the hands-on, home-science parental involvement program increase
parental involvement?

Statements by parents showed thoughts related to their being involved
with the program.

I know we had fun doing the whirly thing. Running up and down the
stairs after it. That was pretty fun. At first I was real excited by it
because we were doing it together and everything. But then it got, it
was like a real switch, we were waiting for the last possible second and
then having an argument over getting it done. (MP.T1.Mother)
You know, it was fun. It was fun to do it together, but ugh, as I indicated on the questionnaire, I don’t help her with any homework. So that was kind of a new experience for me. She just doesn’t come to me for any help. (LP.T1.Mother)

I don't spend enough time with school work. My wife does most of it. I help with the science homework. SPLASH is a neat way to get involved. (HP.T2.Father)

Doing the SPLASH activities helped some parents learn about their children.

You know ((laughs)), she is smarter to me. Yeah, it was kind of fun to actually see her in action. Like I said, you know I just get her report cards and see that, yeah she is doing really well, and all A’s and once in a while a B. It was kind of fun seeing her in action. (LP.T1.Mother)

This is Mom talking, but I always thought she was pretty smart, but I think she is even smarter than I thought. She is very good at coming up with the conclusions. She seems to have a real handle on it and she likes science more than I knew she did. She really does. (HP.T2.Mother)

There were mixed feelings as to whether the program increased the parents level of involvement in other areas beyond SPLASH.

Yeah, it got me more involved with like a parent-son school relationship versus just here we go again Tom, go do your homework find a corner to sit in and get it done yourself. I guess its more of a, rather than a confrontation type of thing, just go do it, you get yourself involved and maybe you can help them get it done a little quicker or help him find the right answer. Help him to see that school work isn’t necessarily all drudgery, there is some fun involved too. (HP.T1.Father)

Interviewer: Do you feel the program made you more involved in your daughter's education?
Mother: I don’t really think so. We pretty much, we were not like king and queen of the PTA, but we are pretty much involved. She is pretty good about sharing her papers and not—there again we don’t need any cramps, but we watch a lot of the NOVA and that kind of
Most students did not notice if their parents became more involved as a result of the SPLASH program.

Interviewer: Did your parents become more interested in what you were doing in school?
Girl: Ugh.. ((laughs)). I don’t know. Ugh, my parents really don’t ask me what I did in school and stuff. Umm. I’m not sure, they might have.
Interviewer: So you didn’t notice any difference?
Girl: No. (LP.T1.Girl)

One student did feel that the program had an impact on his parents being involved with his school work.

Before they used to tell me to do my homework and then after SPLASH, my Mom or my Dad would sit down and help me. (HP.T1.Boy)

Your parents would be into your school work more. They are around to help a lot more. I feel they understood like what was going on in class. (HP.T1.Boy)

3. What are parent and student perceptions about the hands-on, home-science parental involvement program?

There were many perceptions that parents and students had about the program. The lead-in statement of the interview asked the participants to
give their honest views about the program. The first question after this was: What did you think about the SPLASH program? The responses to this question of all seven parents and all six students are presented below.

Parent Responses:

Well for the most part I think it was pretty easy. A lot of the programs I was able to determine what the outcome would be before the experiment started. And I would guess probably about 25% of the time Tom was able to figure it out before the actual experiment occurred. I think if he would have read it and thought about it a little bit more, then it would have been an even higher percent of knowing what the outcome was going to be. Then making sure that the experiment proved him right or wrong. (Laughs) He did have a lot of fun doing it. There was a couple of them as the program continued and continued and continued he said "Gee Dad do we really have to do it?" I said, "We made a commitment. You made a commitment. We've had fun at it so far. Let's finish it up." And we got through it that way. A couple of sheets the directions were just basically the wrong directions. I think one of the probability ones that I mentioned in the survey was—there was no way the answer would have come out at all, because of the way the directions had been set up. I think Mrs. Teacher 1 realized that particular week's progress report was basically vacated. (HP.T1.Father)

The best type of things are hands-on and things that are fun. I thought in general the program was really good. One area that went slow was flipping coins. I understood the concepts and it was neat, but Chris got tired of flipping the coins. It may have been too abstract. Otherwise it was pretty neat. (HP.T2.Father)

I think it's a super idea because I think a lot of parents aren't involved in their children's education. Particularly science because I think a lot of people stay away from science. Science and Math, you know, "that's too hard I can't do that" so they stay away from it. What better way to get kids interested in science than if they think their parents can deal with it and work with them? From all sorts of angles, kids now a day—I think in general—are really needing attention from adults and what a good way to have their attention, at least for one-half an hour you are doing something together. And you are going to get help with
your schoolwork. Plus its interesting. Its interesting to see what the results are.

Overview, I thought the supplies were easy to come up with. We didn't have any times when we really had to go out and buy supplies or make any great effort for that. It took about one-half hour I think, maybe a little bit less. The hard part, I think, would be motivating adults to put down their foot stool and their TV or whatever they are doing and take the time to do it. I'm all for it. Of course I am kind of prejudiced, we sort of emphasize education around here as much as we can. We're prejudiced in favor of it. I think in general it would help get parents involved in their children's education. Which couldn't hurt. I guess that's all I know. Not very much more than I wrote down. (HP.T2.Mother)

I think maybe with a different child it would have been a little bit different. It got to the point where they were, she wouldn't bring them home on Friday and she would wait until Monday to bring them up. And then she would be mad cause I wouldn't do the whole thing for her, and then probably the last half was that way. But she is that way about of everything, I can't really say it has anything to do with the experiment, she seems to like them though. And they were fun at first. (MP.T1.Mother)

The biggest problem was Vance would pull the assignment out of his bookbag after dinner and say "Here, I have to have this done and turned in tomorrow." And then try and scramble and find whatever we needed to get it done that night, considering everything else he had to get done that night. Which isn't the problem, but the SPLASH program is the problem with Vance's organization. (MP.T2.Mother)

Well I told you the other night on the phone, we didn't get too far through it. And I knew it would be like it would be, you know. So. We'll try it. I don't think it's going to work. And we made it through two I think. And her Dad [her ex-husband] and she did one. And she missed a week of school there. Then I went on a week of vacation. Then she comes home one night and says "Mom I have three or four SPLASH—you know this is at 9:30 she told me this ((laughs))—projects I have to do to catch up on." And I look at her and it was like forget it. No. And that was the end of that ((laughs)). The biggie was the lack of time. (LP.T1.Mother)
What the children do at school is why I pay tax dollars. If I am going to be the teacher let them stay home. I will teach them all day. But you know you keep sending—your class might send one thing then another class sends something, before you know it I'm back in school. I graduated, I'm a mother now. I have other children to take care of and help with homework, so these time consuming projects just don't work for me. My husband doesn't help because he works graveyard and is asleep. You know, so, between all that and then this child [refers to seven month old baby] doesn't give anybody a moments peace, because she is still little and it just always came at the wrong time. A couple of them I think I helped Barry with, but they were just like time consuming and irritating to me, so we couldn't have a good time with it. And that's what I told him, if this was last year when we had no baby then it would be fun for me to help him, because I always helped him with his science projects. But I don't want to keep doing that for you.

You know it should be something that children understand, if its not something that children understand you are not getting through to them. Because if you send it home and I do it, pretty much the adult does it, same way with science projects. I went to science fairs all over the country because my husband's in the military, and you could see the children clearly weren't doing it. The parents were doing it with computers and this and that. So how are you evaluating science because the children aren't doing it. I always told my children that science is a thought. Any thought you can possibly have is science. So science is easy. Don't make it hard. But then when they go and see all the other kid's projects, they feel like they failed because they have just had a thought, which is what science is, but these parents with computers they can look up something and boom the kids can't even explain it, but it was great, but you could see an adult did it. And that's the problem with this country is they can't compute science because they don't understand it. The parents are doing it. I don't want to do my child's homework. I think if they can't do it alone then they are not learning anything. I really do.

And my children have always been taught to learn on their own. To be able to function without the help of me. Now if you need to ask a question, fine. But I shouldn't have to spend 30 minutes with you every evening for you to do your homework. That's something you should be able to compute or we need to put you back a grade. See you can compute it on your own. Because nobody ever helped me with homework. And I think it is much harder when I grew up than it is now. I really do. Because we were more focused and we could get ahead faster. These children are less focused and they are not getting
ahead faster because all the work is put on the parents still. I don't mind being involved. I'll be right at the school any time they need me. But I think the school is, should be done in classwork activity. These children I know they don't behave today. It really doesn't help a teacher to get every point across in class, but they are much better to get them to compute on their own. (LP.T2.Mother)

Student Responses:

I liked it a lot. I thought it was fun. It gave me something to do. (HP.T1.Boy)

Well it's pretty much a good concept. Umm. I liked a lot of it. But sometimes it's hard to like getting the parent away from the television or something that they have to do, to have it done. But. (HP.T2.Boy)

I liked it, but, umm, I just, I liked it. I just always didn't get it home on time. So sometimes I didn't get it done. (MP.T1.Girl)

Well, you know, I didn't enjoy it. Number one they were boring activities. I couldn't get my mind into it. And, you know, we would have learned much more if we did the book work instead, you know. Basically, it was, I lost interest after a couple of activities and I just stopped doing them. Basically, I didn't see any point to it. (MP.T2.Boy)

Okay, hmm. At first I thought it was a good idea. But, then some of them were like too confusing or hard. And then sometimes we didn't have enough time to do it and so I wasn't sure about it, that's when we stopped doing it. (LP.T1.Girl)

I didn't really like it. I sometimes needed to do other stuff. Sometimes I didn't have time to do it. Sometimes my parents were not at home. Sometimes I had my Mom sign it and then they were supposed to give me the other homework. So I only did like one SPLASH activity. (LP.T2.Boy)
The wide range of responses reflects the purposeful selection of the interviewees. From the parent and student questionnaires, the time required for SPLASH did not seem to be a problem for most participants. In the interviews with the medium and low participants, finding the time did seem like it was a problem. A big problem seemed to be a tendency by the student to procrastinate and give the parent the activity at the last moment.

I liked it [SPLASH], but, umm, I just, I liked it. I just always didn't get it home on time. So sometimes I didn't get it done. (MP.T1.Girl)

It wasn't a major event. It was something that we just hurried up and did. Realize that I was first year law school that year and it was like just one more thing on the list of stuff to check off and hurry-up and get done and how much time can we allot for this. That kind of thing. And then Vance not being able to look ahead and say "I'll try and get this done" and to work it in, it was probably after school work. Umm. None of that is a reflection on the program. (MP.T2.Mother)

But sometimes this would get put off until the night before it was due. And that has to do with my children not communicating or something, but that's not being able to organize our time. (HP.T2.Mother)

Mother when asked about an activity: I don't remember. It left a real impact (laughs)). That was probably the ten o'clock one where I was sitting there going like this, "Can I just go to sleep?"

Interviewer: Did you usually do them on Monday nights?
Mother: Oh no last minute. Whenever. When were they due? On Wednesday?
Interviewer: Actually they were due on Tuesday, but they were accepted on Wednesday.
Mother: Most have been Monday night then I guess. But she is a good one to wait for the last minute and say, "Oh, by the way Mom." And I would forget...
Mother: I don't know if having it due Monday mornings would be any better than... Cause you know ideally we would have time to do it on Sundays on the weekends that she is with me. I think the child thinks, "It's not due till Tuesday so I will do it on Monday night."
And then you only have Monday night—to forget about it ((laughs)). To forget to do it. I don't know. (LP.T1.Mother)

Interviewer: What do you think were the benefits of the program?
Mother: I think she became a little bit more interested in what was going on in science class. But, umm..., and I guess I had fun with her at first and I thought it was pretty fun but after about the first half it was pretty hard.

Interviewer: Were there any other benefits?
Mother: I can't think of anything. You know it's hard to remember if you have a good morning and the afternoon is really bad, all you remember about is the really bad afternoon you had. So that's kind of the way I am remembering it. I know we had fun doing the whirly thing. Running up and down the stairs after it. That was pretty fun. At first I was real excited by it because we were doing it together and everything. But then it got, it was like a real switch, we were waiting for the last possible second and then having an argument over getting it done. (MP.T1.Mother)

As indicated at the end of the passage above, another problem discerned from analyzing the interviews, was that sometimes parents and children would argue about the activities. The conversation with the aforementioned mother continued.

Interviewer: What would the argument be about?
Mother: Umm, she wanted me to do it. And she wanted to watch. She wanted it to be her hand writing, but that is all she wanted to do.

Interviewer: How did you get that impression that she wanted you to do it?
Mother: Well she would, she told me that she read the instructions, and it was obvious that she hadn't. Then she waited around until I told her the answer because she did not understand it. But I don't think that was the case, the case was it just hadn't been read.

Interviewer: Any other ways you felt she would try and get you to do it?
Mother: Umm. Yeah, it was pretty persistent the way she, she just, I don't know, I just felt like she was trying to get me to do it. I guess you had to be there. (MP.T1.Mother)
In one interview session, after interviewing the student and the mother separately, the mother suggested to the interviewer that they move into the family room where it was cooler. The SPLASH student and his sister were sitting in the family room watching television.

Mother: We were confusing each other until we finally got it right. It wasn't that bad.
Sister: [inaudible.]
Mother: It didn't take 3 hours it took about 20 minutes.
Sister: It seemed like it.
Mother: Yeah because it was a bickering match. That's what I am saying, we had these bickering matches.
Interviewer: Were you arguing about it?
Mother: Yeah, I don't want to do homework anymore, that's why I went to school and graduated. I don't want to do it anymore. I'm telling them the same thing. If you don't want to do homework the only thing you got to do is get through it, get good grades, if you want to decide to go to college a year after you are out on your own, you can go back. But if you mess up now, don't look at me, I'm not helping. Because they've got to do it they've got to understand it. When I went through it I had to do it and I had to understand it. They wouldn't even be here if I thought I couldn't think straight.
Interviewer: What would you bicker about?
Mother: Because he would always try and tell me how it really is supposed to be done and then if I try and give him any kind of insight, I'm wrong. I'm an old lady. I don't know what I am talking about.
Boy: Mommm! [And then they argued about a science fair project they had worked on two years ago.] (LP.T2.Mother)

4. Will the hands-on, home-science parental involvement program improve student science process skills as compared to students in a control group?

Neither of the science process skill instruments showed any significant differences between the treatment and control groups. Was there learning going on? Statements by parents and children indicated that the students were learning.
That’s one of the things I think SPLASH was trying to do was to get kids to think. And then react to that thinking, rather than just “Gee, I don’t know,” and forget the problem all together. He did finally understand that the size of the ball does have something to do with the size of the hole that it will create, but also investigating where the second ball lands, what effect does it have on the first hole. And looking at the pictures of the moon you could figure out somewhat the relationship of where the meteor struck it versus the second versus the third in order to create the end result of what the lunar landscape was. (HP.T1.Father)

This is Mom talking, but I always thought she was pretty smart, but I think she is even smarter than I thought. She is very good at coming up with the conclusions. She seems to have a real handle on it and she likes science more than I knew she did. She really does. (HP.T2.Mother)

Vance would think he would know what was going to happen, and all the time it didn’t turn out that way. So it was a big surprise. Then he had to figure out why it did turn out that way. (MP.T2.Mother)

Probably to make you, like, you learn more out of class, like what you learn out of class, without taking up time of class or something. We learn at home with our parents. (MP.T1.Girl)

You know, basically I taught my parents some things and they taught me some stuff. (MP.T2.Boy)

It like helped me to understand it more than just going through it in the class and stuff. (LP.T1.Girl)

Girl: Well ((laughs)), I wanted to be the leader. I guess, like I dropped the whirlorb and I reversed on the electricity one since I already knew what happened and stuff. We both put the foil on. Umm. The batteries and they—I guess the ones that I knew I let my Mom do most of it, but the ones I didn’t know I did.

Interviewer: Why?
Girl: Cause since I didn't understand it, I wanted, I guess for me, I understand more if I have to actually do it rather than observe.
Interviewer: Did you feel like you were teaching your Mom at times?
Girl: Yeah.
Interviewer: How did that feel?
Girl: Well you know, you like to know more than your parents. But.
Interviewer: Did it help you to understand it at all?

5. Will the hands-on, home-science parental involvement program improve student attitude toward science as compared to students in a control group?

There were no significant primary effects for experimental group on the attitude toward science instrument. There was an interaction between student's sex and experimental group, with girls in the treatment group having higher scores on the science attitude posttest instrument than girls in control group. There were some statements that reflect on science attitudes. One mother indicated that her daughter had become more interested in science class as a result of the program.

I think she became a little bit more interested in what was going on in science class. (MP.T1.Mother)

A different mother discovered from the program that her daughter was very interested in science.

She seems to have a real handle on it and she likes science more than I knew she did. She really does. (HP.T2.Mother)

When a student was asked the benefits of SPLASH she replied:

I guess it could, umm, help you, like, make science funner instead of just, you know, just finding it in class, and books, and papers. (LP.T1.Girl)
Summary of Results

A majority of students and adults participated in doing some SPLASH activities. The levels of student completion initially were higher than the levels of completion of a normal homework assignment. There was a decline in the levels of participation toward the end of the program.

Parents became involved in doing the SPLASH activities. Mothers were more likely to help than were fathers. A majority of parents indicated they had become more involved in their children's education as a result of SPLASH. There was no evidence that parents were spending more time helping or monitoring homework, however, there was evidence that suggested parents spent more time helping with and monitoring science homework when the SPLASH work was included. There was no evidence to support the hypothesis that parents in the SPLASH program would be more likely to attend the parent teacher conferences.

In general, both parents and students expressed positive attitudes about the program on the SPLASH questionnaires. Parents tended to view the program more favorably than did students. The materials used in the SPLASH program were easy to obtain by most participants. Participants in general did not find the length of an individual activity to be too long. However, finding the time sometimes seemed to be a problem due to a tendency for the students to procrastinate.

A majority of parents and the students indicated on the SPLASH questionnaires that they thought the student had learned science by doing the activities. Comments during the interviews by both parents and students indicated that learning had occurred. However, there were no significant
differences on either of the two science process skill achievement instruments based only on experimental group.

Only 28.8% of the SPLASH students agreed or strongly agreed that their attitude toward science had improved as a result of the program. The science attitude instrument failed to show any significant differences based only on experimental group. There was a statistically significant interaction between students' sex and experimental group. Girls in the treatment group improved their science attitude scores, while girls in the control group had lower scores.
CHAPTER V

SUMMARY, DISCUSSION OF RESULTS, CONCLUSIONS,
IMPLICATIONS, AND FUTURE RESEARCH

Summary

Many people recognize the need for involving parents in their children's education. Many people also recognize the need for quality science education in precollege instruction. Some programs have attempted to improve science education through increased parental involvement. The majority of the reported programs relied on special out-of-home classes for parents and children that were not directly connected to science instruction occurring in the schools (Beane, 1990; Cohen, 1979; Gennaro, Bullock, & Alden, 1980; Heller, Padilla, Hertel, & Olstad, 1988; Rand & Gibb, 1989; University of Minnesota, 1982). These programs were enjoyed and valued by the participants. None of the programs compared students in the program to an equivalent group not in the program.

Other programs sought to involve parents through the use of science activities done in the home (Franklin & Krebil, 1993; Gennaro & Lawrenz, 1992; Graika, 1981; Williams-Norton, Reisdorf, & Specs, 1990). As with the out-of-home programs, these programs reported that the participants liked the programs. The program of Gennaro and Lawrenz was the only program
found with substantial evaluative data and was the only program that was reported in a research journal; the others were reported in journals for practitioners. In the Gennaro and Lawrenz study, no significant differences in attitudes were observed between parents or elementary school students in the treatment group (doing activities) and the control group (not doing activities).

This study evaluated a program called Student Parent Laboratories Achieving Science at Home (SPLASH). This program was similar to programs that sought increased parental involvement through the use of science activities done at home. However, a major difference from previous programs of both the out-of-home and in-home variety was that the SPLASH activities were given as homework assignments for the students to complete with their parents or another adult. Introducing SPLASH as an assignment, rather than making it a voluntary activity, was done to maximize student and parent participation. If the parent or adult was unwilling or unable to complete the assignment, they were instructed to sign it and an alternative assignment was given to the student.

Another difference between SPLASH and the program of Gennaro and Lawrenz (1991), is that SPLASH did not send materials home for the activities. Unlike science kit type programs, SPLASH desired to have all students do the same activity so that the activity results could be discussed in class. It was felt that it would be too expensive and time consuming for teachers to prepare enough material packages for all their students. Thus, SPLASH activities were designed to use materials commonly available in homes.

The evaluation of the program utilized a quasi-experimental design with a total of eight classes and two teachers participating. For
each teacher, two classes were randomly assigned to the treatment group and the other two classes served as the control group. Students and their parents in the treatment group were informed of the SPLASH program and received 10 SPLASH activities. Students in the control group received their normal homework assignments. Five research questions were used to guide the evaluation of the program: (1) What percentage of families complete the hands-on, home-science activities and how does that vary over time? (2) Does the hands-on, home-science parental involvement program increase parental involvement? (3) What are parent and student perceptions about the hands-on, home-science parental involvement program? (4) Will the hands-on, home-science parental involvement program improve student science process skills as compared to students in a control group? (5) Will the hands-on, home-science parental involvement program improve student attitude toward science as compared to students in a control group?

Discussion of Results

This section presents a discussion of the results presented in Chapter 4. The discussion of results is organized by research questions.

1. What percentage of families complete the hands-on, home-science activities and how does that vary over time?

   The teachers in the study estimated that the student completion rate for normal homework assignments was between 70 to 75%. The completion rates for SPLASH activities done by students in the first two weeks of the program were higher than the approximated normal homework completion
rates. From an initially high rate of participation in the program, a decline occurred in weeks three and four.

Parents' comments on SPLASH activity four indicated that the snowy and cold weather conditions influenced some participants to decide not to go outside and dig up soil. In the discussion of results with the cooperating teachers, observations they made confirmed that the inclement weather lowered participation for SPLASH activities three and four. Teacher 1 described the cold, snowy weather as a barrier to obtaining materials: "I asked a couple of them [the students], why didn't you do this 'We couldn't get the materials' is what they were saying."

After activities three and four, Teacher 1's students completed the activities at a higher rate than the estimated rate of completion of normal homework assignments. For activity nine there was a slight decline in the level of completion of the activities and in activity ten there was a more pronounced decline.

After activities three and four, Teacher 2's students had levels of completion that were below the normal estimated homework completion rates. In activities nine and ten, Teacher 2 also had a decline in the percentage of students completing activities.

The decline in percentages of students completing activities nine and ten could be due to a decrease in the participants' enthusiasm for doing the SPLASH activities. Comments during interviews with parents and students indicated there was less enthusiasm for the activities as the program continued. Comments by the teachers also indicated that this was a possibility.
Teacher 2: I know I had kids coming in and saying "We're tired of doing this every week" and they were parroting what their parents said at home. "Our parents are tired of doing this every week." And I think when they heard that from their peers they took that home and said "Well so-and-so is tired of doing it, how about you?" and their Mom or Pop would probably say "Yeah I am tired of doing it." So I felt like they contributed to one another's lack of interest here. Although I tried to talk it up, there is not much you can do when...

Teacher 1: At first we thought, "Oh, ten does not sound like a lot." But it was getting pretty long. And I don't know if it would change if you did it every other week.

Teacher 2: Well that's what I was thinking. Even once a month or once a grading period and carry it on all year.

Teacher 1: Yeah.

Another reason for the decline in participation in the last two activities could be that starting with the penultimate activity, there was a shift away from what was being done in the classroom, so that the labs could be made more open ended. "The Great Popcorn Lab" was developed to help give experiences in designing and conducting experiments (Appendix Q). "Hey! What's Your Problem?" was a totally open-ended lab, where the parents and students chose a problem to investigate, designed an investigation, and conducted the investigation (Appendix R). The shift away from the curriculum at the time, and a perceived greater difficulty may have led parents or students to decide not to do these activities. One parent interviewed, predicted a lower rate of completion for activity ten due to its difficult nature: "The last experiment was not intimidating to me but it might have been to others.... I predict that there will be a drop at the end, for the last activity" (HP.T1.Father).

Another factor that may have lowered activity completion rates emerged from the parent and student interviews. Student procrastination...
created situations where participants forgot to do activities or it created situations where the participants completed the activities in a hurried manner. According to a low SPLASH participation mother interviewed: "I think the child thinks, 'It's not due till Tuesday so I will do it on Monday night.' And then you only have Monday night—to forget about it ((laughs)). To forget to do it." Methods for dealing with procrastination should be explored.

There was a statistically significant difference between the rates of completion of the activities for Teacher 1 and Teacher 2. In discussing this difference with the two teachers, both teachers agreed that teacher behavior can influence the level of completion of the activities. Possible reasons mentioned by the teachers for the different rates of SPLASH activity completion include: (a) grading systems used, (b) discussing activities after students completion, (c) the level of difficulty of the alternative assignment, (d) the comfort and experience of the teachers, and (e) possible differences between students.

The grading systems used for the SPLASH activities were the same systems used by the teachers for their ordinary homework. Teacher 2 used a check minus, check, check plus system for poor, average, and good work, respectively. Teacher 1 used a grading system based on a percentage correct system. Because many of the SPLASH homework questions did not have strict right and wrong answers and because they were receiving help from their parents, grades on the SPLASH activities tended to be high. This might have motivated some grade conscious students in Teacher 1's class to do SPLASH rather than the alternative assignment. For Teacher 2's students, the check system might not have been as motivating.
Both teachers indicated that they talked about the SPLASH activities to the students when they handed out the activities. However, there were differences in how they approached discussing the activities when they were due. Teacher 1 focused more effort on discussing the SPLASH activities when students turned them in and when they received their grades.

Teacher 1: I think I did more of that [talking about the activities when students turned them in] towards the end than I did in the beginning. And I found out the kids got more psyched up. "Oh, is that what you did?" You know. The sandwich one. A lot of them were going "Huh?" And the ones that really got into it talked about it more and they were like "Ohh!!"

Teacher 2: We didn't do very much talking afterwards. Well, because there wasn't the interest. You know, you try and talk and ((mumbles)) nah-nah-nah.

According to Teacher 1, the alternative homework assignments she gave for SPLASH activity nine involved a lot of writing. She felt that this might have influenced students to do SPLASH since it was less work than the alternative.

Teacher 1: I think the popcorn one, for me, why it stayed up [in contrast to Teacher 2], was I talked about it more before I handed it out. And I think the other assignment [alternative] was not a whole lot of fun assignment, it was something dealing with a whole lot of writing, if I can remember correctly. And I think that influenced a lot of them, plus popcorn was easy to get. I am pretty sure that what my alternative assignment was a bunch of writing. I'm pretty sure it was.

In comments by some students during the interviews, their reasons for doing or not doing the SPLASH activities related to their perceptions of which would be easiest to do. Thus, some students may have tended to take the path of least resistance.
Teacher 2 suggested that the differences in levels of participation might have been due to different levels of experience and confidence of the teachers. Teacher 2 had been an elementary school teacher and this was her first year at this middle school. She felt her many other concerns caused her to pay less attention to SPLASH. Teacher 2 also presented the possibility that differences between students' SPLASH completion rates for the teachers might have been due to differences between the students.

Despite not sending materials home and requiring the help of parents, there were initially high levels of completion of activities; activity one had a student completion rate of 92%, activity two had a completion rate of 79%, and activity three had a completion rate of 77%. The unavailability of soil during a snowstorm and the subsequent decline in levels of participation during these weeks indicate the importance of designing SPLASH activities to use readily available materials. The differing levels of participation of the two cooperating teachers indicates the importance of the teacher in the SPLASH program.

2. Does the hands-on, home-science parental involvement program increase parental involvement?

The SPLASH program was effective in getting parents to work on hands-on science activities with their children. Almost all students (97%) completed at least one SPLASH activity. Approximately one quarter of the students completed all ten of the activities. Including SPLASH time, parents in the treatment group reported spending more time helping and monitoring science homework than did parents in the control group. The evidence
indicates that the students were involving their parents in working on the activities.

Did SPLASH produce a spillover effect, with parents becoming more involved in general? A majority of parents indicated that they felt more involved in their children's education as a result of SPLASH. However, only about one-third of the students indicated that their parents were more involved as a result of SPLASH with about one-quarter indicating they were undecided. There was no evidence to suggest that parents were spending more time helping and monitoring homework for all classes during the SPLASH intervention.

A question that was not directly asked of parents was how much time did you spend helping with your child's homework? A question was asked about the time spent for both monitoring and helping. However, monitoring homework is a very different type of activity than helping with homework. In the factor analysis of the items on the Parent Questionnaire, the item on making sure their child's homework is completed (item 2, Table 11) loaded with other items of parental involvement. The two items on helping with science homework (item 1 and 6, Table 11) loaded as a separate factor. It is possible that SPLASH did cause some parents to spend more time actively helping rather than passively monitoring. Comments from the interviews suggest this might have been the case:

Yeah, it got me more involved with like a parent-son school relationship versus just here we go again Tom, go do your homework, find a corner to sit in and get it done yourself. (HP.T2.Father)

Before they used to tell me to do my homework and then after SPLASH, my Mom or my Dad would sit down and help me. (HP.T2.Boy)
Parents in the treatment group had higher scores than parents in the control group on the variables Parent Involvement and Parents Helping with Homework. These differences may reflect increased involvement due to the SPLASH program, however, these differences were not statistically significant and there was no attempt to equate groups prior to SPLASH implementation. If it is assumed that the random assignment of classes into treatment and control groups produced equivalent parent groups, the lack of significance could mean that there had simply not been any changes in parents' behavior or thoughts. Another possibility is that parents were answering the questions based on their typical habits and SPLASH was viewed as an atypical event.

One research hypothesis was that parents in the treatment group would report that they were more involved in their children's education as a result of the SPLASH program. This hypothesis was supported; 58.8% of the parents agreed or strongly agreed with this statement. Looking at the item most related to parent involvement in science education, "I have a good idea of what my child does in science class," 76.5% of the treatment group and 54.8% of the control group agreed or strongly agreed with this statement. It may be that SPLASH was responsible for helping treatment group parents understand what was happening in their child's science class. While it is hard to gauge the educational impact, increasing parents' knowledge of their children's science education is a positive outcome.

On the variable Parent Comfort in Science, the control group had a higher mean than the treatment group, but the difference was not statistically significant (Table 12). Perhaps the challenge of the SPLASH activities might
have caused some parents to feel less comfortable with science. Teacher 1 expressed her thoughts on parent's discomfort as follows:

I'm wondering if because they were doing the SPLASH activities they actually found out how little they do remember from their own sixth grade science classes and doing those types of things. Plus, how did they do sixth grade science back then? If they were like me, they were in a book oriented... So they're not as oriented to science this way.

It was hypothesized that parents in the treatment group would be more likely to attend parent teacher conferences. There was no evidence to support this hypothesis. The reasons for attending parent teacher conferences are varied and may be unrelated to parents helping their children with science activities.

3. What are parent and student perceptions about the hands-on, home-science parental involvement program?

While there were some participants who did not like the SPLASH program, the majority of students and parents expressed positive opinions about aspects of the program. A majority of parent respondents on the Parent Questionnaire indicated they enjoyed the activities, that they would recommend SPLASH to a friend, and that the program should be done again next year. Only 22.7% of the parents disagreed or strongly disagreed that they had learned science from the program, and 64.3% agreed or strongly agreed that their child had learned from SPLASH. A large majority of parents (83.6%) indicated that all parents should do at least one activity.

Student opinions about the program, while less positive that their parents, also indicated that they viewed aspects of SPLASH favorably. A
majority of students indicated they would rather do SPLASH than regular
homework, they learned science from SPLASH, and they would rather work
with their parents on SPLASH activities than work by themselves. Only
about one quarter of the students disagreed or strongly disagreed with the
statement, "I enjoyed the SPLASH activities." While all students will never
love anything that is considered homework, SPLASH may be a more
acceptable alternative to traditional homework.

In interviews with parents, students, and the teachers, it did seem that
for some participants, ten activities was too many and that one activity a week
was too frequent. The frequency of the SPLASH activities and the duration of
the program needs to be explored further.

Parents who hold a delegation model, as did the two low participating
parents in the interviews, may never favorably view a program that causes
them to be involved in something that they don't feel is their responsibility.
However, if these parents attempt SPLASH activities—and they enjoy doing
the activities and learning with their children—they may move away from
the delegation model. Although there was only a moderate correlation
(r=0.38, p<0.001) between the variable Student Benefits of SPLASH and the
number of activities completed, lack of enthusiasm by the child of a
deviation model parent might be a compounding problem for low
participation. As one low SPLASH participation mother put it: "If he said he
doesn't want to do them then why should I bother? Fine. Send it back and
get the homework." Thus, one possible avenue for greater participation in
the program is generating greater student enthusiasm for doing the SPLASH
activities. If children become more excited about the prospect of doing the
activities, perhaps more parents would participate.
The potential problem for parents in doing SPLASH activities is an important consideration. The variable Parent Problems With SPLASH had a higher significant correlation with the number of activities completed ($R=-0.44, p<0.001$) than any other variable in the study. The negative correlation indicates that parents who agreed with the problem items in the questionnaire, tended to do less SPLASH activities.

Parents tended to disagree with most of the items in the variable Parent Problems With SPLASH. The evidence suggests that the SPLASH activities were successful in not using too much time for each activity. The average length of time per activity was 30.0 minutes. Only 14.3% of the parents agreed or strongly agreed that the activities took too much time. Only 3.5% of the parents agreed that the activities were too difficult. Overall, the required materials were not expensive and were easy to obtain. As one high participation mother described it: "I thought the supplies were easy to come up with. We didn’t have any times when we really had to go out and buy supplies or make any great effort for that."

The biggest problem with the activities from the parents’ point of view was confusing directions. Twenty-five percent of the parents agreed and 2.4% strongly agreed that the instructions were too confusing. It is a challenge to design activity directions that are not excessively discursive, but that clearly explain the activity protocol. In one of the interviews it became apparent that in one activity the parent thought there was a mistake in the directions, but in actuality there was no mistake. To prevent this perception, perhaps answers and feedback should be provided for parents after each activity.
4. Will the hands-on, home-science parental involvement program improve student science process skills as compared to students in a control group?

While both parents and students thought the students learned from SPLASH, there was no evidence from the two science process instruments that SPLASH improved science process skills for these sixth grade students. This is consistent with a study by Padilla, Okey, and Garrard (1984) that also found no significant differences in science process skill achievement for sixth graders in three very different experimental groups: (a) no science process skill instruction, (b) two weeks of process skill instruction, and (c) two weeks of process skill instruction with one science process skill activity for the subsequent fourteen weeks.

There are many possible reasons to explain why there were no significant differences in science process skill achievement between the treatment and control groups in this study. It is possible that for some reason, the activities, the parent-child interactions, or the development level of the child, there was simply no improvement in science process skills taking place due to the SPLASH program. It is also possible that the instruments used in this study were not sensitive to the type of learning that was occurring in the SPLASH activities.

One problem that might have interfered with learning emerged during interviews with parents and students. It seems as though most students had a tendency to procrastinate on the activities. Doing the activities at the last minute caused some participants to just want to do the activities to get them done. One mother's recall of an activity was limited because they had waited
Procrastination may have had a negative impact on learning.

One objective of the SPLASH program was to have all students doing the same activities so that they could be discussed in class. However, Teacher 2 indicated that she did not discuss the activities when they were turned in. Teacher 1 indicated that she started discussing the activities more near the end of the program. Perhaps if more attention was focused on discussing completed activities, more learning would have occurred.

The achievement in process skills of the treatment (SPLASH) group was compared to the level of achievement of the control group. The teachers in the study both used a large amount of hands-on learning in their teaching. Each teacher estimated that they used 2.5 science activities per week. The following segment from the discussion illustrates the teachers' view of the importance of hands-on learning in the classroom.

Teacher 1: Sixth graders are the first grade, really, [in this district] where they have a science class. Some of the elementary school teachers do science and some of them don't. And I think a lot of them got excited about having science class per se, even at the middle school and I think, and I don't mean to toot Teacher 2's and my horn, our idea of science is hands-on and I think a lot of our other things, not only SPLASH, were hands-on oriented, and I think our beliefs of science filtered onto science across the board....

Teacher 2: Even Mike's [a student teacher] teacher from Ace University [name changed], who came in today, and he was doing hands-on, she says "these kids aren't at all surprised that they are working with their hands. I go into a regular classroom and if you give them a battery or bulb or something and they're bonkers. Its obvious they do textbook."

It is possible that the high level of hands-on science utilized by these two teachers could have reduced the effects of the SPLASH program.
5. Will the hands-on, home-science parental involvement program improve student attitude toward science as compared to students in a control group?

There were no significant main effects by experimental group on scores on the *Attitude Toward Science in School Assessment* instrument. There was a statistically significant interaction between sex and experimental group. Boys in the treatment group had lower scores before SPLASH implementation and after SPLASH implementation. In both cases these differences were statistically significant. In discussing the results, the cooperating teachers could not suggest any reason why the boys' attitudes in the treatment group would be lower before or after SPLASH implementation.

Girls in the treatment group started off with lower attitudes than girls in the control group. These differences were not statistically significant. On the posttest, there was an increase in the mean scores for the treatment group girls and a decrease for the control group mean scores, such that the difference between the groups was statistically significant on the posttest. It is difficult to make any rigorous conclusions from this disordinal interaction but the possibility that girls' attitudes benefit from the SPLASH program should be investigated in subsequent research. The benefit for girls doing the hands-on science activities at home with their parents might be explained by the tendency of boys in the classroom “to manipulate the equipment more during labs while the females watch” (Dalton, Rawson, Tivnan, & Morocco, 1993, p. 2). Girls working at home on the activities would not have to compete with boys, and this might help to improve their attitudes toward science. Also, girls have fewer out-of-school science experiences than do boys.
Providing additional out-of-school science experiences may have benefited the girls.

Beyond benefiting from the manipulation of materials, female students may also benefit from the interaction with their parents. "Males are also more likely to attempt responses to questions even when they are unsure of the answer, enabling the teacher to prompt and guide them to a more accurate response" (Dalton et al., 1993, p. 3-4). Working at home with their parents may make girls more comfortable with suggesting answers that may be wrong. Their parents can then prompt and guide them, helping them in Vygotsky's (1979) Zone of Proximal Development.

Comparing girls and boys, girls had higher means on all three of the variables of the Student SPLASH Questionnaire and girls had a slightly higher level of completion of SPLASH activities. While these differences were not statistically significant it is possible that girls benefited more than boys from the program, and that helped to improve their attitudes toward science.

**Summary of Findings**

The following summary statements can be made based on this evaluation of the implementation of the SPLASH program with students in the sixth grade in a central Ohio middle school.

(a) Almost all students in the classes with SPLASH implementation did at least one SPLASH activity.

(b) The activity rates of completion began at a high level and declined during the program period.

(c) The SPLASH activities did involve parents in helping their children. Mothers were more likely than fathers to help with the activities.
(d) The classroom teacher appears to have influenced the level of completion of activities. Discussing the activities when they are returned to class, the level of difficulty of the alternative assignment, and the marking system appear to be important factors in SPLASH completion rates.

(e) On the SPLASH questionnaires, a majority of parents and students expressed positive opinions about the SPLASH program. For the most part, parents did not feel the activities were too difficult for their children, and parents thought they helped their children by working together on the activities. Most students preferred SPLASH to regular homework and most would rather work on SPLASH with an adult than by themselves.

(f) On the SPLASH questionnaire, most parents did not view time, expenses, instructions, level of difficulty, or their science background as problems with the SPLASH program. While these problems did not seem to be major barriers for most parents, the variable they comprised, the variable Parent Problems With SPLASH, had a higher correlation with the total number of SPLASH activities completed than any other variable. From the questionnaire, the biggest problem seemed to be the confusing directions.

(g) In the interviews with parents and children, the biggest problem for SPLASH participants who had only done a few activities seemed to be finding the time to do the activity. A problem that many participants (high, medium, and low levels of SPLASH completion) reported in interviews was a tendency for the student to procrastinate in bringing the activity to the parent. This resulted in last minute rushes to complete the activities and caused some non-completion of activities.

(h) A majority of the participants answering the SPLASH questionnaires felt that the student had learned from doing the activities.
However, there were no significant differences between experimental groups on the science process skill instruments.

(i) There were no main effects for experimental group on the science attitude instrument. However, girls doing SPLASH had higher posttest scores than the girls not doing SPLASH. This resulted from a disordinal interaction where the scores for girls in the treatment group increased and scores for girls in the control group declined. The pretest differences favoring the girls in the control group were not statistically significant. The posttest differences favoring the treatment group were statistically significant.

**Implications for the SPLASH Program**

The average length of time per activity (30.0 minutes) did not seem too long for most participants. However, the length of the program (10 activities) seemed too long for some participants. Perhaps there should be SPLASH units or SPLASH months so that the program does not run as long. It was suggested by teachers and some parents that it might improve the program to assign the activities every other week rather than every week.

Obtaining materials, with the exception of getting soil during cold weather and a snowstorm, was not a problem for most parents. Nor was the expense of the materials a problem. Thus, the same strategies could be used in developing future activities. It does appear that parents can be involved in science activities without sending home kits.

The directions for the activities need to be revised. The level of difficulty of the activities was not seen as a problem, but problems were seen in the wording of the activities. The activity wording should be checked for
it's age appropriateness for the students and parents. The directions should be revised so that the instructional sequence is clear. Feedback to parents on obtained results might help parents feel more comfortable that they had completed activities correctly.

Procrastination seemed to be a problem for many of the participants who were interviewed. Having the activities due on Tuesday may defeat the purpose of assigning the activities over the weekend, since it seemed many students were waiting until Monday night to ask their parents for help. Perhaps, as one parent suggested, the activities should be due on Monday. Another option is for the student to take the activity home when it is assigned, have the parent sign it and indicate on the activity what day is best for the parent. If this system was used, then parents who were unable or unwilling to work on the activity during that week could ask that the alternative assignment be assigned. Then the alternative activity would be due on the same day as the SPLASH activity.

One parent questioned the need for parent survey questions on the bottom of each activity. The questions were of limited use in designing the activities, but free response comments parents made were useful. Thus, open-ended questions seeking comments about specific activities should remain, however, the yes/no questions should be modified or removed from future SPLASH activities.

Educating teachers about their roles in the SPLASH program could improve the effectiveness of the program. To maximize the number of parents involved—an important goal of the SPLASH program—teachers need to generate student excitement about the program. Both teachers introduced the SPLASH activities. Only one teacher focused on discussing
the activities when they were returned. This teacher's students had a higher rate of activity completion. Teachers should also be educated about ways of discussing the activities to maximize learning and improvement of attitudes.

Alternative homework assignments were provided for students whose parents were unavailable to do a SPLASH activity. Teachers should carefully consider what they assign as alternative homework activities. Some students will opt for the easiest of the activities. Thus, the alternative activity should not appear easier than the SPLASH activity. But to be fair to students whose parents cannot or will not help them, the alternative activities should not be more difficult than SPLASH activities.

Creating the SPLASH activities took about three hours per activity. In this study, the teachers did not develop their own activities. Since teachers know their curriculum and students, they would be in a good position to develop their own SPLASH activities that correspond to their curriculum and that are appropriate for their students. If the teachers made their own activities, the goals of the activities would be clearer to them, and discussions could be more meaningful. However, many teachers do not have the time required to make the activities. SPLASH activity templates and SPLASH graphics on computer discs might make it easier for teachers to adapt pre-existing activities into SPLASH activities.

Parents may be aided by more education about their role in the SPLASH program. Providing parents strategies for helping and working with their children may be useful. This might also help reduce potential arguments between parents and their children. Tips for dealing with procrastination in the activities might prevent the stress of doing the activity at the last minute.
Some parents indicated they would have liked some feedback about the activities they had been doing. Perhaps activity summary sheets could be produced that would help parents and children discuss their results of completed activities. Or perhaps some parents would wish to attend parent meetings during the program to discuss their findings and experiences with other parents and the teacher.

Finally, some information to parents might be aimed at fighting the delegation model that suggests that parents pay taxes so that the school should do all the work in educating their children. Parents need to be convinced that they should be partners in their children's education.

Recommendations for Future Research

This evaluation of the SPLASH program has created many interesting and potentially important questions that can be used for future research. While future research areas could be clustered in many different ways, they will be presented here in five non-mutually exclusive clusters: SPLASH and outcomes, SPLASH and parents, SPLASH and students, SPLASH and teachers, and SPLASH and the curriculum.

A program such as SPLASH has the potential to impact the participants in many diverse ways. Outcomes regarding student achievement, attitudes, and behavior; parent attitudes and parent involvement; and student-parent relationships should be investigated with qualitative and quantitative methodologies.

This study found no significant primary effects due to experimental group for student's science process skill achievement or their attitudes toward science. As the program is refined these outcomes should be reinvestigated to
see if the program has an impact. Perhaps there are better indicators of the effects of the program than the instruments used in this study. Outcomes research should investigate alternative methods for assessing cognitive and affective outcomes of the program. In addition to assessing the impact of the program on science process skills and attitudes, other dimensions such as problem solving, logical thinking, and overall academic achievement should be evaluated. The long term impact of SPLASH programs should also be considered. Long term factors to assess include aspects of parent involvement, student course selection, and student achievement.

In this study there was a disordinal interaction between sex and experimental group. The possibility that programs such as SPLASH may help girls' science attitudes should be explored. It may be that girls benefit by not having to compete with the boys for the manipulation of apparatus. Perhaps doing hands-on science activities at home will give girls either increased confidence or desire to take more of an active role in classroom activities. This possibility could be investigated with behavioral studies of classrooms.

The parent is an important key to the SPLASH program. Qualitative studies of how parents and children work on the activity should be done. What is going on in Vygotsky's (1979) theorized "Zone of Proximal Behavior"? From these findings may come suggestions for improving parent effectiveness in SPLASH and parent involvement in general.

It seems that some parents would benefit from knowing more about the program before it started. Some parents indicated they would like greater feedback about the activities that they are doing. Comparing different types of pre-SPLASH and during SPLASH parent education strategies, such as parent meetings or handouts, could be made to determine their effect on the
SPLASH program and SPLASH outcomes. It is also important to ascertain before SPLASH implementation the number of parents who subscribe to the delegation model of education. Then the effectiveness of the SPLASH program in motivating these parents to become involved could be evaluated. Parents in higher socioeconomic levels are often perceived as being more involved in their children's education. The SPLASH program should be evaluated at different family socioeconomic levels. It may be more effective for certain types of parents and families.

Students are the most important players in the SPLASH program. The program should be evaluated at different age levels to see if it is more effective at certain grade levels. Student enthusiasm might be the key to getting parents involved. Factors to increase intrinsic motivation, such as students feeling good about doing the activities with their parents and feeling good about discussing the activities in class, need to be explored. Perhaps other student incentives might be explored to increase the students' desire to do the activities. For example, in the Reading is Fundamental program participants had their names put in for a raffle for t-shirts (Hart, 1988). Extrinsic reward options might include obtaining gifts from a sponsor for completion of activities, for example, Splashers candy or, if geographically and economically feasible, a trip to one of Disney's Splash Mountain. The effect of rewards on activity completion and resulting attitudes would need to be explored. Finally, just as parents may need advice on how to work with their children, maybe children need advice on how to work with their parents. Different forms of student education could be compared.

The SPLASH program is intricately tied into the classroom, and the teacher is extremely important. Comparisons and studies of the program's
effectiveness with different styles of teaching should be made. Perhaps SPLASH would have a greater impact on students with teachers who do not regularly use hands-on activities. Strategies that teachers use to improve the effectiveness of the program could be explored including how teachers teach process skills, introduce activities, discuss activities, and motivate students. Finally the positive and negative impact on the teacher of using SPLASH should be explored. Are potential gains from the SPLASH program worth the increased amount of time and effort the teacher would need to invest in the program?

Research needs to be conducted on the relationship between SPLASH and the science curriculum. While the intent of the program is to parallel the curriculum, there are many possibilities for how closely the activities can match what was actually done in class. Are there benefits to students for repeating with their parents the same activities they did in class? Should activities be different from activities in class but be related to the same specific concepts? Should activities relate in general to units of study (for example Earth Science) but not necessarily be tied directly to previous learning in class?

Along with the curriculum is a question of the frequency of giving the SPLASH activities. What are the effects on outcomes of shorter implementations of SPLASH? Unit exams could be used to compare SPLASH students to students studying the same unit but not utilizing SPLASH. Year long implementations could be compared to three week implementations. And assigning SPLASH every other week as opposed to every week could be compared for its effects on outcomes and levels of completion.
Final Thoughts

Most people connected with education would agree that involving parents in education is an important goal. Many educators have realized the value of hands-on science experiences for promoting discussion and meaningful learning. The Student Parent Laboratory Achieving Science at Home (SPLASH) program evaluated in this study, attempted to provide students additional science experiences and involve their parents. In this regard, the program was a success.

The program also attempted to improve science process skills and science attitudes of the students. There were, however, no significant differences between treatment and control groups on the science process skill and science attitude instruments. Aspects of the program need to be modified to explore SPLASH's potential impact on student learning and student and parent attitudes.

Still the program holds promise, as one mother's description of the program attests:

I think it's a super idea because I think a lot of parents aren't involved in their children's education.... What better way to get kids interested in science than if they think their parents can deal with it and work with them? From all sorts of angles, kids now a days—I think in general—are really needing attention from adults and what a good way to have their attention, at least for one-half an hour you are doing something together. And you are going to get help with your schoolwork. Plus its interesting..... I think in general it would help get parents involved in their children's education.

By adjusting the SPLASH program based on this evaluation and subsequent evaluations, it is hoped that the program will become more than a program with promise, but a program that promises results.
REFERENCES


Sheldon, E. A. (1869). *A manual of elementary instruction, for the use of public and private schools and normal classes; containing a graduated course of object lessons for training the sense and developing the faculties of children.* New York: Charles Scribner.


APPENDIX A

LETTER TO ALL PARENTS IN STUDY
January 15, 1992

Dear Parent/Guardian,

One of the nation's education goals is to make American students first in the world in science and math achievement. To help work towards this goal we are conducting a research project with the assistance of Ms. E. Hoelzel and Ms. P. Agnor. Through this project we hope to find ways of improving your child's achievement in science. Specifically, we are looking at ways in which home science activities can improve science education.

Under the supervision of Ms. Hoelzel and Ms. Agnor we would like your permission to have your child (1) answer questionnaires concerning their attitudes toward science and home science activities and (2) complete tests measuring their process skills in science.

The information will be very useful in helping us to improve science education at Ashton Middle School. Participation or non-participation in the project will not affect your child's grade. If you have any questions or concerns please contact Peter Rillero at the above address or telephone numbers.

Attached is a form for you to indicate consent for your child to participate. Please sign it and have your child bring it to his or her science teacher.

Thank you very much for your help.

Sincerely,

Stanley L. Helgeson
Principal Investigator

Peter Rillero
Home Phone 792-6599

* * *

Place an X in front of the statement of your choice.

_____ Yes. I give my consent for my child to participate in the above study.

_____ No. I do not want my child to participate in the above study.

Name of Student _____________________________

Name of Parent or guardian ______________________________

Signature of Parent or guardian ___________________________

Date ___________
APPENDIX B

LETTER TO PARENTS IN TREATMENT GROUP
February 2, 1993

Dear Parent/Guardian,

Our nation increasingly recognizes the importance of science in our lives and the importance of science education. As educators we also recognize the importance of parental involvement in improving education.

In your child's science class we will be implementing the SPLASH (Student Parent Laboratories - Achieving Science at Home) program. The goal of this program is to have you and your child do hands-on science activities that take about 20 to 30 minutes to complete.

When we start the program, every Thursday your child will bring home a SPLASH activity. If you elect to do the activity, please work with your child to complete the activity and the worksheet. The activities will be due the following Tuesday. Ten activities will be sent home, one per week. The first activity will be given on February 11th.

We realize that you are busy and may not always have the time to complete the activity. For this reason, we are making the activity optional. If you decide that you cannot do the activity during a particular week, simply sign and write that on the SPLASH sheet. Your child will be given an alternate assignment. Please note: A child should never do these SPLASH activities without adult supervision.

We are not assuming that you know a great deal of science. The activities are simple and enjoyable; and we think both you and your child will learn from them. However, we know that you may have concerns and questions about doing science activities at home. Thus, we are having a special optional SPLASH parent night this Tuesday (February 9th) at 7:15 PM in the school cafeteria. We hope that you can come to the meeting. During the program we will be seeking your opinion about the program. In about 11 weeks we will also send you a questionnaire that we hope you will complete. Please feel free to give us a call if you have any questions.

Thank you for your continued support.

Sincerely,

Mr. R. D. Gillum  
Principal

Ms. E. Hoelzel  
Science Teacher

Ms. P. Agnor  
Science Teacher
P.S. Please acknowledge receipt of this letter by completing the following and having your child return it to their science teacher.

I understand that each Thursday my child will be coming home with an optional SPLASH activity. If we decide to complete the activity, it is due the following Tuesday. If we decide not to complete the activity, my child will instead complete a traditional homework assignment. My child should not work on the SPLASH activities by himself or herself.

Student name ________________________________________________________

Parent/Guardian name ________________________________________________

Parent/Guardian signature _____________________________________________

Date _______________

Please check one of the following:

____ I will be coming to the optional SPLASH parent night.

____ I will not be coming to the optional SPLASH parent night.

SPLASH

Student Parent Laboratories –
Achieving Science at Home.
APPENDIX C

PARENTS NIGHT HANDOUT
What is SPLASH?

SPLASH is a program that involves parents and guardians working on hands-on science activities at home with their children. The SPLASH activities are designed to be enjoyable and educational for both the adult and child.

Why science?

Science is an extension of children’s natural curiosity. In a rapidly changing world, we as a nation need citizens with more training in science and technology. While, scientists, health care workers, and engineers are a necessity, we also need ordinary citizens who understand science.

What is science?

While facts are a part of science, science is much more than memorizing facts. Science is a way of thinking and a way of investigating; science is a process not a product. Basic skills in science include observing, classifying, using numbers, communicating, measuring, inferring, and predicting. Higher level science process skills include formulating hypotheses, controlling variables, interpreting data, and experimenting.

Why hands-on science?

Children learn science best if they are able to investigate and experiment. Hands-on science can help improve student attitudes toward science and achievement in science. Hands-on science can also help students improve their ability to solve problems and think critically.

(more on the back)
Why involve parents?

As educators we realize that parents can help their children to achieve to the best of their abilities. Parents can also influence student attitudes toward school. We would like for you to work with your child on hands-on science activities to provide more out of school science experiences for your child, to help you understand what your child is doing in school science, and to encourage a dialog about science between you and your child.

What is my role in the SPLASH activities?

The SPLASH activities have been designed so that you are an active participant. You and your child will be asked to do activities and to write down answers and comments on the sheet. We have tried to create activities that will help you and your child learn and enjoy science.

What do I do if I do not have the time?

We understand how busy people are in today's world. We designed the SPLASH activities to take about 20 to 30 minutes to complete. Most adults have more time on weekends, so we will give the SPLASH activities on Thursdays and make them due on Tuesdays. Despite this we realize there may be weeks when you simply do not have the time to do the activity with your child. It may be an option to let your child work on the SPLASH activities with another trusted adult. Please do not let your child work alone on the activities. If you or another adult cannot work on the SPLASH activity during a particular week, please sign the activity sheet and write this as a short note. Your child will then be given a traditional homework assignment.

What do I do if I do not know much about science?

We do not expect you to know a great deal about science. The focus of SPLASH is on the processes of science and not on understanding or memorizing scientific facts. Together with your child we hope you can make observations, try some experiments, and think about the results. If you don't know something, tell your child and then together try and figure out how you can find answers. If you have any problems, give Peter Rillero a call (792-6599).

How long will the program last?

The program will start this Thursday. There will be 10 activities assigned, one per week of school. After 10 activities are completed, the program will be evaluated. The results will be presented to Mr. Gillum and Ashton's science teachers so they can decide whether to adopt the program.
Name of student ________________________
Science Class Teacher & Period ________________________

Dear Student,

We would like to know what you think about SPLASH (Student-Parent Laboratories Achieving Science at Home). Please take the time to complete this final questionnaire. There are no right or wrong answers to the following questions. You are simply being asked to give your opinion. **Your answers will be kept confidential.** Please indicate your true feelings and not what somebody else may feel is the best answer. Circle the number that shows how you feel about each statement. Answer every question. Give only one answer for each question.

Use these answers for each question:
1. Strongly Disagree  
2. Disagree  
3. Undecided  
4. Agree  
5. Strongly Agree

**Example:** I like to travel. (If you agree you would circle number 4.)

1. I enjoyed the SPLASH activities.  
2. SPLASH activities helped me learn science.  
3. The SPLASH activities helped me know my parents better.  
4. I would recommend SPLASH activities to my friends.  
5. The SPLASH activities required too much time.  
6. The SPLASH program should continue.  
7. My parents learned a lot from doing SPLASH.  
8. I think my parents are more involved in all my school work as a result of being in the SPLASH program.
9. Hands-on science activities, like those used in SPLASH are a good way to learn science. 1 2 3 4 5

10. I would rather do SPLASH homework than do a regular homework assignment. 1 2 3 4 5

11. I like science more because of SPLASH. 1 2 3 4 5

***
Please write in your answers to the following questions.

1. Would you have rather worked on the SPLASH activities by yourself or with your parent or guardian? (put an X in front of your answer)
   
   _____ by myself  _____ with parent or guardian

   Please explain your answer to question 3 in the space below:

4. Please tell us what you thought were the best things about the SPLASH activities and the SPLASH program.

5. Please tell us what you thought were the worst things about the SPLASH activities and the SPLASH program.

Please make sure you have answered each question.

Thank you for your help.
APPENDIX E

PARENT QUESTIONNAIRE (CONTROL GROUP)
Dear Parent or Guardian,

We are working to improve science education at Ashton Middle School. We would like to know a little about your views and your involvement in your child's science education. Please take the time to complete this questionnaire. If there is more than one adult living at home, please have the adult who is most involved in your child's education answer this survey.

There are no right or wrong answers to the following questions. You are simply being asked to give your opinion. Your answers will be kept confidential. Teachers at Ashton will be informed of the overall results of this survey, but they will not read your individual answers. Please indicate your true feelings and not what somebody else may feel is the best answer. Circle the number that shows how you feel about each statement. Answer every question. Give only one answer for each question.

When you have completed this questionnaire, please fold it in half and staple or tape it closed. Then have your child return it to school.

Please use these answers for each question:

1. Strongly Disagree (SD)
2. Disagree (D)
3. Undecided (U)
4. Agree (A)
5. Strongly Agree (SA)

Example: I like to travel. (If you agree you would circle number 4.)

1. My child does not usually ask for help with science homework.
2. On the majority of school nights I make sure my child has completed all of his or her homework assignments.
3. I have a good idea of what my child does in science class.
4. I frequently talk to my child about science.
5. Hands-on science activities are a good way to learn science.
6. I frequently help my child with science homework.
Please use these answers for each question:
1. Strongly Disagree (SD)
2. Disagree (D)
3. Undecided (U)
4. Agree (A)
5. Strongly Agree (SA)

7. I would feel comfortable helping my child with a science fair project.
8. I would feel comfortable helping my child with science homework.
9. I feel involved in my child's education

Please write your answers to the following questions in the space provided:

1. Please estimate how many minutes you spend a week helping with or monitoring your child's homework activities (for all classes).

2. Please estimate how many minutes you spend a week helping with or monitoring your child's science homework activities.

3. What is your relationship to the child? (Please place a check in front of the most appropriate answer)
   __mother, __father, __stepmother, __stepfather, __aunt,
   __uncle, __grandfather, __grandmother, __other.

4. How many children (under 18 years old) live in your household? _____
   How many adults (besides yourself) live in your house? _____

5. What is your occupation? ________________________________
   If you are married, what is your spouse's occupation? ________________________________

   Thank you for your help.

Please fold these sheets in half and staple or tape closed.

Please have your child return this questionnaire to science class.
APPENDIX F

PARENT QUESTIONNAIRE (TREATMENT GROUP)
Dear Parent or Guardian,

We are working to improve science education at Ashton Middle School. We would like to know a little about your views and your involvement in your child's science education and the SPLASH program. Please take the time to complete this questionnaire. If there is more than one adult living at home, please have the adult who was most involved in SPLASH program answer this survey.

There are no right or wrong answers to the following questions. You are simply being asked to give your opinion. Your answers will be kept confidential. Teachers at Ashton will be informed of the overall results of this survey, but they will not read your individual answers. Please indicate your true feelings and not what somebody else may feel is the best answer. Circle the number that shows how you feel about each statement. Answer every question. Give only one answer for each question.

When you have completed this questionnaire, please fold it in half and staple or tape it closed. Then have your child return it to school.

Please use these answers for each question:

1. Strongly Disagree (SD)
2. Disagree (D)
3. Undecided (U)
4. Agree (A)
5. Strongly Agree (SA)

Example: I like to travel. (If you agree you would circle number 4.)

1. My child does not usually ask for help with science homework.
2. On the majority of school nights I make sure my child has completed all of his or her homework assignments.
3. I have a good idea of what my child does in science class.
4. I frequently talk to my child about science.
5. Hands-on science activities are a good way to learn science.
6. I frequently help my child with science homework.
Please use these answers for each question:

1. Strongly Disagree (SD)
2. Disagree (D)
3. Undecided (U)
4. Agree (A)
5. Strongly Agree (SA)

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<th>Question</th>
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<tr>
<td>7. I would feel comfortable helping my child with a science fair project.</td>
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<td>8. I would feel comfortable helping my child with science homework.</td>
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<td>9. I feel involved in my child’s education</td>
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<td>10. I enjoyed the SPLASH activities.</td>
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<td>11. SPLASH activities helped me learn science.</td>
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<td>12. The SPLASH activities helped me know my child better.</td>
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<td>13. I would recommend SPLASH activities to my friends.</td>
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<td>14. The SPLASH activities required too much time.</td>
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<td>15. The SPLASH program should be done again next year.</td>
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<td>16. My child learned a lot from doing SPLASH.</td>
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<td>17. I feel more involved in my child’s education as a result of my SPLASH participation.</td>
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<td>18. The SPLASH activities required too much money for materials.</td>
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<td>19. The instructions in the SPLASH activities were confusing.</td>
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<td>20. I did not know enough science to work effectively on the SPLASH activities.</td>
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<td>21. I helped increase my child’s understanding of the SPLASH activities by working with him or her.</td>
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<td>22. Most of the SPLASH activities were too difficult for my child.</td>
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<td>23. The materials for SPLASH activities were too hard to get.</td>
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<td>24. All parents should do at least one SPLASH activity.</td>
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Please write your answers to the following questions in the space provided:

1. Please estimate how many minutes you spend a week helping with or monitoring your child's homework activities (for all classes, but do not count time for SPLASH).

__________

2. Please estimate how many minutes you spend a week helping with or monitoring your child's science homework activities (do not count time for SPLASH).

__________

3. What is your relationship to the child? (Please place a check in front of the most appropriate answer)

   ___ mother, ___ father, ___ stepmother, ___ stepfather, ___ aunt,
   ___ uncle, ___ grandfather, ___ grandmother, ___ other.

4. How many children (under 18 years old) live in your household? _____

   How many adults (besides yourself) live in your house? _____

5. What is your occupation? ____________________________

   If you are married, what is your spouse's occupation? ____________________________

6. How many SPLASH activities did you help your child complete? _____

7. What is the average amount of time in minutes to complete one SPLASH activity? _____

8. Did another adult help complete any activities? ___ yes ___ no.

   If yes, how would you describe the relationship of this person to your child?

   ____________________________

   How many activities did they work on? _____

9. What was the biggest obstacle for you to overcome in order to complete the activities?
10. Please tell us what you thought were the **strengths** of the SPLASH activities and the SPLASH program.

11. Please tell us what you thought were the **weaknesses** of the SPLASH activities and the SPLASH program.

12. If you think the SPLASH program should be used again next year, what can you suggest to make it better?

Thank you for your help.

Please fold these sheets in half and staple or tape closed.

Please have your child return this questionnaire to science class.
Parent/Guardian Interviews:

Name of Parent/Guardian: _____________________ Name of Student: _____________________

Hello, ___________; My name is Peter Rillero, I am from the Ohio State University. I would like to tape record this interview so that I can write less right now. Is this okay with you? Do you have any questions before we begin? I am really interested in your honest opinions about the SPLASH program. Before I invest many years of my life into the program, I want to fairly evaluate it. So please tell me what you really feel and think.

What did you think about the SPLASH program?

How many SPLASH activities did you complete?

Did anybody else help ____ with the SPLASH activities?

Please describe what you and your child did on the last SPLASH activity.

What were benefits of the programs?

What did you dislike about the program?

What was the biggest obstacle to completing activities?

Which activity did you like the most? Why?

Which activity did you like the least? Why?

How did you feel about the program at the beginning?

What kinds of things did you learn about your child as a result of SPLASH participation?

What strategy did you use in working with your child on the SPLASH activities?

What suggestions would you make that can be used to improve the program?

Did the program affect your participation in your child’s schooling? (If yes) How?

Thank you very much for your time and honesty in answering these questions.
Student Interviews:

Name of Student ______________________

Hello, ____________; My name is Peter Rillero, I am from Ohio State University. I would like to tape record this interview so that I can write less right now. Is this okay with you? Do you have any questions before we begin? I am really interested in your honest opinions about the SPLASH program. Before I invest many years of my life into the program, I want to fairly evaluate it. So please tell me what you really feel and think.

What did you think about the SPLASH program?

How many SPLASH activities did you complete?

Who helped you work on the SPLASH activities?

Please describe what you and _____ did on the last SPLASH activity.

What were benefits of the programs?

What did you not like about the program?

Which activity did you like the most? Why?

Which activity did you like the least? Why?

How did you feel about the SPLASH program in the beginning?

Would you have rather worked on the SPLASH activities with your parent or by yourself? Why?

What kinds of things did you learn about your parent (or guardian) as a result of SPLASH participation?

What suggestions would you make that can be used to improve the program?

When you started do SPLASH, did your parents become more interested in what you were doing in school?

Thank you very much for your time and honest in answering these questions.
APPENDIX H

SPLASH ACTIVITY 1
Splash Light!
Circuits, Bulbs, and Batteries.

In this lab you will construct an aluminum foil wire and use it to make circuits with a flashlight bulb and battery.

Making a flat aluminum wire. The adult and student should construct one wire each. Get a thin piece of aluminum foil. Stick masking tape on the foil so that it is about 30 cm long. You can use the ruler on the next page.

Aluminum foil

Remove all the foil on both sides of the ruler. Take the tape with the foil on it and fold it in half.

Crease the fold by rubbing it along the edge of a table. Trim the edges of your new wire so it is exactly 25 cm long. You should have two wires 25 cm long, hold the two wires up and see if they are the same length.

The Challenge! Now take your battery and bulb and two wires and see if you can get the bulb to light.

Please don't turn this page until you can get the bulb to light!!!
Good job! Light on Target! Now draw a picture of how you arranged the wires to get the bulb to light.

Challenge two. Now think of a way to get the bulb to light using only one wire. Draw how you were able to accomplish this!

Challenge three. If you made it this far you are showing that you know something about circuits. Let's put you up for the "Light Prediction Challenge." Look at the diagrams below and each of you predict if the light bulb will light or not light. Write your prediction in the correct space. Then connect the wires as indicated by the wires and see if you were right. Please share the work in checking the results.

<table>
<thead>
<tr>
<th>Connections</th>
<th>Student's Prediction</th>
<th>Adult's Prediction</th>
<th>Results Did it light?</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Diagram 1" /></td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td><img src="image2.png" alt="Diagram 2" /></td>
<td>2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Connections | Student's Prediction | Adult's Prediction | Results | Did it light?
---|---|---|---|---

3

4

Conclusions: Think about what it took to light the light bulb using the battery. Write a few sentences describing what was necessary to light the bulb.

HOME-TO-SCHOOL COMMUNICATION
Dear Parent,
Please give us your reaction to your's and your child's work on this activity. Write a yes or no for each statement.

- 1. My child understood the activity and was able to discuss it.
- 2. My child and I enjoyed the activity.
- 3. This assignment helped me know what my child is learning in science.

Any other comments:

Parent’s Signature: ___________________________ Date __________
APPENDIX I

SPLASH ACTIVITY 2
The Superposition Lab

Purpose: How can we tell the relative age of meteor craters?

1. How does a meteor produce a crater?

Look out! The sky is falling!

meteor traveling with a large velocity.

Crater formed from impact

Broken meteor
2. Obtain 3 small "meteors" of different sizes. These can be round rocks, golf balls, marbles, ball bearings, super balls, etc. Find a plastic bowl or metal bowl. Fill the bowl half full with flour or corn starch.

3. The student should drop a "meteor" into the flour. Carefully remove the meteor (tweezers or tongs may help). Observe the crater produced. Drop a different size meteor on to a part of the first crater. Remove this meteor and observe the interaction of the two craters. Drop the third meteor and observe.

4. Smooth the flour and the adult should repeat step 3, but drop the meteors in a different order. While you are doing this think and talk about how you could look at meteor craters and know the order in which they were formed. Repeat step 3 a couple more times (alternating between student and adult) with different orders of meteors.

5. Use what you have learned to solve this problem: Astronomers observe a planet with the craters shown below. They want to know which is the oldest and which is the newest crater.

What is the order in which the craters (A, B, and C) were formed?

Explain how you came up with your answer.

Use your flour and "meteors" to check your answer.
Measurement question: In the diagram on the previous page, what is the diameter (in centimeters) of the largest crater?

A space ship lands in the center of the large crater. What direction will the travelers have to walk if they want to get supplies from the storage hut?

How far will they actually have to travel from the center of the crater to the storage hut if 1 cm on the map is equal to 1 kilometer in actual distance?

---

HOME-TO-SCHOOL COMMUNICATION

Dear Student,
Please write a few sentences telling us what you think of this SPLASH activity and the first SPLASH activity:

---

Dear Parent,
Please give us your reaction to your's and your child's work on this activity. Write a yes or no for each statement.

_____ 1. My child understood the activity and was able to discuss it.
_____ 2. My child and I enjoyed the activity.
_____ 3. This assignment helped me know what my child is learning in science class.

Any other comments:

Parent's Signature: _________________________ Date ___________
APPENDIX J

SPLASH ACTIVITY 3
Introduction: This SPLASH activity explores motion using a whirly bird. In this activity you will construct a whirly bird and conduct an experiment.

1. Make your whirly bird. Follow the cut out and folding instructions on the last page.

2. Drop your whirly bird and describe what happens. (Student should write description here)

3. Have the adult hold the whirly bird and drop it so that it falls at least 7 feet. The student should time how many seconds it takes for the whirly bird to hit the ground after being dropped. To time the fall it is best to use a digital watch with a stop watch function, however a regular watch will also work. The timing is a bit tricky because it happens quickly. **Good teamwork is essential!** If you can safely drop the whirly bird from a higher distance, for example down a stair well, this will make timing the fall easier. Practice the timing a few times to make sure you will get good results.

4. Now that you are expert timers we are ready for the experiment! We will conduct an experiment to answer the following problem.

**Problem:** How will adding more paper clips affect the time it takes for the whirly bird to fall?

Now lets think of a hypothesis. Remember, a hypothesis is an educated guess about the answer to a problem. Please think and then write your hypotheses on the next page.
Student's hypothesis:

Adult's hypothesis:

Conducting the experiment: To be a fair experiment, we want to change only one thing. The thing we change is called the variable. In this experiment the variable is the number of paper clips. Everything else must be the same.

Drop the whirlybird with one paper clip and record the time it took to fall. Write this time in the data table below. Add two more paperclips so you have a total of three. Drop the whirlybird and record the new time for it to fall. Add two more and repeat. Add two more and repeat.

<table>
<thead>
<tr>
<th>Number of paperclips</th>
<th>Time taken to fall (in seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
</tr>
</tbody>
</table>

Now take your data from the table and put it into the graph below.

If you dropped it from very high, you may need to change this time axis!
QUESTIONS:

1. Look at the data table and look at the graph that you made. Think about the problem and your hypotheses.

What is the answer to the problem: How will adding more paper clips affect the time it takes for the whirly bird to fall? (student should write answer here)

2. Were your hypotheses proved or disproved by the experiment.

Student hypothesis (Student write answer 2 here)

Adult hypothesis (Adult write answer 2 here).

3. To be a fair experiment, all the variables had to be kept the same – except for the number of paper clips. What are three variables in this experiment that you made sure you kept constant for the entire experiment?

HOME-TO-SCHOOL COMMUNICATION

Dear Parent,

Please give us your reaction to your's and your child's work on this activity. Write a yes or no for each statement.

1. My child understood the activity and was able to discuss it.
2. My child and I enjoyed the activity.
3. This assignment helped me know what my child is learning in science.

Any other comments:

Parent's Signature: ______________________________ Date ________________
2. Cut along all dotted lines.

2. Fold along solid lines.

3. Place a paper clip on the bottom of the whirly bird after it is assembled.
Introduction: This SPLASH activity deals with sediments that form layers. Moving water carries dirt, gravel, leaves, and sand as it flows. These materials will eventually settle out of the water. This lab will help us to see which materials settle out the fastest and which materials settle out the slowest.

Materials: see step 1 and 2.

Directions:
1. Get two tall see through bottles. This can be a clear pop container such as a 16-ounce pop bottle, a plastic seltzer bottle, a mayonnaise jar, or spaghetti sauce jar.

2. Obtain a couple of handfuls of soil — regular outdoor soil is best, but you can also use bagged top soil. Obtain about 1/2 to 3/4 cup of gravel. This can be small stones found outside, gravel from a fish tank or from construction. You can also use gravel substitutes such as marbles, sand, ball bearings, screws, etc.

3. The student should put about 1/4 cup of soil and 1/4 cup of gravel into one bottle. The adult should do the same for the other bottle.

4. Add water so the bottles are 3/4 full.

Hypothesis time: After you shake up the stuff and allow it to settle, what do you think will end up on the bottom?

Student write hypothesis here ________________________________

Adult write hypothesis here ________________________________
5. Shake the bottle (if it is glass, be careful you do not drop it or shake too hard).

Optional sing along, "Well, shake it up baby ... twist and shout ..."

Sing along with Splish & Splash!

6. Place bottles on a flat surface and let settle for a couple of minutes. Observe and answer the following questions.

<table>
<thead>
<tr>
<th>Student</th>
<th>Adult</th>
</tr>
</thead>
<tbody>
<tr>
<td>Which materials are on the bottom? ______________________</td>
<td>______________________</td>
</tr>
<tr>
<td>Which materials are on the next layer? __________________</td>
<td>__________________</td>
</tr>
<tr>
<td>Which materials never settled down? ____________________</td>
<td>____________________</td>
</tr>
</tbody>
</table>

7. Add 1/4 cup of soil to each bottle and shake again.

New optional sing along -

"Gonna shake, rattle, and roll; gonna shake, rattle and roll ...

8. Allow the materials to settle over night. Do steps 9 and 10 tomorrow. Now you can go to the third page and answer the questions.

<table>
<thead>
<tr>
<th>Student</th>
<th>Adult</th>
</tr>
</thead>
<tbody>
<tr>
<td>9. How many layers of material can you see? ______</td>
<td>______</td>
</tr>
<tr>
<td>10. Did any materials still not settle? ______</td>
<td>______</td>
</tr>
</tbody>
</table>

Don't forget these steps!

If yes, what are they ______ | ______

This is Splish.
Questions for thinking

A) Was your hypothesis from page 1 correct? Explain.

Student's answer:

Adult's answer:

B) How are the materials which settled first different from the other materials? (Discuss this and the following questions together and have students write the answer):

C) Why did some materials take so long to settle?

D) There is a bridge over a river. A truck carrying paper clips collides with a truck carrying quarters. All the paper clips and quarters fall into the river. The river carries them to the ocean where they settle. Jacques Fastener dives and locates where the paper clips are located. You want the quarters (what would you do with them all?). A map shows where Jacques found the paper clips. Put a small circle in the area where you would start looking for the quarters.

![Diagram]

Explain why you drew the circle where you did.
We would like some information from the adult co-SPLASH worker.

How long did it take to gather the materials for this activity?

How long did it take to actually do the activity?

On what day did you first start working on this activity?

What is your relationship to the student?

What can we do to make the SPLASH activities better?

Thanks for the feedback!

~This is Splash.

HOME-TO-SCHOOL COMMUNICATION
Dear Parent,
Please give us your reaction to your and your child's work on this activity. Write a yes or no for each statement.

1. My child understood the activity and was able to discuss it.
2. My child and I enjoyed the activity.
3. This assignment helped me know what my child is learning in science.

Any other comments:

Parent's Signature: ___________________________ Date ____________
APPENDIX L

SPLASH ACTIVITY 5
The Pore Fact Lab

Pore-pus: Soils differ in how much open pore space they contain. In contemplating colonizing other planets and moons, the porosity of the soil is an important consideration in deciding where to build and where to grow plants. In this activity you will investigate characteristics of soil that create pore space.

Procedure:
1. You will need three of the same kind of clear glass or plastic cups, one measuring cup, and three different kinds of "soils." These three soils can be potting soil, soil from outside, sand, gravel, or small rocks. Gravel substitutes such as marbles, bolts, screws, etc. can also be used.

What are the three types of "soil" you will use? 1. ____________________________,
2. ____________________________ 3. ____________________________

2. Mark two lines on each cup using a marker or tape (see the diagram below). Label the cups 1, 2, and 3.
3. Adult, put your soil #1 (as you indicated on page 1) into cup #1. Fill cup so that it goes up to the soil line but not over it. Student, place your soil #2 into cup #2 and soil #3 into cup #3 in the same way. When you get done you should have something like this:

![Diagram of cups with soil and water lines]

4. Look at your cups.
   a. Which has the most amount of pore space? (student write answers here.)
   b. Which has the least amount of pore space?

5. Hypothesis time: Make your guess! (Oh come on, don't be a "pore" sport!)
   **Which cup would require the most water to fill it up to the water line?**

   **Student's Hypothesis and reason**

   ________________________________________________________________

   **Adult's Hypothesis and reason**

   ________________________________________________________________

6. Roll up your sleeves — here comes the tough part. You want to find out how much water it takes to fill each cup up to the water line. You need to figure out how to do this!

   **Hint #1:** Use your measuring cup to measure the volume.

   **Hint #2:** Measure water before it goes in, because what goes in does not always come out. If your measuring cup has milliliters (ml) use this metric scale. Otherwise, use the ounces (oz.).

7. Measure amount of water used to fill each cup to the water line. Results:

   Cup #1 _________  Cup #2 _________  Cup #3 _________
8. Check your hypothesis from step 5 with your answer.
Student: Was your hypothesis right? Explain how you know.

Adult: Was your hypothesis right? Explain how you know.

Congratulate yourselves if you got a “pore-fect” answer!

Questions for deep thought:
1. Why did one cup of "soil" take more water to fill than the others.

2. If it rained hard for forty days and forty nights, would you rather live on rocky soil or sandy soil? (All discuss, student writes)

Why?

3. A fictitious plant, Air rootus needs lots of air for its roots to survive. Your friend from NASA wants to plant it in an enclosed greenhouse on the moon. She asks you if she should plant it in sandy soil or rocky soil. Describe what you would tell your friend and your reasons.

HOME-TO-SCHOOL COMMUNICATION
Dear Adult,
Please give us your reaction to your's and your child's work on this activity. Write a yes or no for each statement.

_____ 1. My child understood the activity and was able to discuss it.
_____ 2. My child and I enjoyed the activity.
_____ 3. This assignment helped me know what my child is learning in science.

Any other comments:

Adult's Signature: ___________________________ Date _________________
APPENDIX M

SPLASH ACTIVITY 6
Dear Parents,
In science class we are on a unit in earth science. This week we are learning about features of the world and land forms. In this activity we will create sandwiches that model layers of the earth. We hope you find this activity educational and enjoyable.

Materials: Six slices of white bread, knife, grape jelly, peanut butter, cinnamon (or powdered chocolate), plate, paper towels.

Directions: (Student and Adult should make their own sandwich. If you wish to eat the sandwich at the end, make sure your hands and everything else is clean).

1. Sprinkle some cinnamon or powdered chocolate onto one piece of bread. This will represent dirty sandstone.
2. Slightly toast one piece of bread. This will be brown shale.
3. The other piece of bread will be white sandstone.
4. Let one material represent purple-blue limestone. Write that material here ________________________
5. Let one material represent the sticky conglomerate. Write that material here ________________________
6. Put the dirty sandstone down on the plate and spread some purple-blue limestone on top. Place the brown shale on top of this. Next add some sticky conglomerate and then put the white sandstone on top of this. Your sandwich should look like the one below. Student should write the rock names in the spaces below.
Questions for student to answer:

1) Which layer is the oldest? (use rock names)

2) Which layer is the newest?

3) What is the relative age of the brown shale layer? (Relative means compared to the other layers.)

4) The Law of Superposition helps us determine the relative age of the layers. Based upon this activity, write what you think this law states.

Procedure (continued) Student and adult should now work together.

7. One person should gently fold one sandwich so it resembles the diagram below.

   In geology, this resembles a syncline. Push side of bread in so top edges curl up. edges curve up

8. If the high parts of the syncline (the ridges on the edges) were worn off (due to erosion) to the next layer, would the rock in the center be older or younger than the rock on either side? (Student write answer here)

9. Tear off or eat off the uplifted edges of the top layer (bread). Draw what your sandwich looks like from the top. Use your diagram to help explain your answer in step 8.
10. One person should gently fold the other sandwich so it resembles this diagram. 

In geology, this resembles an anticline. Push edges in so the top middle bulges up.

11. If the high part of the anticline (the center ridge) was worn off would the rock in the center be older or younger than the rock on either side?

12. Tear off or eat off the center ridge down to the next layer. Draw what the sandwich looks like from the top. Use your diagram to help explain your answer to step 11.

Question: What is the difference between a syncline and an anticline?

Did you know? The Appalachian mountains were formed by compression due to the Earth's forces. This created great anticlines and synclines.

HOME-TO-SCHOOL COMMUNICATION
Dear Parent,
Please give us your reaction to your's and your child's work on this activity. Write a yes or no for each statement.

_____ 1. My child understood the activity and was able to discuss it.
_____ 2. My child and I enjoyed the activity.
_____ 3. This assignment helped me know what my child is learning in science.
Any other comments:

Parent's Signature: _______________________________ Date ___________
APPENDIX N

SPLASH ACTIVITY 6
Dear Parents,
In science class we have been studying space and now we are starting rocketry. In this activity we will create paper airplanes and investigate characteristics of their flight.

Materials: scissors, paper clip, tape measure (optional).

Introduction: Splish and Splash are designing a glider ship that will glide over planets that have atmospheres. They want their ship to travel relatively straight so that it can explore more of the planets surface. Your mission is to construct the spacecraft and then try to improve it.

Directions:
1. Construct the paper airplane that is enclosed.
2. Caution: Never throw the airplane at somebody else because it could hit them in the eye. In the biggest room of the house throw the airplane.
3. One of the most important skills in science is being able to accurately describe something. Throw the airplane again. Student, write a description of the flight of the Leaping Lizard.

Adult, write details of the flight that the student might have left out. (It's hard for one person to get them all)

4. Let's find out the average distance the plane travels. Each time you must throw it the same way (don't throw it too hard, because rooms are small). When the plane lands measure its distance on the ground to where you threw it from. You can use a tape measure if you have one. If not, use the length of your feet to measure how many of your feet away it landed. Repeat this three times and find the average.

\[
\text{Average} = \frac{A + B + C}{3} = \underline{\text{_____________________}}
\]
Now the challenge! We want to make the plane fly a longer distance.

Brainstorm time: Think of possible things you could do to that plane to make it fly a longer distance. Write as many things as you can think of in the space below. Do not worry if your ideas are right, you can test them later.

**Things that might make the space craft fly a longer distance.**

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

Now, evaluate your list. Choose the two that you think will be most likely to improve the flight of the plane. Write the two variables that you will test below.

1. ________________ 2. ____________________

Repeat step 4 with variable 1. Remember to do everything exactly the same (we want this to be a controlled experiment). Record that data below and write the average.

A. ________________  B. ________________  C. ________________

\[ \text{Average} = (A + B + C) \div 3 = \ldots \]

Student write any differences in the airplane flight due to variable 1.

Repeat step 4 with variable 2. Record that data below and write the average.

A. ________________  B. ________________  C. ________________

\[ \text{Average} = (A + B + C) \div 3 = \ldots \]

Adult write any differences in the airplane flight due to variable 2.

Now put all the averages in one table:

<table>
<thead>
<tr>
<th>Type of Plane</th>
<th>Average Distance Traveled</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal Splash Airplane</td>
<td></td>
</tr>
<tr>
<td>Variable 1 Airplane</td>
<td></td>
</tr>
<tr>
<td>Variable 2 Airplane</td>
<td></td>
</tr>
</tbody>
</table>
Use this space to make conclusions about your data. Explain if your investigation answered your problem. Describe the results of your investigation.

Questions:

1) Was there a control group in your investigation? ____ Yes ____ No. If you answered yes, what was the control group?

2) Were there any problems which interested you but that you decided that it would be too difficult or impossible to conduct an investigation to answer?

____ Yes ____ No. If Yes, what was one of these problems and why was it too difficult to answer?

3) There are some things which prevent scientists from trying to answer certain problems. Describe what might make a scientist decide not to investigate a problem that interests him or her.

HOME-TO-SCHOOL COMMUNICATION

Dear Parent,

Please give us your reaction to your's and your child's work on this activity. Write a yes or no for each statement.

____ 1. My child understood the activity and was able to discuss it.

____ 2. My child and I enjoyed the activity.

____ 3. This assignment helped me know what my child is learning in science.

Any other comments:

Parent's Signature: _____________________________ Date ______________
Now we will make a bar graph of our data table. This is an example of a fancy bar graph.

On the axis below, make a bar graph (using simple rectangles) of the average distance traveled for your airplane trials.

### Downtown Office Occupancy Rate

<table>
<thead>
<tr>
<th>%</th>
<th>100%</th>
<th>75</th>
<th>50</th>
<th>25</th>
</tr>
</thead>
</table>

Questions: Which airplane flew the longest average distance?

Why do you think we make bar graphs?

---

**HOME-TO-SCHOOL COMMUNICATION**

Dear Parent,

Please give us your reaction to your's and your child's work on this activity. Write a **yes** or **no** for each statement.

- 1. My child understood the activity and was able to discuss it.
- 2. My child and I enjoyed the activity.
- 3. This assignment helped me know what my child is learning in science.

Any other comments:

Parent's Signature: ____________________________ Date _______________
1. Cut along the outside of the plane (solid line).
2. Make indicated folds in the order indicated (1 to 4).
3. For thick dotted lines — crease fold completely.
4. Put small paper clip on the nose of the plane.
5. Do not throw near a person’s face.
APPENDIX O

SPLASH ACTIVITY 7
Dear Parents,

This week we are starting a unit on genetics. We will be learning about heredity, chromosomes and genes, and meiosis and the production of sperm and eggs. Humans have 23 pairs of chromosomes in our body cells. Since there are 23 pairs of chromosomes, this means we have a total of 46 chromosomes in our cells. In meiosis, the pairs of chromosomes separate to eventually produce sperm and eggs with only 23 chromosomes. In sexual reproduction, when a sperm and egg unite (fertilization) they each bring 23 chromosomes which restores the original number of 46 chromosomes.

One pair of chromosomes is called the sex chromosomes because they determine if an individual will be male or female. If a person gets an X from an egg and an X from the sperm, this person will be a female. If a person gets an X from the egg and a Y from the sperm, this person will be a male.

In this activity we will seek to answer the following question:

Why are there almost equal numbers of males and females in our world?

Materials: tape, one quarter, one dime, and a pen.

Procedure:

1. Put a small piece of tape on both sides of the quarter and the dime. The tape should not go over the edges.

2. The quarter will represent the egg because it is bigger. Write an X on the tape of one side of the quarter and another X on the other side.

3. The dime will represent the sperm. Write an X on one side of the dime and a Y on the other side.

4. Let's produce a family with 10 children. One person should take both coins shake them in his or her hands and drop them on a table. The other person should record if it produces an XX or an XY. Record your data in an organized table below.
5. Count up the number of boys (XY) and girls (XX).

Boys ______
Girls ______
Total ______

6. Calculate the percentage of your "children" that are boys and the percentage that are girls. In case you forgot how to calculate percentages this is how you would do it for boys: Number of boys divided by the total number of children and then multiply this by 100. For example if you had 4 boys your calculation would look like this:

\[(\frac{4}{10}) \times 100 = 40\%\]

Now calculate the percentage of your "children" that are boys and girls. Please show all work below.

Percentage of boys:

Percentage of girls:

7. If we assume that the world population of males is 50% and females is 50%, how do your results compare to these percentages.

8. In step 7, you may have found the percentages of your "children" to be different from the world. You may also have noticed that most real families are not exactly 50% male and 50% female. The odds of getting the true percentage are improved if we use a larger sample size. In this step, instead of making a family of 10, we will make a community of 100. Work as a team, design a data table, one person flip the two coins, and the other person should record if they are XX or XY. Put all your data below.
9. In the spaces below write in the number of males and females in your community and then record the percentages of males and females.

What is the number of males in your community? __________

What is the number of females in your community? __________

What is the percentage of males in your community? _________

What is the percentage of females in your community? ________

Questions:

1. How do your percentages of males and females for your community compare with the percentages of males and females in the world?

2. Why are there approximately the same number of males as females in the world?

3. Why is it good to have a large sample size when doing an experiment?

4. Henry VIII was very mad at his wives for "giving" him no sons. Today, some people conclude that the father has more influence in determining if a child will be a boy or girl than does the mother. Why do they think this?

HOME-TO-SCHOOL COMMUNICATION
Dear Parent,
Please give us your reaction to your's and your child's work on this activity. Write a yes or no for each statement.

_____ 1. My child understood the activity and was able to discuss it.

_____ 2. My child and I enjoyed the activity.

_____ 3. This assignment helped me know what my child is learning in science.

Any other comments:

Parent's Signature: ___________________________ Date _______________
Dear Parents,

This week we are continuing our unit on genetics. We will be learning that organisms have two genes for a trait. One they get from their mother and the other comes from their father. The two genes the offspring gets interact to produce characteristics of the offspring. If one gene is expressed over another gene, this gene is said to be dominant. In this activity we will recreate a part of Gregory Mendel's famous experiments with pea plants as we try to answer the following questions:

(1) If a pure tall pea plant mates with a pure short pea plant, what will the offspring look like?

(2) If these offspring plants mate, what will their "children" look like?

Materials: tape, one quarter, one dime, and a pen.

Procedure:
1. Put a small piece of tape on both sides of the quarter and the dime. The tape should not go over the edges.

2. The quarter will represent the egg because it is bigger. Write a capital "T" on the tape of one side of the quarter and another "T" on the other side. These capital "T"s represent the two genes of the pure tall pea plant. It will only give one of these to its offspring.

3. The dime will represent the sperm. Write a lower case "t" on one side of the dime and another "t" on the other side. These lower case "t"s represent the two genes the pure short pea plant has. It will only give one of these to its offspring.

4. We use a capital "T" to represent one tall gene because this is a dominant gene. A lower case "t" represents the short gene. If a pea plant has a tall gene (T) and a short gene (t) the plant will be tall because the tall gene wins out. The key below should help. 

   This is the key
   If a plant has the genes TT it is pure tall.
   If a plant has the genes Tt it is hybrid tall.
   If a plant has the genes tt it is pure short.
5. Let's produce a family with 10 plant "children". One person should take both
coins shake them in his or her hands and drop them on a table. The other person
should record if it produces a TT, Tt or a tt. Record your data in an organized table
below.

6. Count up the number of each kind.

<table>
<thead>
<tr>
<th>Pure tall</th>
<th>TT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hybrid tall</td>
<td>Tt</td>
</tr>
<tr>
<td>Pure short</td>
<td>tt</td>
</tr>
</tbody>
</table>

What is your answer to problem number (1) If a pure tall pea plant mates with a
pure short pea plant, what will the offspring look like?

7. If you did the above steps correctly, all of the plants produced by a pure tall
plant (TT) crossed with another pure short plant (tt) should have been hybrid tall
(Tt). They would look just like the tall plants but they would have different genes.
Now let's take two hybrid plants (Tt) and cross them together. Write a capital "T" on
one side of each coin and a lower case "t" on the other side. Decide how many offspring
plants you will create. We suggest at least 20 but the more you do the more accurate
your results will be. Toss the coins to create each offspring. Create a data table to
record the genes of the plants produced.

8. Using the key on the bottom of page 1, figure out how many of your pea
plants will be tall and how many will be short.

Number of tall pea plants (pure and hybrid) _______
Number of short pea plants (all will be pure) _______
Total number of pea plants produced _______

9. Convert the numbers in step 8 into percentages.

Percentage of tall pea plants (pure and hybrid) _______
Percentage of short pea plants (all will be pure) _______
Questions:

1. What is your answer to the second problem: If these hybrid offspring plants mate, what will their "children" look like?

2. Why is it when a pure tall pea plant is crossed with a pure short pea plant the offspring are all tall?

3. When a hybrid tall pea plant is crossed with another hybrid tall pea plant, why are there more tall plants than short plants?

4. Assume that people are as genetically simple as plants, and that brown eyes are dominant over blue eyes. If a hybrid brown eyed mother has children with a hybrid brown eyed father, what percentage of the children would we expect to have blue eyes?

HOME-TO-SCHOOL COMMUNICATION
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Any other comments:

Parent's Signature: ____________________________ Date ___________
APPENDIX Q

SPLASH ACTIVITY 9
Dear Parents,

In class this week we are studying about human reproduction. This SPLASH activity focuses on science process skills and does not relate to sexual reproduction (with the exception that it does show that individual members of the same species can be different). The purpose of this experiment is to give students practice in selecting and defining a problem, suggesting a hypothesis, designing an experiment, analyzing data, and reporting the results. Since these are difficult skills to acquire, there is no need to further complicate the situation with an elaborate and confusing experiment. Thus, a fun, simple experiment has been chosen. In this activity you and your child will be asked to select a variable and investigate the effect of that variable on the popping ability of popcorn. Materials needed for this experiment are: unpopped popcorn and a method to pop it.

Introduction: Orville Splashenbocker is upset because not all of the popcorn kernels he sells pops. He wants you to try and figure out a way to make more of the popcorn kernels pop. Orville cautions that whatever you do, remember that people will eat the popcorn so you should not do something which would be harmful to a person.

Your mission in this laboratory is to choose something (a variable) you can do to the unpopped popcorn and design and conduct an experiment to see how this variable affects the popping of that popcorn.

Step 1. Brainstorm a list of treatments that you can do to popcorn that may affect its popping ability. Write all of these here.

Step 2. Choose one of the above variables for your experimental test. Write that variable in the blank below.

Problem: What is the effect of _____________ on popcorn's popping ability?
Step 3. Write out your hypotheses to the above problem.

Student Hypothesis:

Adult Hypothesis:

Step 4. Design an experiment to test your problem statement.

   A. Many experiments are designed in order to compare. The unchanged part of the experiment is called the control.

   There are different kinds of controls. Plants with fertilizer are compared to plants that are not fertilized. Hearing ability with a hearing aid is compared to hearing ability without the aid. These are all controlled experiments that allow a comparison to be made.

   Another example is giving a new medicine to half the animals who have a disease. Then compare how many animals using the new medicine get better compared to those not getting the medicine.

   For your experiment, in order to see the effect of your variable you need a control group. **What will be your control group?**

   B. How many popcorn kernels will you use in your entire experiment? __________

   C. Design a data table to show your results. Put the table in space below.

Step 5. Conducting the experiment.

   A. You will need some way to pop your popcorn. You can use a hot air popper, a microwave oven, or vegetable oil in a large pot with a lid. **Adults: please ensure this is done safely.** If you use a hot air popper make sure your treatment of the popcorn will not harm the machine. Whatever method you use make sure you follow the directions on the popcorn container. **Remember the popcorn will be hot after popping, so allow adequate time for it to cool down.**
B. Work together to conduct your experiment and record your results in your data table.

Questions:
A. What is the answer to your problem statement?

B. Would you suggest that Orville use your variable on the popcorn he sells? Explain.

C. A student wanted to test a new kind of battery in his Walkman. She put in the battery and let the Walkman run until it went dead. Then she recorded how many hours the Walkman played. She decided the battery was pretty good.
   Describe what is wrong with this experiment and suggest a better experiment.

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   2. My child and I enjoyed the activity.
   3. This assignment helped me know what my child is learning in science.

Any other comments:

Parent's Signature: ___________________________ Date ________________
Dear Parents,

In class this week we are learning about the male and female reproductive systems. This SPLASH activity does not cover that material but seeks to further develop science process skills. In this activity you and your child will choose a problem to investigate, design and conduct an investigation, record the results, and interpret the data.

Introduction: Often people have problems that interest them. In this SPLASH activity you will get a chance to investigate your own problem. Thinking of a good problem to investigate is exciting, but also very challenging. There are many possibilities, for example, you may want to know which store products are best or you may want to know how a variable affects something else. Each of you should think of two problems that you might want to investigate. Put your problem into question form. Write the problems below.

Student Problems for possible investigation:
(1)

(2)

Adult Problems for possible investigation:
(1)

(2)

Now decide together which problem you will choose for conducting your investigation. If you cannot agree, think of more problems that you can investigate.
until you arrive at one that you both want to investigate. You may need to rewrite a problem so that you can design an investigation to answer it. Then either circle the number of the problem on the previous page that you will investigate or in the space below write out the problem you will investigate.

Now design your investigation. Careful observation or measurement should be used in your investigation. Some investigations have a control group. Most investigations have a way to record data. Tables simplify the recording of data. Graphs simplify understanding of data. Conclusions should be based on the data collected.

Write the steps you will follow for your investigation.

Use this space (or another page) to record your data.

If your data has numbers in it, use this space (or graph paper) to make a graph.
Use this space to make conclusions about your data. Explain if your investigation answered your problem. Describe the results of your investigation.

Questions:

1) Was there a control group in your investigation?  ____ Yes  ____ No. If you answered yes, what was the control group?

2) Were there any problems which interested you but that you decided that it would be too difficult or impossible to conduct an investigation to answer?  ____ Yes  ____ No. If Yes, what was one of these problems and why was it too difficult to answer?

3) There are some things which prevent scientists from trying to answer certain problems. Describe what might make a scientist decide not to investigate a problem that interests him or her.

HOME-TO-SCHOOL COMMUNICATION

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Any other comments:

Parent's Signature: ___________________________ Date ______________