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ABSTRACT

The middle school years can be important for developing student attitudes about learning, school, and careers. However, it is often difficult to involve parents in working with middle schools to help adolescents form positive attitudes toward school and science. This exploratory study investigates a method of potentially having all of a teacher's middle school students do the same activity with their parents. The non-kit activity consists of a homework sheet with activity procedures that utilize readily available items. The study explores what percentage of parents and students completed the activities, change in the level of participation over time, participant attitudes towards the homework assignments, benefits participants experienced, and whether or not participation in the program helped student science process skills and science attitudes. A quasi-experimental, control-group design using within-teacher random assignment of classes was employed. Study results provide evidence that it is possible to implement a hands-on science, at-home, parental involvement program where the activity materials are not sent home. Parents, in general, thought positively of the program. A majority of students preferred this type of homework over traditional homework. (LZ)

An Evaluation of the Use of Hands-On Science Homework Assignments by Sixth Grade Students and their Parents

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The middle school years are important for developing student attitudes about learning, school, and careers. Success, in coping with the transitions of middle schools and adolescent life, influences student attitudes and academic progress (Reynolds, 1991). During the middle school years, students form attitudes that 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). Varied and positive science experiences should be a part of adolescent life.

Middle schools need to work with parents to help adolescents form positive attitudes toward school and science. However, 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). The transition from elementary to middle school makes being an involved parent more difficult (Berla, 1991). Instead of one main teacher in an elementary school grade, there are four to six teachers in a middle school grade, which makes it more difficult for parents to establish or maintain contact.

Involving parents is also difficult because many parents feel it is not their responsibility. Seeley (1989) calls an aspect of this the "Delegation Model." Parents consciously or unconsciously feel because they pay taxes for education, it is someone else's responsibility. Methods of increasing and sustaining parent involvement need to be explored (Berla, 1991; Caplan, Choy, & Whitmore, 1992; Epstein & Conners, 1992; Heller, Padilla, Hertel, & Olstad, 1988).

Involving Parents through Hands-On Science

A variety of programs have sought greater parental involvement in science by creating opportunities for parents and their children to jointly do hands-on science. Families doing science activities at schools or other institutions is a feature of some programs (for example Barrow, 1995; Beane, 1990; Canizo, 1995; Ostlund, Gennaro, & Dobbert, 1985; Rand & Gibb, 1989). Other programs have been designed to have parents work on science activities in a more convenient place—their own homes.

One variety of at-home science program provides kits for students to take home and conduct activities with their parents (for example Ashford, 1995; Gennaro & Larenz, 1989; Tripp & Melear, 1995). In typical kit programs, educators create reusable kits that contain needed materials for doing hands-on activities. Enough kits are made for all the students in the class; each kit is different so that students can have a variety of experiences throughout the year. The strength of these programs is they maximize ease of participation for parents and students. Disadvantages are the time and expense required of school personnel in creating the science kits. A less obvious, but arguably greater disadvantage, is each student is taking home different kits. Thus, in-depth preactivity or postactivity class discussion is not possible. While the kits might relate to a variety of different science topics taught throughout the school year, a kit might be brought home that has nothing to do with what is currently being discussed in class. Thus, the kits may not provide a rich curriculum to home connection that is an important dimension of parental involvement programs.

Research Design

This exploratory study investigated a method of potentially having all of a teacher's middle school students do the same activity with their parents. Using the protocol of Rhcton (1989), "the term 'parent' can mean any adult in the home or outside the home responsible for the welfare of the child" (p. 11). A middle school science teacher may teach as many as 150 students; making kits for all these students on a regular basis is not practical. Hence, the program was designed whereby supplies were not given or loaned to the student to complete activities with their parents. The only thing sent home was an homework sheet explaining how to use readily available materials to complete the activities. To enhance participation, the activities were assigned as homework. However, parents were told if they could not do an activity, they should sign the homework sheet; the student would then be given a conventional homework assignment. Parents and students were informed that students should not complete the activities alone. The non-kit, at-home, hands-on science, parent involvement program was called Student-Parent Laboratories Achieving Science at Home (SPLASH) (Rillero, 1995).

What percentage of parents and students would actually do the activities? How would the level of participation change over time? How would the participants feel about these homework assignments? What problems would participants encounter in the program? What benefits would participants experience? Would participation in the program help improve student science process skills and science attitudes? These were some of the questions this exploratory study attempted to answer.

Two teachers in a central Ohio middle school participated in the study (Rillero, 1994). The socio-economic level of the district residents was characterized as middle to lower-middle class. Each teacher had two classes randomly assigned to the treatment group and two classes randomly assigned to the control group.

Students in the treatment group were given hands-on science homework assignments that required the participation of their parents. Ten activities were assigned over a 14 week period. A sample activity is presented in Appendix 1.

The percent completion for each SPLASH activity was recorded. Parents were asked to sign each activity and they were given space to provide comments. On each activity there was a small questionnaire for parents and on one activity there was a questionnaire for students. At the conclusion of the program a questionnaire was administered to help determine student and parent attitudes toward the program. Interviews with seven parents, six students, and two teachers were used to illustrate personal perspectives and experiences of participants, as recommended by Patton (1990).

Students in the treatment group (N=101) were compared to students in the control group (N=99) with a quasi-experimental, control-group design using Slavin's (1992) recommended within-teacher random assignment of classes. Participation in the program was the independent variable. Students in the control group completed their traditional homework assignments. The dependent variables were students' score on the *Attitude Toward Science in School Assessment* Instrument (Germann, 1988), students' science process skill achievement, and measures of parents' involvement in their children's education. A paper-and-pencil exam and a practical exam were used to assess

science process skill achievement; these exams were the *Science Process Assessment* (Smith & Welliver, 1990) and the *Science Process Practical Examination* (Kanis, Doran, & Jacobson, 1990), respectively.

Analysis of Instruments

Five instruments were used in the evaluation of the hands-on, home-science, parental involvement program. Exploratory factor analyses of the Likert-item instruments were performed to help identify subsections and variables within the instruments. Data for the reliability of these instruments or subsections of these instruments are presented in Appendix 2. The means, standard deviations (SD), and sample sizes for each instrument are also reported in Appendix 2. 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.

Results and Discussion

Activity completion rates for the program began high (Figure 1). In the first week the student completion level was 87%. There was a gradual decline in participation from the first activity to the last activity, with a sharp decline for activities four and five. In comments expressed by parents, an important reason for the decline in activities four and five was unusually cold, snowy weather disinclined some participants from going outdoors to obtain soil and rocks needed for these activities. In the final week of the program the student completion level was 45%. An analysis of Figure 1 suggests enthusiasm for the program was waning.

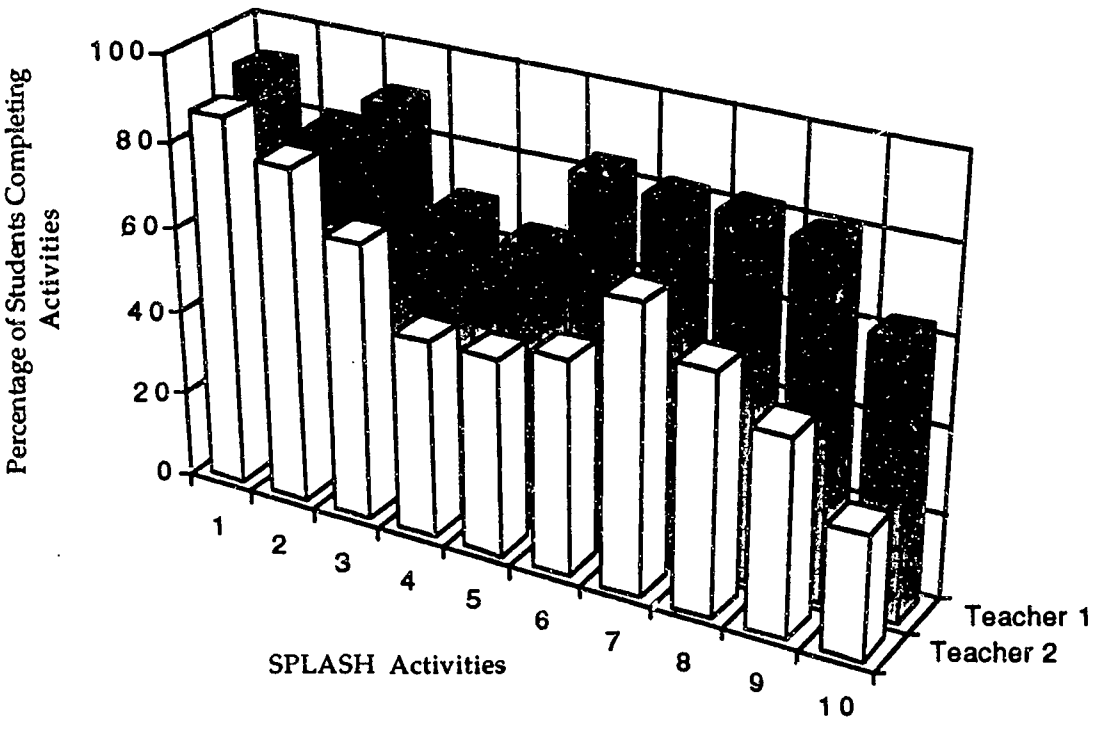

Figure 1. *Activity Completion Percentages for Each Week by Teacher.*

The decline in participation near the end of the program was more pronounced for Teacher One than for Teacher Two. There was a significant difference ($p<.001$) between the students' level of activity completion for the two teachers (Table 1). The teachers proposed the following differences in their behavior as possible reasons for the completion level differences: (a) different grading systems used and (b) Teacher One discussed the activities when they were returned to class but Teacher Two did not.

Table 1
Means, Standard Deviations, and t-Test for Number of Students Completing Activities by Teacher

	n	Mean	SD	*t*	*p*
Teacher 1	49	7.86	2.25		
Teacher 2	52	5.71	3.39		
t-test Statistics				3.73	<.001

How did participants feel about the program? A five-point, Likert-item questionnaire administered to parents (84% were returned) and students (96% were returned) indicated positive attitudes towards the program and activities (Table 2). A majority of parent respondents (63.5%) agreed or strongly agreed that they enjoyed doing the activities and 64.3% agreed or strongly agreed that their children had learned a lot from their involvement with the program. A majority of the parent respondents agreed or strongly agreed to the following statements: "I would recommend SPLASH to my friends" (57.6%); "SPLASH should be done again next year" (61.2%); "I feel more involved in my child's education as a result of SPLASH" (58.8%); "I helped increase my child's understanding of the activity by working together with him/her" (70.6%); and "All parents should do at least one SPLASH activity" (83.6%). More than 65% of all the parent respondents **disagreed** or strongly disagreed that the requirements of time and money, their knowledge of science, availability of materials, and level of difficulty of the activities were problems (Table 2).

Student answers to the questionnaire were also positive but for items that were identical on the student and parent questionnaires, the students' responses were not as positive as their parents' responses (Table 3). While 63.5% of the parents agreed or strongly agreed that they enjoyed the activities, only 47.5% of the student respondents felt this way. A majority of the students agreed or strongly agreed that they had learned science from the activities (61.9%), the activities were a good way to learn science (63.9%), they would rather do SPLASH homework than traditional homework (56.6%), and the program should continue (50.5%).

Did parents help with the activities? Since the activities required signatures and asked parents to write some answers on the homework sheet, it would have been very difficult for students to pretend that parents were helping. Families were instructed that any adult could help with the activities. Data from a variety of sources indicate mothers were more likely to help with the activities than were fathers. In a few cases grandparents, aunts, uncles, and adult friends helped with the activities. Despite worries about not knowing science, only 9.4% of the parents disagreed or strongly disagreed that they had helped their children learn science through their participation in the activities.

Table 2

Likert Items on Parent SPLASH Questionnaire with Percent Responses, Mean, And Standard Deviation Grouped by Factors

Item No.	Items	% of Answers St D	D	U	A	St A	Mean	(SD)
	Parent Benefits of SPLASH							
10	I enjoyed the SPLASH activities.	4.7	7.1	24.7	43.5	20.0	3.67	(1.03)
11	SPLASH helped me learn science.	6.0	16.7	31.0	34.5	11.9	3.30	(1.07)
12	The SPLASH activities helped me know my child better.	7.1	25.9	21.2	37.6	9.2	3.14	(1.11)
13	I would recommend SPLASH to my friends.	2.4	10.6	29.4	40.0	17.6	3.60	(0.98)
15	SPLASH should be done again next year.	3.5	7.1	28.2	38.8	22.4	3.69	(1.01)
16	My child learned a lot from doing SPLASH.	2.9	9.5	23.8	53.6	10.7	3.61	(0.89)
17	I feel more involved in my child's education as a result of the SPLASH.	7.1	16.5	17.6	45.9	12.9	3.41	(1.13)
24	All parents should do at least one SPLASH activity.	3.5	4.7	8.2	51.8	31.8	4.04	(0.96)
	Parent Problems with SPLASH							
14	The SPLASH activities required too much time.	13.1	52.4	20.2	4.8	9.5	2.45	(1.09)
18	Activities required too much money.	33.3	47.6	16.7	2.4	0	1.88	(0.77)
19	Instructions too confusing.	11.9	36.9	23.8	25.0	2.4	2.69	(1.05)
20	I did not know enough science to work effectively.	22.4	47.1	12.9	14.1	3.5	2.30	(1.10)
22	Most activities were too difficult.	18.8	62.4	15.3	3.5	0.0	2.04	(0.70)
23	Materials too hard to get.	21.2	55.3	15.3	8.2	0	2.11	(0.83)
	Item did not load on either factor							
21	I helped increase my child's understanding of the activity by working together with him/her.	1.2	8.2	20.0	64.7	5.9	3.66	0.77

Note. St D=strongly disagree (1); D=disagree (2); U=undecided (3); A=agree (4); St A=strongly agree (5).

Table 3

Likert Items on Student SPLASH Questionnaire with Percent Responses, Mean, and Standard Deviation, Grouped by Factors

Item No.	Item	% of Answers St D	D	U	A	St A	Mean	(SD)
	Student Benefits of SPLASH							
1	I enjoyed the SPLASH activities.	7.2	16.3	28.9	35.1	12.4	3.29	(1.11)
2	SPLASH activities helped me learn science.	4.1	12.4	21.6	52.6	9.3	3.51	(0.97)
4	I would recommend SPLASH activities to my friends.	13.5	16.7	32.3	25.0	12.5	3.06	(1.21)
6	SPLASH should continue.	17.5	9.3	22.7	29.9	20.6	3.27	(1.37)
9	Hands-on science activities, like those in SPLASH are a good way to learn science.	4.1	5.2	26.8	34.0	29.9	3.80	(1.06)
11	I like science more because of SPLASH.	19.6	25.8	25.8	20.6	8.2	2.72	(1.23)
	Student Views of SPLASH and Parent							
3	The SPLASH activities helped me know my parent better.	23.7	29.9	24.7	11.3	10.3	2.55	(1.26)
7	My parent learned a lot from doing SPLASH.	12.4	11.3	37.1	26.8	12.4	3.16	(1.17)
8	My parents are more involved in my education as a result of the SPLASH.	19.6	25.8	25.8	18.6	10.3	2.74	(1.26)
	SPLASH Time/ Homework							
5	The SPLASH activities required too much time.	14.4	34.0	17.5	19.6	14.4	2.86	(1.30)
10	I would rather do SPLASH HW than regular HW.	13.4	14.4	16.5	24.7	30.9	3.45	(1.41)

Note. St D=strongly disagree (1); D=disagree (2); U=undecided (3); A=agree (4); St A=strongly agree (5).

There were no statistically significant differences between parents in the control and experimental groups on the amount of time reported helping and monitoring their children's homework for all subjects (Table 4 & 5). There was a significant difference (p=0.04) on the amount of time parents in the control and experimental group reported helping and monitoring homework in science. This difference favored the treatment group (Table 4 & 5). Therefore, it is possible the program did not increase the amount of time parents spent helping and monitoring their children's homework, but parents simply allocated more time to helping with science homework. It is also possible parents spent more time playing an active role in helping with homework, rather than in the passive role of monitoring. These possibilities should be explored in future research.

Table 4

Means and Standard Deviations of Parents Reported Time Spent Monitoring and Helping with Homework by Experimental Group

Time Reported for Monitoring and Helping with Homework	Treatment		Control	
	Mean	(SD)	Mean	(SD)
1. Total Time	122.8	(106.2)	125.0	(142.1)
2. Science Total	49.6	(32.0)	32.3	(64.8)

Table 5

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

Time Reported for Monitoring and Helping with Homework	df	Mean Square	F	*p*
1. Total Time	1	282.95	0.02	.896
2. Science Total	1	11588.67	4.31	.040

For almost all the students in the treatment group, the program did increase their involvement in hands-on science experiences. The program also appears to have been successful in increasing parental involvement in science education. However, there were no significant differences between the experimental and control groups on three factors distinguished in a factor analysis of the Likert items on the *Parent Questionnaire.* Comparing individual items, two responses displayed significant differences between the treatment and control groups. For the item "I frequently help my child with science homework," the mean scores were 3.02 (SD=1.13) and 2.61 (SD=1.01) for the treatment and control groups, respectively (F=6.37; df=1, 145; p=0.013). 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. This provides further evidence that parents in the treatment group spent more time helping their children with science homework than did parents in the control group and this involvement might have resulted in a greater awareness of what these children were studying in science class.

The quasi-experimental, control-group design was also used to compare the treatment and control groups' student performance on science attitude and science process skill instruments. Data on the reliability of the *Attitude Toward Science in School Assessment* Instrument (Germann, 1988), the *Science Process Assessment* (Smith & Welliver, 1990), and the *Science Process Practical Examination* exams (Kanis, Doran, & Jacobson, 1990) are presented in Appendix 2. There were no significant differences between the experimental and control groups on these instruments.

Interviews with parents and students revealed benefits and problems with the program. In the seven parent interviews, a few parents reported discoveries about their children.

> 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. (Low Participation, Teacher 1, 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. (High Participation, Teacher 2, Mother)

A couple of parents indicated a change in their homework helping behavior.

> 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. (Low Participation, Teacher 1, 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. (High Participation, Teacher 2, Father)

A high-participation student described his observation of a change in his parent's behavior; "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."

A difference was found in the interviews of high-level participants and low-level participant parents regarding their views of parental involvement in education. High-level participants seemed to view involvement as a responsibility. Low-level participants seemed to have the "Delegation Model" view. One low-participation parent stated: "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."

Students who were low participants seemed apathetic about the program. The student's lack of enthusiasm coupled with a parent's delegatory view, may create a formidable barrier to parental participation in the program. As one low-participation mother expressed: "If he said he doesn't want to do them then why should I bother? Fine. Send it back and get the homework." To overcome this problem, methods to motivate the students to want to participate need to be explored.

This study provides evidence it is possible to implement a hands-on science, at-home, parental involvement program where the materials are not sent home. Parents, in general, thought positively of the program. A majority of students preferred this type of homework over traditional homework, despite the fact that it made the students more accountable for doing their homework, because they would be doing it with their parents.

In implementing similar programs, it is advisable to maximize participation by exciting students. Class discussion, when assigning and collecting activities, may add excitement and promote learning. The activities should be designed to be interesting and relevant to the student, parent, and

curriculum. Programs may be strengthened if the activities used are field tested first. Only three of the ten activities used in this study were previously field tested. When activities are fine tuned, program evaluators should consider investigating the effectiveness of the program on science attitudes and science achievement.

Conclusions

The results of this study can be used to guide the development of programs seeking greater parental involvement and an improvement in science education. The study indicates it is possible to give sixth grade students more out-of-school science experiences and to involve their parents in these experiences without sending the materials home for the activities. The program appears to be acceptable to the majority of student and parent participants. However, more must be done to generate excitement, discussion, and learning.

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Appendix 1

Sample Activity

Middle School

Sixth Grade Science

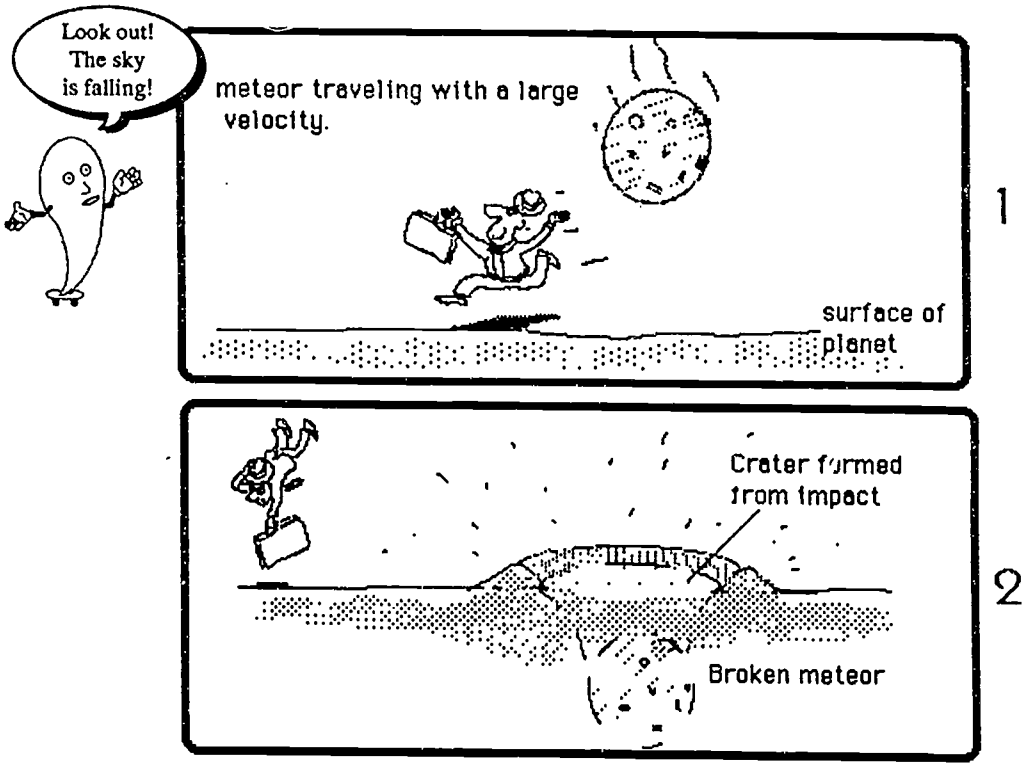
Student's name _____ Date Assigned Feb. 18, 1993

Adult's name _____ Date due Feb. 23, 1993 Tuurs.

The Superposition Lab

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

1. How does a meteor produce a crater?

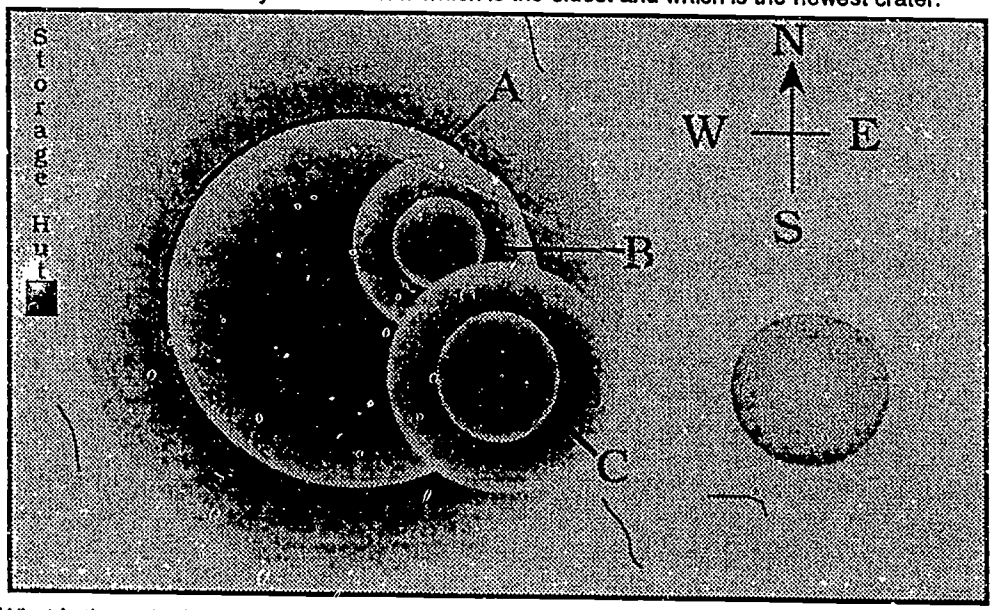


2. Obtain 3 small "meteors" of different sizes. These can be round rocks, golf balls, marbles, ball bearings, super balls, etc. Find a plastic bowl or metal bowl. Fill the bowl half full with flour or corn starch.

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 2

Reliability of Instruments

Descriptive Statistics and Reliabilities for Instruments Used in Study

Instrument/ Section	N=	Means	(SD)	Reliability
Attitude Toward Science in Scnool Assessment				
Pretest	190	4.04	(0.75)	0.95
Posttest	192	4.11	(0.69)	0.94
Science Process Assessment				
Pretest	196	31.44	(6.33)	0.87
Posttest	193	32.35	(6.54)	0.89
Sci. Proc. Prac. Exam A	102	11.32	(2.18)	0.96
Sci. Proc. Prac. Exam B	89	6.83	(2.06)	0.90
Parent Data Likert Items				
Parent Involvement	169	3.76	(0.67)	0.67
Parent Comfort	169	4.15	(0.64)	0.74
Homework	169	3.79	(0.65)	0.69
Parent SPLASH Data				
Benefits	85	3.56	(0.83)	0.92
Problems	85	3.76	(0.68)	0.82
Student SPLASH Attitude				
Benefits	97	3.30	(0.97)	0.91
SPLASH and Parents	97	2.81	(1.02)	0.77
Time and Homework	97	3.30	(1.17)	0.66