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ABSTRACT

Alabama Science in Motion (ASIM) is a statewide in-service and outreach program designed to provide inservice training for teachers in technology and content knowledge. ASIM is also designed to increase student interest in science and future science careers. The goals of ASIM are to complement, enhance, and facilitate implementation of the "Alabama Course of Study-Science" to increase student interest in science and scientific careers and to provide high school science teachers with curriculum development and staff development opportunities that will enhance their subject-content expertise, technology background, and instructional skills. This study was conducted to evaluate the goals and other measurable outcomes of the chemistry component of ASIM. Survey and student record data were collected from 19 chemistry teachers and 182 students that participated in ASIM and 6 chemistry teachers and 42 students that did not participate in ASIM. Pre-treatment Chi-Square tests revealed that the teachers did not differ in years of chemistry teaching experience, major in college, and number of classes other than chemistry taught. Pre-treatment Chi-Square tests revealed that the students did not differ in age, ethnicity, GPA, school classification, or school type. The teacher survey used measured attitudes towards inquiry-based teaching, frequency of technology used by teacher self-reported and perceived teaching ability of chemistry topics from the "Alabama Course of Study-Science." The student surveys used were the Test of Science Related Attitudes (TOSRA) and a modified version of the Test of Integrated Process Skills (TIPS). The students' science scores from the Stanford Achievement Test (SAT-9) were also obtained from student records. Analysis of teacher data using an MANOVA design revealed that participation in ASIM had a significant effect on teacher attitude towards inquiry-based teaching and the frequency of technology used; however, there was no significant effect on the perceived teaching ability of topics from the "Alabama Course of Study-Science." Similar analysis of student data revealed that participation in ASIM had a significant effect on student process skills acquisition and science achievement, but there were no significant effects on science attitudes. (Contains 16 references.) (Author/MM)

"The Evaluation of a Statewide In-Service and Outreach Program—Preliminary Findings"

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Abstract

Alabama Science in Motion (ASIM) is a statewide in-service and outreach program designed to provide in-service training for teachers in technology and content knowledge. ASIM is also designed to increase student interest in science and future science careers. The goals of ASIM include: to complement, enhance and facilitate implementation of the *Alabama Course of Study: Science,* to increase student interest in science and scientific careers, and to provide high school science teachers with curriculum development and staff development opportunities that will enhance their subject-content expertise, technology background, and instructional skills. This study was conducted to evaluate the goals and other measurable outcomes of the chemistry component of ASIM. Data were collected from 19 chemistry teachers and 182 students that participated in ASIM and 6 chemistry teachers and 42 students that do not participate in ASIM with surveys and from student records. Pre-treatment Chi-Square tests revealed that the teachers did not differ in years of chemistry teaching experience, major in college, and number of classes other than chemistry taught. Pre-treatment chi-square tests revealed that the students did not differ in age, ethnicity, GPA, school classification, or school type. The teacher survey used measured attitudes towards inquiry-based teaching, frequency of technology used by teacher self-report and perceived teaching ability of chemistry topics from the *Alabama Course of Study—Science*. The student surveys used were the Test of Science Related Attitudes (TOSRA) and a modified version of the Test of Integrated Process Skills (TIPS). The students' science scores from the Stanford Achievement Test (SAT-9) were also obtained from student records.

Analysis of teacher data using an MANOVA design revealed that participation in ASIM had a significant effect on teacher attitude towards inquiry-based teaching and the frequency of technology used; however, there was no significant effect on the perceived teaching ability of topics from the *Alabama Course of Study—Science*. Similar analysis of student data revealed that participation in ASIM had a significant effect on student process skills acquisition and science achievement, but there were no significant effects on science attitudes.

Introduction

The Alabama Science in Motion (ASIM) Program is a statewide program that was established in 1994, as a practical method of addressing the problems Alabama science teachers must overcome in order to teach secondary science. Science is a discipline that is rooted in experimentation and inquiry. In order to incorporate these elements into the science classroom, students must be actively engaged in laboratory activities. The problem is many science teachers lack the equipment, preparation time, and motivation to run an effective science laboratory program. ASIM is a statewide program that services eleven in-service districts across the state.

Each site is provided two fully equipped vans, one in chemistry and the other in either physics or biology with each van driven by certified master teachers. Each van contains over $100,000 worth of technology and equipment. ASIM provide in-service training to teachers during the summer and also brings the equipment into the classrooms for the students to use.

The goals of ASIM are as follows:

1. To complement, enhance, and facilitate implementation of the *Alabama Course of Study: Science.*

2. To provide students with experiences using state-of-the-art scientific equipment and instrumentation in their school laboratories, to prepare them upon graduation for entry into postsecondary education or the work force, and to increase their interest in science and science careers.

3. To provide high school science teachers with curriculum development and staff development opportunities that will enhance their subject-content expertise, technology background, and instructional skills and to prepare them to present more challenging and stimulating instruction in science for Grades 9-12.

4. To provide equity of opportunity for students across the state, regardless of the public school they attend, to use this technology and to benefit from more challenging and stimulating instruction.

5. To provide opportunities to develop mentoring links between university faculty and classroom teachers and to develop models for effective university/school system partnerships.

(Executive Summary of the Annual Report on the ASIM Program, May 2001)

Purpose

To evaluate every goal of ASIM would be beyond the scope of this study; therefore, the purpose of this study was to determine to what extent ASIM is achieving goals number two and three stated above. Both teacher and student outcomes were studied. The measurable teacher outcomes were attitudes towards inquiry-based teaching, frequency of chemistry technology used and perceived teaching ability of the chemistry topics contained in the *Alabama Course of Study—Science*. The measurable student outcomes were attitudes towards science topics, activities, problem solving strategies, and future science careers. The other student outcomes are science process skill acquisition and science achievement.

Review of Literature

Over the years, science educators have given research attention to attitudes because of assumed relationships between attitude and a variety of variables (Koballa, 1988). Today the affective goals, attitude being in the forefront, are receiving as much attention as the cognitive goals. Petty and Cacioppo (1981) state the first reason for studying attitudes is that attitudes are enduring; that is, relatively stable over time. Fishbein and Ajzen (1975) state that the second reason for studying attitudes is that attitudes are learned. And lastly, Ajzen and Fishbein (1980) state that the third and most important reason for studying attitude is that attitude is related to behavior.

Science process skills have also been a major theoretical force in science education (Padilla, Okey, & Garrard, 1984). Whether the goal is philosophical (e.g. science process skills are used by scientists) or practical (e.g. science process skills are needed to solve everyday problems), science process skills have been strongly emphasized within the elementary, middle, and secondary science curricula. Padilla, Okey, & Dillashaw (1983) found that science process skills are highly correlated with formal thinking ability.

The teacher components of ASIM include increase in inquiry teaching, use of technology and increased chemistry knowledge through inservice training. Inservice training programs have shown to increase teacher attitudes towards inquiry (Lawrenz, 1984), increase use of technology (Dori & Barnea, 1994) and increase content knowledge of subject area (Clermont, Krajcik, and Borko, 1993).

The student components of ASIM include increased laboratory instruction and use of technology through outreach. Laboratory instruction has been shown to have a positive effect on student science attitudes (Freedman, 1997; Harty & Al-Faleh, 1983) and increased science process skill acquisition (Goh, Toh, & Chia, 1989). Technology and outreach have also been shown to have a positive effect on student science attitudes (Heinze, Allen, Jacobsen, 1995) and increased science process skill acquisition (Lazarowitz & Huppert, 1993).

Method

The general design of the evaluation will be quasi-experimental with the data collected and analyzed quantitatively. Teachers and students who participate in ASIM will be compared to teachers and students that do not participate in ASIM.

Seven research questions were examined in this study. The questions, written in the form of null hypotheses, were:

1. The teachers who elect to participate in ASIM do not differ in years of chemistry teaching experience, major in college, or number of classes other than chemistry taught when compared to a control group of non-participating teachers.

2. The teachers who elect to participate in ASIM do not demonstrate more positive attitudes towards inquiry instruction when compared to the control group.

3. The teachers who elect to participate in ASIM do not demonstrate higher use of technology when compared to the control group.

4. The teachers who elect to participate in ASIM do not demonstrate higher perceived teaching ability of the chemistry topics from the *Alabama Course of Study—Science* when compared to the control group.

5. The students participate in ASIM do not show more positive attitudes towards scientific inquiry, enjoyment of science lessons, leisure interest in science, and career interest in science when compared to the control group of non-participating students as measured by the Test of Science Related Attitudes (TOSRA).

6. The students that participate in ASIM do not show greater science process skill acquisition when compared to the control group as measured by the Test of Integrated Process Skills (TIPS).

7. The students that participate in ASIM do not score higher on standardized science tests (SAT-9) when compared to the control group.

Selection Process

The chemistry van drivers from all eleven ASIM sites across the state were contacted during the first semester of the 2000-01 school year, to determine if there were any schools in their district that contain chemistry teachers that participated in ASIM and teachers that did not participate in ASIM in the same school to ensure the equivalency of the participating and non-participating groups.

To increase the sample size, the eleven chemistry van drivers were contacted again and were asked to supply a list of their top participating schools and non-participating schools that were equivalent in size, ethnicity, and socioeconomic status. A list of 56 schools, both participating, non-participating, and both participating and non-participating at the same school was compiled from all the responding chemistry van drivers.

A stratified random sample of thirty teachers that participate in ASIM were selected on the basis of participation in ASIM and an equivalent sample of thirty teachers that did not participate in ASIM were invited to participate in this study. Nineteen ASIM teachers and six non-ASIM teachers agreed to participate. Once the teachers agreed to participate in the study, both groups were administered a teacher survey. The participating teachers selected one class of their chemistry students to be administered the student survey. The student subjects consisted of 182 students who participated in ASIM and 42 students who did not participate in ASIM.

Instrumentation

The teacher survey that was developed for this study contains three sections (See Appendix A). The first section consists of nine items designed to measure the teachers' attitude towards inquiry-based science teaching. The second section consists of fifteen items designed to measure the frequency of chemistry technology used in the classroom from teacher self-report. The last section consists of twenty-five items designed to measure the teachers' perceived teaching ability of the chemistry topics from the *Alabama Course of Study—Science*. The reliabilities for each component of the teacher survey are shown in Table 1.

Table 1
Reliability Analysis of Teacher Survey Scales

Scale	Number of Items	Cronbach's Alpha
Inquiry	9	.68
Use of Technology	15	.74
Perceived Teaching Ability	25	.91

Demographic data were also collected on the participating teachers. Among them were years of teaching experience, major in college, and number of classes taught other than chemistry.

The Student Survey consists of two parts (See Appendix B). The first part is a modified version of the Test of Science Related Attitudes (TOSRA) (Fraser, 1978). Four of the seven TOSRA scales were used in the Student Survey. The scales selected for this study were as follows: Attitude towards Scientific Inquiry, Enjoyment of Science Lessons, Leisure Interest in

Science, and Career Interest in Science for a total of 40 items. The reliability analyses of the four scales are shown in Table 2.

Table 2
Reliability Analysis of Selected TOSRA Scales

Scale	Number of Items	Cronbach's Alpha
Attitude towards Inquiry	10	.87
Enjoyment of Science Lessons	10	.93
Leisure Interest in Science	10	.89
Career Interest in Science	10	.91

The second part is a modified version of the Test of Integrated Process Skills (TIPS). The TIPS was developed by Dillashaw & Okey (1980) to measure the following science process skills: (1) identifying and controlling variables, (2) stating and revising hypotheses, (3) operationally defining critical terms, (4) designing an experiment, and (5) graphing and interpretation of graphs. Only 18 of the original 36 TIPS items were selected for the Student Survey. The modified TIPS has a reliability coefficient of .81.

Demographic data were also collected on the participating students. Among them were years of age, gender, ethnicity, school classification (freshman, sophomore, junior, senior), GPA, and school type (small rural, large rural, suburban, urban).

The students' science achievement was measured by the Stanford Achievement Test (SAT-9). The science scores were obtained from the students' permanent records.

Data Analyses

The initial equivalency of the teacher groups was established using two separate independent-samples t-tests and a chi-square test. The remaining teacher data were analyzed using three separate Multivariate Analysis of Variance (MANOVA) tests. The student data were also analyzed four separate MANOVA tests and two separate independent-samples t-tests.

Results

Table 3 shows the summary of the teacher demographic data. The ASIM teachers did not differ in years of chemistry teaching experience ($t(25) = -1.73$, $p > .05$), major in college ($\chi^2 = .46$, $p > .05$), or classes other than chemistry taught $t(25) = 1.03$, $p > .05$) when compared to the teachers that did not participate in ASIM. The first null hypothesis can be rejected.

Table 3
Summary of Teacher Demographic Data

	ASIM **N=19**	**Non-ASIM** **N=6**
Years of Teaching Experience	Mean =10.95 SD =7.07	Mean = 5.50 SD = 5.39
Major in College	General Science: 7 Chemisty: 7 Biology: 1 Physics: 0 Biology/Chemistry: 4	General Science: 1 Chemisty: 1 Biology: 1 Physics: 1 Biology/Chemistry: 2
Classes other than Chemistry Taught	Mean = 1.10 SD = 1.53	Mean = 1.83 SD = .98

The summaries of the three teacher survey scales are shown in Tables 4 - 6. There were significant differences among the teachers in their attitudes towards inquiry: $F(9,14) = 2.88$, $p < .05$. Analyses of variances (ANOVA) on each Inquiry item were conducted as follow-up tests to the MANOVA. The ANOVA tests revealed that there were significant differences between the teachers on item 6, $F(1,25) = 11.79$, $p < .05$, and item 12, $F(1,25) = 11.27$, $p < .05$. There were also significant differences between the teachers in their reported frequency of technology used: $F(9,14) = 4.50$, $p < .05$. The ANOVA tests revealed that there were significant differences between the teachers on item 17, $F(1,25) = 13.38$, $p < .05$, item 24, $F(1,25) = 12.16$, $p < .05$, item 28, $F(1,25) = 6.16$, $p < .05$, item 29, $F(1,25) = 6.21$, $p < .05$, and item 30, $F(1,25) = 17.80$, $p < .05$. The second and third null hypotheses can be rejected. There was no significant difference among the teachers with regards to perceived teaching ability of selected topics from the *Alabama Course of Study-Science*: $F(1,25) = 28.51$, $p > .05$. The fourth null hypothesis can not be rejected.

Table 4

Means and Standard Deviations for Inquiry Scale (Items 6-14)

Item	ASIM M N=18	SD	Non-ASIM M N=6	SD
6	4.17	.51	3.33	.52
7	3.89	.76	3.50	.84
8	4.00	.84	3.83	.75
9	3.50	1.15	3.83	1.60
10	3.89	.96	4.17	.75
11	3.33	1.03	4.00	1.10
12	2.72	.96	1.33	.52
13	2.11	.90	2.83	1.60
14	2.00	.84	1.50	.55

Table 5

Means and Standard Deviations for Lab Use of Technology Scale (Items 15-30)

Item	ASIM M N=19	SD	Non-ASIM M N=6	SD
15	1.76	.44	2.17	.75
16	1.71	.47	1.33	.52
17	2.00	.50	1.17	.41
18	1.41	.51	1.00	.00
19	1.65	.61	1.17	.41
20	2.82	.88	2.33	.52
21	1.29	.47	1.50	1.22
22	2.06	.75	2.33	1.21
23	1.65	.70	1.17	.41
24	1.82	.39	1.17	.41
25	1.76	.66	1.33	.52
26	1.18	.39	1.00	.00
27	1.24	.44	1.00	.00
28	1.53	.51	1.00	.00
29	1.71	.47	1.17	.41
30	1.76	.44	1.00	.00

Table 6

Means and Standard Deviations for Perceived Teaching Ability Scale(Items 31-56)

Item	ASIM M N=19	SD	Non-ASIM M N=6	SD
31	3.21	.63	3.50	.84
32	3.32	.58	3.50	.55
33	2.58	.84	2.83	.41
34	3.53	.51	3.33	.82
35	3.32	.48	3.33	.52
36	3.37	.68	3.33	.82
37	3.11	.74	2.67	.82
38	3.37	.60	3.17	.98
39	2.58	.77	2.50	.84
40	3.00	.58	2.67	.82
41	3.16	.50	3.17	.75
42	3.05	.71	3.17	.41
43	2.26	.65	2.67	.82
44	2.68	.82	2.67	.82
45	2.11	.57	2.00	.89
46	3.21	.85	3.17	.98
47	3.05	.52	2.83	.75
48	2.53	.61	2.67	.82
49	2.89	.74	2.50	.55
50	3.21	.71	3.00	.63
51	2.74	.65	3.33	.82
52	2.53	.61	2.83	.75
53	2.63	.68	2.67	.82
54	2.68	.67	3.00	.63
55	2.42	.69	2.67	.82
56	2.00	.75	2.33	1.03

Table 7 shows the summary of student demographic data. The students that participated in ASIM do not differ in age, $\underline{t}(224) = 1.27$, $\underline{p} > .05$, ethnicity, $\chi^2 = .07$, $\underline{p} > .05$, overall GPA, $\chi^2 = .128$, $\underline{p} > .05$, school classification, $\chi^2 = .16$, $\underline{p} > .05$, or school type, $\chi^2 = .16$, $\underline{p} > .05$, when compared to the students that do not participate in ASIM. However, the students that participated in ASIM did differ in gender, $\chi^2 = -.215$, $\underline{p} < .05$, when compared to the students that do not participate in ASIM. There was no significant difference between male and females in the non-ASIM group; however, there were more females than males in the ASIM group.

Table 7
Summary of Student Demographic Data

Variable	ASIM (N=182)	Non-ASIM (N=42)
Age	Mean = 16.53 SD = .66	Mean = 16.64 SD = .58
Gender	N (%)	N (%)
Male	56 (30.8)	24 (57.1)
Female	126 (69.2)	18 (42.9)
Ethnicity	N (%)	N (%)
African American	18 (9.9)	4(9.5)
Caucasian	142 (78.0)	33 (78.6)
Asian	10 (5.5)	1 (2.4)
Other	12 (6.6)	4 (9.5)
GPA	N (%)	N (%)
Less than 2.0	4 (2.2)	0 (0)
2.0 – 2.5	17 (9.3)	5 (11.9)
2.5 – 3.0	28 (15.4)	10 (23.8)
3.0 – 3.5	47 (25.8)	12 (28.6)
3.5 – 4.0	86 (47.3)	15 (35.7)
School Classification	N (%)	N (%)
Freshman	0 (0)	1 (2.4)
Sophomore	30 (16.5)	8 (19.0)
Junior	148 (81.3)	33 (78.6)
Senior	4 (2.2)	0 (0)
Other	0 (0)	0 (0)
School Type	N (%)	N (%)
Small rural	53 (29.1)	10 (23.8)
Large rural	37 (20.3)	16 (38.1)
Suburban	77 (42.3)	13 (31.0)
Urban	15 (8.2)	3 (7.0)

Tables 8 - 12 show the summaries of the student data. There were no significant differences between the students that participated in ASIM and students that did not participate in ASIM among the following attitude scales measured by the TOSRA: attitudes towards scientific inquiry, $\underline{F}(10,213) = .89$, $\underline{p} > .05$, enjoyment of science, $\underline{F}(10,213) = 1.27$, $\underline{p} > .05$, leisure interest in science, $\underline{F}(10,213) = 1.22$, $\underline{p} > .05$, or career interest in science $\underline{F}(10,213) = 1.06$, $\underline{p} > .05$. The fifth null hypothesis can not be rejected. There was a significant difference among the students on their TIPS scores ($\underline{F}(1,224) = 12.32$, $\underline{p} < .05$) with the students that participated in ASIM having higher science process skill acquisition. And lastly, there was a significant difference between the students in their science achievement test raw scores, $\underline{t}(210) = -2.23$, $\underline{p} <$

.05, with the students who participated in ASIM having higher science SAT-9 raw scores. The sixth and seventh null hypotheses can be rejected.

Table 8

Means and Standard Deviations for Attitude towards Inquiry Scale

Item	ASIM M N=182	SD	Non-ASIM M N=42	SD
1	3.96	1.08	3.93	1.05
5	4.04	1.06	4.24	.85
9	4.16	1.02	4.02	.84
13	3.65	1.14	3.93	.92
17	3.60	1.08	3.52	.97
21	3.42	1.03	3.36	1.06
25	3.38	1.16	3.38	1.13
29	3.45	1.02	3.33	.93
33	3.47	1.04	3.48	.86
37	3.53	.98	3.40	1.08

Table 9

Means and Standard Deviations for Enjoyment of Science Lessons Scale

Item	ASIM M N=182	SD	Non-ASIM M N=42	SD
2	2.90	1.03	2.67	1.22
6	3.08	1.12	3.02	1.12
10	2.48	.99	2.48	.99
14	2.87	1.31	3.05	1.31
18	2.96	1.30	2.79	1.30
22	3.71	1.17	3.60	1.17
26	2.63	1.08	2.36	1.08
30	3.12	1.19	2.95	1.19
34	2.59	1.06	2.60	1.06
38	3.23	1.21	3.12	1.21

Table 10

Means and Standard Deviations for Leisure Interest in Science Scale

Item	ASIM M N=182	SD	Non-ASIM M N=42	SD
3	2.54	1.17	2.29	1.29
7	2.80	1.25	2.90	1.21
11	2.07	1.12	2.36	1.36
15	2.27	1.09	2.45	1.17
19	2.57	1.18	2.69	1.20
23	2.36	1.15	2.45	1.15
27	2.18	1.10	2.36	1.10
31	1.99	1.02	2.24	1.23
35	2.86	1.16	3.21	1.44
39	2.90	1.11	2.98	1.16

Table 11
Means and Standard Deviations for Career Interest in Science Scale

Item	ASIM M N=182	SD	Non-ASIM M N=42	SD
4	2.71	1.36	2.93	1.35
8	2.63	1.12	3.02	1.00
12	2.62	1.23	2.88	1.31
16	3.03	1.15	3.26	1.17
20	3.07	1.13	3.17	1.17
24	1.87	.91	2.00	.99
28	2.97	1.14	2.98	1.14
32	3.09	1.13	3.07	1.11
36	3.33	1.14	3.26	1.06
40	2.29	1.02	2.26	1.13

Table 12
Means and Standard Deviations for TIPS and SAT-9

Scores	ASIM M N=182	SD	Non-ASIM M N=42	SD
TIPS	11.71	3.83	8.07	4.23
	ASIM M N=171	**SD**	**Non-ASIM M N=41**	**SD**
SAT-9 Raw Score	25.11	5.98	22.71	7.03

Discussion

The results of this study indicate that teachers who participate in ASIM have a more positive attitude towards inquiry teaching. The specific items that these teachers used more were hands-on activities and computers for collecting and/or displaying data. These two areas are heavily emphasized at the ASIM inservice workshops; however, it is difficult to confirm that ASIM is directly attributing to the differences between the teacher groups. Since there is no pre-ASIM data on these teachers, it is impossible to determine if the more positive attitudes result from participation in ASIM. Perhaps these teachers already had higher attitudes towards inquiry teaching and that is why they participate in ASIM.

The ASIM teachers also reported higher frequency of technology used. The instruments that the ASIM teachers used significantly more often were as follows: CBL w/ Temperature and Pressure Probes, Spectrum Emission Tubes, Gas Chromograph, Column Chromatography, and Nuclear Counters. Many of these instruments are not available to teachers who do not participate in ASIM. However, there is evidence that teacher inservice can improve attitudes towards inquiry teaching and increase frequency of technology used.

Teachers who participate in ASIM did not have higher perceived teaching abilities of the chemistry topics from the *Alabama Course of Study-Science* compared to teachers who did not participate in ASIM. A possible explanation is the major emphasis on hands-on and practical training for chemistry teachers in laboratory technology with a lesser emphasis on actual chemistry content teaching during the ASIM inservice. Another explanation is that with increased chemistry knowledge teachers are made more aware of their incompetence.

The results indicate that students who participate in ASIM have higher science process skills when compared to students who do not participate in ASIM. This is in line with other published findings that laboratory instruction and technology can help improve students' science process skills. The results also indicate that students who participated in ASIM have higher science achievement. However, since the effect size is low, generalization from this finding might not be possible. And lastly, this study indicates that students who participate in ASIM do not have higher science attitudes when compared to students who do not participate in ASIM. This is contrary to other published findings. A possible explanation for this finding is that actual student contact with ASIM is very low over the course of the school year. Even with maximum participation, ASIM is only in the schools a small fraction of the total school year. Therefore, other instruction is likely to influence the science attitudes of the students.

The teachers and students who participated in this study comprise only 25 and 224 teachers and students respectively, selected from the 2000/2001 chemistry classes from 10 inservice districts across the state of Alabama. This sample size is small, and the teachers and students who participate in ASIM and in the control group do not represent a random sample of chemistry teachers and students in Alabama, so generalization from the study may not be possible. Future studies need to include larger samples of teachers and students. This study only investigated the chemistry component of ASIM. Future studies are needed of the Biology and Physics programs. This study only studied ASIM during one academic year. Future longitudinal studies should investigate teachers and students as they progress through the program over a number of years. Lastly, the data in this study were collected using only quantitative means. Future research should include both quantitative and qualitative components.

In conclusion, this study is the first to attempt a formal evaluation of ASIM. It indicates that ASIM has positive effects on both teachers and students. With regard to the goals of ASIM, this study indicates that the teacher component is successful in increasing the technology expertise and inquiry based teaching practices, but there needs to more emphasis on chemistry content knowledge. Students are using state-of-the-art scientific equipment and instrumentation in their school laboratories. However, this study indicates students' interest in science or science careers has not increased. More research is needed before any additional conclusions can be drawn.

References

Ajzen, I., & Fishbein, M. (1980). *Understanding attitudes and predicting social behavior.* Englewood Cliffs, NJ: Prentice Hall.

Clermont, C.P., Krajcik, J.S., & Borko, H. (1993). The influence of an intensive in-service workshop on pedagogical content knowledge growth among novice chemical demonstrators. *Journal of Research in Science Teaching, 30*(1), 21-43.

Dillashaw, F.G., & Okey, J.R. (1980). Test of the Integrated Process Skills for secondary science students. *Science Education, 64*(5), 601-08.

Dori, Y.J., & Barnea, N. (1994). In-service chemistry teachers training: The impact of introducing computer technology on teachers' attitudes. Paper presented at the annual meeting of the National Association for Research in Science Teaching, Anaheim, CA, March 26-29. ED 369 646.

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention, behavior: An introduction to theory and research.* Reading, MA: Addison-Wesley.

Fraser, B.J. (1978). Development of a Test of Science-Related Attitudes. *Science Education,62*(4), 509-15.

Freedman, M.P. (1997). Relationship among laboratory instruction, attitude toward science, and achievement in science knowledge. *Journal of Research in Science Teaching, 34*(4), 343-57.

Goh, N.K., Toh, K.A., & Chia, L.S. (1989). Use of modified laboratory instruction for improving science process skills acquisition. *Journal of Chemical Education, 66*(5), 430-32.

Harty, H., & Al-Faleh, N. (1983). Saudi Arabian students' chemistry achievement and science attitudes stemming from lecture-demonstration and small group teaching methods. *Journal of Research in Science Teaching, 20*(9), 861-866.

Heinze, K.F., Allen, J.L., & Jacobsen, E.N. (1995). Encouraging tomorrow's chemists. *Journal of Chemical Education, 72*(2), 167-169.

Koballa, T.R., Jr. (1988). Attitude and related concepts in science education. *Science Education,72*(2), 115-126.

Lawrenz, F.P. (1984). An evaluation of the effect of two different lengths of inservice training on teacher attitudes. *Journal of Research in Science Teaching, 21*(5), 497-506.

Lazarowitz, R., & Huppert, J. (1993). Science process skills of 10th grade biology students in a computer-assisted learning setting. *Journal of Research on Computing in Education, 25*(3), 367-82.

Padilla, M.J., Okey, J.R., & Dillashaw, F.G. (1983). The relationship between science process skill and formal thinking abilities. *Journal of Research in Science Teaching, 20*(3), 239-46.

Padilla, M.J., Okey, J.R., & Garrard, K. (1984). The effects of instruction on integrated science process skill achievement. *Journal of Research in Science Teaching, 21*(3), 277-87.

Petty, R.E., & Cacioppo, J.T. (1981). *Attitudes and persuasion: Classic and contemporary approaches.* Dubuque, IA: William C. Brown.

TEACHER SURVEY

Demographics

Please answer the following.

1. How many years have you taught Chemistry?	
2. In college, what was your science concentration area?	**Biology** **Chemistry** **Physical Science** **General Science** **Physics** **Other:**
3. Do you teach only Chemistry? If NO, how many other classes do you teach in one day?	**YES or NO** **Number of Other Classes:**
4. In the last year, how many chemistry teaching workshops have you attended?	
5. Do you participate in Alabama Science in Motion? If YES, how many days has the Chemistry Van visited your classroom?	**YES or NO** **Days:**

Science in Your Classroom

About how often do students in your science classes participate in the following?

	Activity	**Never**	**Once Per Quarter/ Semester**	**Once Per Month**	**Once Per Week**	**Once Per Day**	**More Than Once Per Day**
6.	Hands on activities.	1	2	3	4	5	6
7.	Observe teacher demonstrations.	1	2	3	4	5	6
8.	Complete worksheets.	1	2	3	4	5	6
9.	Inquiry-based problem solving activities.	1	2	3	4	5	6
10.	Answer written questions during class.	1	2	3	4	5	6
11.	Use a textbook to do assignments in class.	1	2	3	4	5	6
12.	Use computers for collecting and/or displaying data.	1	2	3	4	5	6
13.	Read textbooks in class.	1	2	3	4	5	6
14.	Work on science projects over extended time periods at school.	1	2	3	4	5	6

Chemistry Technology

For each of the chemistry instruments listed, please indicate the frequency of use in your classroom.

Instrument	Frequency of Use				
	Never	Once Per Quarter/ Semester	Once Per Month	Once Per Week	Once Per Day
15. pH meters	1	2	3	4	5
16. Spectroscopes	1	2	3	4	5
17. CBL w/ Temperature & Pressure Probes	1	2	3	4	5
18. CBL w/ Conductivity & Ion Selective Electrodes	1	2	3	4	5
19. Melting Point Apparatus	1	2	3	4	5
20. Analytical Balances	1	2	3	4	5
21. Water Quality Analysis Apparatus	1	2	3	4	5
22. Microscale Glassware	1	2	3	4	5
23. Distillation Apparatus	1	2	3	4	5
24. Spectrum Emission Tubes	1	2	3	4	5
25. Visible Spectrophotometer	1	2	3	4	5
26. Scanning UV-Visible Spectrophotometer	1	2	3	4	5
27. IR Spectrophotometer	1	2	3	4	5
28. Gas Chromograph	1	2	3	4	5
29. Column Chromatography	1	2	3	4	5
30. Nuclear Counters	1	2	3	4	5

Chemistry Teaching

For each of the following topics addressed in the Alabama Course of Study—Chemistry Core, please indicate your perception of your ability to teach this topic.

Key:

Needs Improving: You do not feel comfortable teaching this topic.
Area of Weakness: You can teach this topic, but not as well as you could.
Area of Strength: You can teach this topic and you feel that you do a pretty good job.
Mastery: You teach this topic very well and could help other teachers with this topic.

Topic	Needs Improving	Area of Weakness	Area of Strength	Mastery
31. Relate the macroscopic (ie. hardness) and microscopic (ie. close-packing) characteristics of the four states of matter.	1	2	3	4
32. Explain characteristics of atoms and relationships that exist among them.	1	2	3	4
33. Relate the half-life of radioactive elements to age estimation of appropriate materials.	1	2	3	4
34. Predict patterns of change of properties by groups and periods on the Periodic Table.	1	2	3	4
35. Relate changes of properties and energy to physical and chemical changes.	1	2	3	4
36. Differentiate among types of chemical reactions in the laboratory.	1	2	3	4
37. Simulate physical and chemical interactions of atoms, ions, and molecules using balanced equations, physical models, and computer models.	1	2	3	4
38. Analyze different types of stoichiometric relationships.	1	2	3	4
39. Analyze variables and their influence on rates of reaction using the kinetic theory and the collision theory of reaction.	1	2	3	4
40. Apply models to describe relationships among variables involved in physical and chemical changes (ie. verbal statements, mathematical statements, graphs, tables, and spreadsheets).	1	2	3	4
41. Describe the preparation and properties of solutions (ie. components, classifications, solubility and concentration, conductivity, and colligative properties).	1	2	3	4

Topic	Needs Improving	Area of Weakness	Area of Strength	Mastery
42. Differentiate between acids and bases (ie. pH and pOH, weak and strong, and dilute and concentrated).	1	2	3	4
43. Explain the ways in which buffers maintain constancy of pH.	1	2	3	4
44. Apply Le Chatelier's principle to explain a variety of changes in physical and chemical equilibria.	1	2	3	4
45. Explain the ability of biogeochemical cycles to lessen some environmental problems.	1	2	3	4
46. Use models to make predictions about chemical bonds, chemical reactivity, and polarity of molecules.	1	2	3	4
47. Analyze physical and chemical processes involving atoms, molecules, and ions that result in endothermic and exothermic changes.	1	2	3	4
48. Explain the relationship of energy, stability, and disorder (entropy) to chemical spontaneity.	1	2	3	4
49. Explain the origin and use of different types of electromagnetic spectra.	1	2	3	4
50. Distinguish between chemical and nuclear changes.	1	2	3	4
51. Apply chemical knowledge and processes to other science disciplines and to other fields of study.	1	2	3	4
52. Relate the use of modern chemical techniques, materials, and analytical methods to careers and realworld applications.	1	2	3	4
53. Discuss the mutual influences of science, technology, and society.	1	2	3	4
54. Identify trade-offs that individuals and society must consider when making decisions concerning the use or conservation of resources.	1	2	3	4
55. Discuss factors that serve as potential constraints on technological design and use (ie. ethics, ecology, manufacturing process, operation, maintenance, replacement, disposal, and	1	2	3	4
56. Serve the community through a science-related project (ie. recycling in school, monitoring air and water quality, and evaluating waste-management issues).	1	2	3	4

STUDENT SURVEY

Science Attitudes

Directions:

- This test contains a number of statements about science. You will be asked what you yourself think about these statements. There are no right or wrong answers. Your opinion is what is wanted.
- All answers should be given on the separate Answer Sheet. Please do not write on this booklet.
- For each statement, draw a circle around:

  SA if you STRONGLY AGREE with the statement.

  A if you AGREE with the statement.

  NS if you are NOT SURE.

  D if you DISAGREE with the statement.

  SD if you STRONGLY DISAGREE with the statement.

Science Statements

1. I would prefer to find out why something happens by doing an experiment than by being told.
2. Science lessons are fun.
3. I would like to belong to a science club.
4. I would dislike being a scientist after I leave school.
5. Doing experiments is not as good as finding out information from teachers.
6. I dislike science lessons.
7. I get bored when watching science programs on TV at home.
8. When I leave school, I would like to work with people who make discoveries in science.
9. I would prefer to do experiments than to read about them.
10. School should have more science lessons each week.
11. I would like to be given a science book or a piece of scientific equipment as a present.
12. I would dislike a job in a science laboratory after I leave school.
13. I would rather agree with other people than do an experiment to find out for myself.
14. Science lessons bore me.

15. I dislike reading books about science during my free time.

16. Working in a science laboratory would be an interesting way to earn a living.

17. I would prefer to do my own experiments than to find out information from a teacher.

18. Science is one of the most interesting school subjects.

19. I would like to do science experiments at home.

20. A career in science would be dull and boring.

21. I would rather find out about things by asking an expert than by doing an experiment.

22. Science lessons are a waste of time.

23. Talking to friends about science after school would be boring.

24. I would like to teach science when I leave school.

25. I would rather solve a problem by doing an experiment than be told the answer.

26. I really enjoy going to science lessons.

27. I would enjoy having a job in a science laboratory during my school holidays.

28. A job as a scientist would be boring.

29. It is better to ask the teacher the answer than to find it out by doing experiments.

30. The material covered in science lessons is uninteresting.

31. Listening to talk about science on the radio would be boring.

32. A job as a scientist would be interesting.

33. I would prefer to do an experiment on a topic than to read about it in science magazines.

34. I look forward to science lessons.

35. I would enjoy visiting a science museum on the weekend.

36. I would dislike becoming a scientist because it needs too much education.

37. It is better to be told scientific facts that to find them out from experiments.

38. I would enjoy school more if there were no science lessons.

39. I dislike reading newspaper articles about science.

40. I would like to be a scientist when I leave school.

Science Process Skills

Directions:

This part of the test is to see how well you can use the science process skills. Read each question carefully. Choose the one best response to answer each question. Mark the space on the answer sheet with the letter of your answer.

Questions 1-2 refer to the following situation.

The superintendent is concerned about the accidents in schools. He makes the hypothesis that safety advertising will reduce school accidents. He decides to test the hypothesis in four middle schools. Each school will use a different number of safety posters to see if the number of accidents are reduced. Each school nurse will keep a record of students that come to the office because of an accident.

1. How is safety advertising measured in this study?
   A. Number of accidents reported to the nurse.
   B. Number of middle schools involved.
   C. Number of safety posters in each school.
   D. Number of accidents in the school.

2. How are the school accidents measured in this study?
   A. Number of accidents reported to the nurse.
   B. Number of middle schools involved.
   C. Number of safety posters in each school.
   D. Number of accidents in the school.

3. An ecology club studies factors that might affect pollution of Harding Creek. Fertilizers, sewage, and trash from a garbage dump are possible polluting factors. Chemicals in the creek are not a problem because there are no chemical plants in the area.

   Which of the following is a hypothesis that they could test?

   A. The more fertilizer in a stream, the more crops will grow along the stream.
   B. The more chemical plants there are, the more chemical pollution that results.
   C. The more trash sent to the garbage dump, the higher the income of the family.
   D. The more sewage in a stream, the more pollution in the stream.

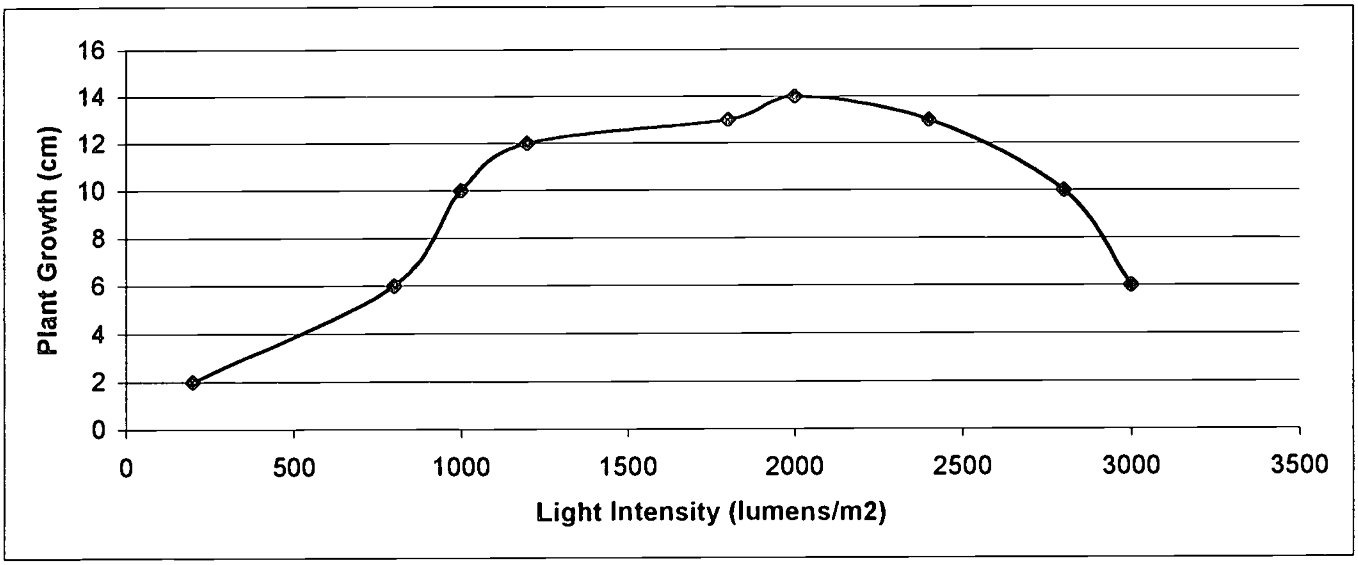
4. Suppose you wanted to test the following hypothesis:

   The hotter the water, the faster sugar will dissolve.

   Which would be the best plan to test the hypothesis?

   A. Set up four beakers of water; #1 at a temperature of 20° C, #2 at a temperature of 40° C, #3 at a temperature of 60° C, #4 at a temperature of 80° C. Use one teaspoon of sugar in each beaker and time the dissolving.
   B. Set up two beakers of water; #1 at a temperature of 20° C, #2 at a temperature of 30° C. Use one teaspoon of sugar in each beaker and time the dissolving. The beakers should be the same kind.
   C. Set up three beakers of water all at the same temperature. Put one teaspoon of sugar in each beaker. Heat beaker #1 over low heat. Heat beaker #2 over high heat. Do not heat beaker #3. Time each one until the sugar has dissolved.
   D. Set up four beakers of water. In beaker #1, put one teaspoon of sugar. In beaker #2, put two teaspoons of sugar. In beaker #3, put three teaspoons of sugar. In beaker #4, put four teaspoons of sugar. Time all four until the sugar has dissolved.

5. The following graph shows the relationship of plant growth to light intensity:



The relationship between light intensity and plant growth can be stated:

A. As light intensity increases, plant growth increases.
B. As plant growth increases, light intensity increases to a point, then decreases.
C. As light intensity increases, plant growth increases to a point, then decreases.
D. As plant growth increases, light intensity increases.

Questions 6-10 refer to the following situation.

Sarah wanted to find out if temperature has an effect on the growth of bread mold. She grew the mold in the nine containers containing the same amount and type of nutrients. Three containers were kept at 0° C, three were kept at 90° C, and three were kept at room temperature (about 27° C). The containers were examined and the growth of the bread mold was recorded at the end of four days.

6. Which of the following is her hypothesis?
   A. The type of nutrient used will cause differences in the amount of bread mold.
   B. The temperature affects the amount of bread mold.
   C. The amount of bread mold is determined by the amount of nutrients used.
   D. The number of containers influences the amount of bread mold.

7. The controlled variable is:
   A. temperature of the containers.
   B. type of container used.
   C. temperature of the bread mold.
   D. amount of bread mold.

8. The dependent or responding variable is:
   A. growth of bread mold.
   B. amount of nutrients in each container.
   C. temperature of the containers.
   D. Number of containers at each temperature.

9. The independent or manipulated variable is:
   A. temperature of the containers.
   B. amount of nutrients in each container.
   C. growth of bread mold.
   D. number of containers at each temperature.

10. Which of the following would NOT be a suitable way to measure growth of bread mold in this experiment?
    A. The number of spots of bread mold.
    B. The size of the bread mold spots.
    C. The diameter of the bread mold spots.
    D. The color of the bread mold spots.

11. John cuts grass for seven different neighbors. Each week he makes the rounds with his lawn mower. The grass is usually different in the lawns. In some lawns it is tall, but not in others. He begins to make hypotheses about the height of grass. Which of the following is a suitable hypothesis he could test?

    A. Lawn mowing is more difficult when the weather is warm.
    B. The amount of fertilizer a lawn receives is important.
    C. Lawns that receive more water have longer grass.
    D. The more hills there are in a lawn, the harder it is to cut.

12. A student has been playing with a water rocket. He can change the amount of water in the rocket and the angle at which he releases the rocket. He can also change the weight of the rocket by adding sand in the nose cone. He wants to see what might affect the height to which the rocket will rise.

    Which of the following is a hypothesis he could test?

    A. Rockets with warm water will rise higher than rockets with cold water.
    B. Rockets with four tail fins will rise higher than rockets with two tail fins.
    C. Rockets with pointed nose cones will rise higher than rockets with rounded nose cones.
    D. Rockets with more water will rise higher than rockets with less water.

Questions 13-16 refer to the following situation.

A forest fire destroys trees in a large area. The forest rangers use the burned area to study the effects of different types of grasses on soil erosion. They choose ten plats of ground that are the same size. Each of these plots receives the same amount of sun. Each of these plots also has the same kind of soil and the same slope. The rangers plant each plot with a different type of grass. Measurements of soil erosion are made every week for the entire summer.

13. What is the independent or manipulated variable in this study?
    A. The size of the plots.
    B. The types of grasses.
    C. The amount of soil erosion.
    D. The type of soil in the plots.

14. What is the dependent or responding variable in this study?
    A. The size of the plots.
    B. The types of grasses.
    C. The amount of soil erosion.
    D. The type of soil in the plots.

15. What hypothesis is being tested in this study?
    A. Some types of grass reduce soil erosion more than others.
    B. The slope of the land affects soil erosion.
    C. Burned over areas have greater erosion than forested areas.
    D. Planting grass will reduce the amount of soil erosion.

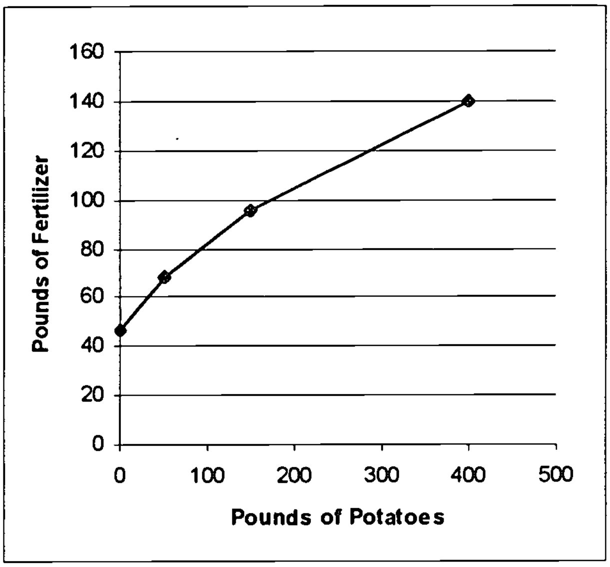
16. Which of the following variables is NOT controlled in this study?
    A. The size of the plots.
    B. The type of soil in the plots.
    C. The amount of soil erosion.
    D. The amount of sun the plots receive.

17. Mr. Jordan is experimenting in his garden. He adds different amounts of fertilizer to his soil to see how it affects his potato production. This year he has four different potato patches. Each patch is the same size, but each receives a different amount of fertilizer. This is the information he collects.

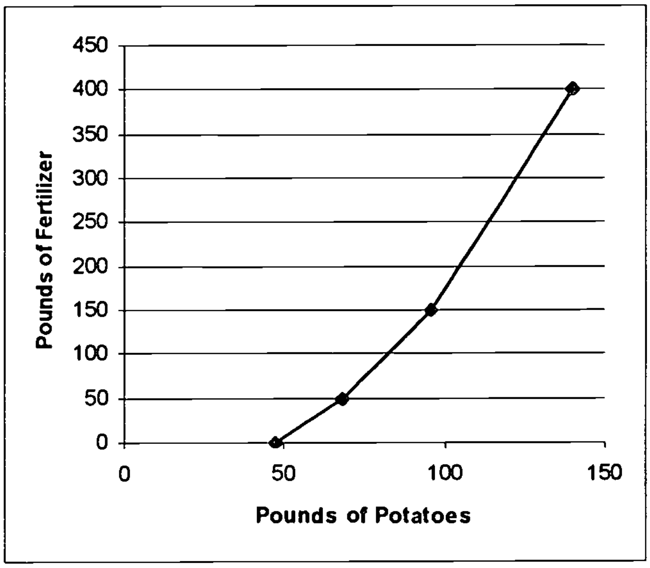
Patch	Pounds of Fertilizer	Pounds of Potatoes Produced
1	0	47
2	50	68
3	150	96
4	400	140

Which of these graphs correctly represents Mr. Jordan's information?

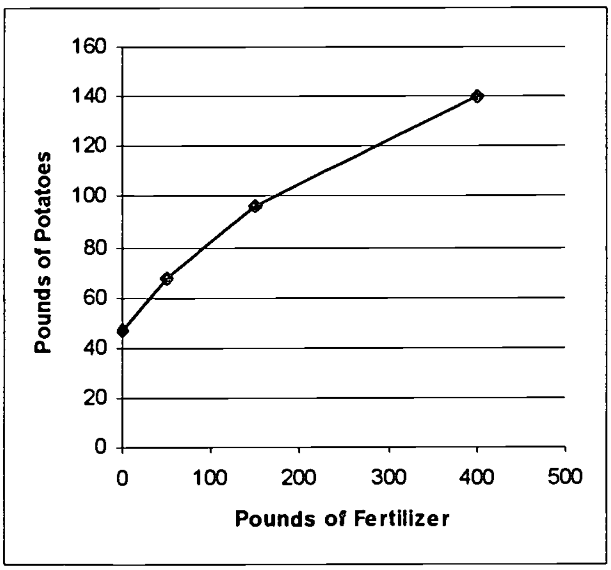
A.



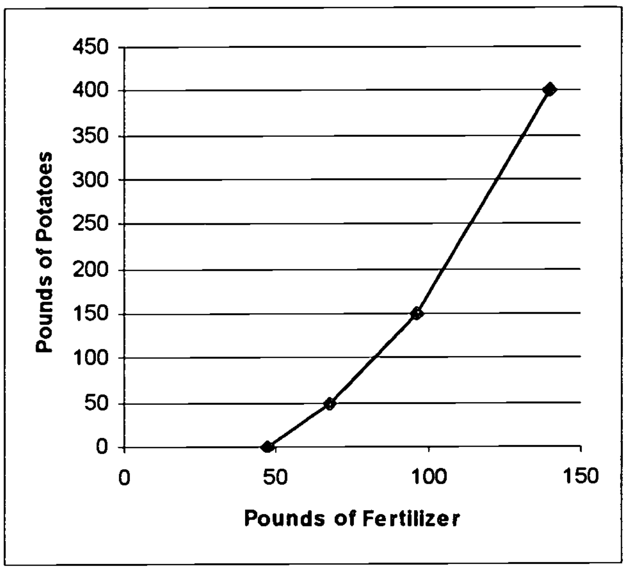
B.



C.



D.

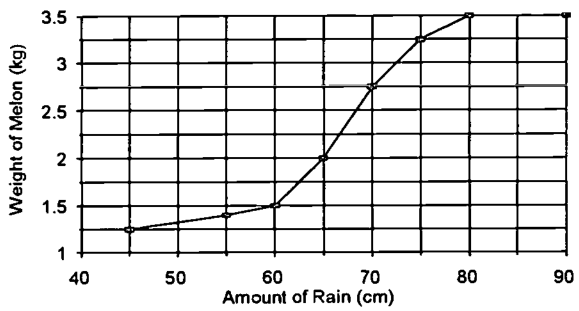


18. An experiment is done to determine the effect of amount of rainfall on the weight of watermelons. The data are summarized in the table below.

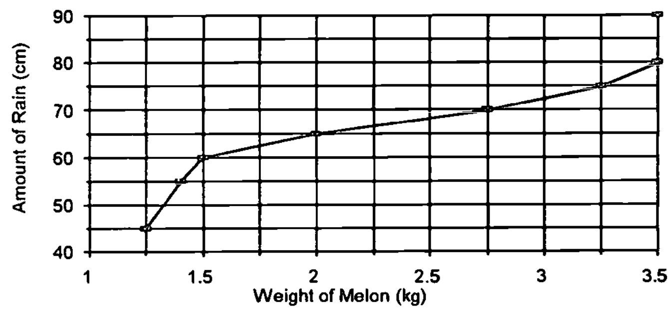
Amount of Rain (cm)	Weight of watermelons (kg)
45	1.25
55	1.40
60	1.50
65	2.00
70	2.75
75	3.25
80	3.50
90	3.50

Which of the following graphs correctly pictures the data?

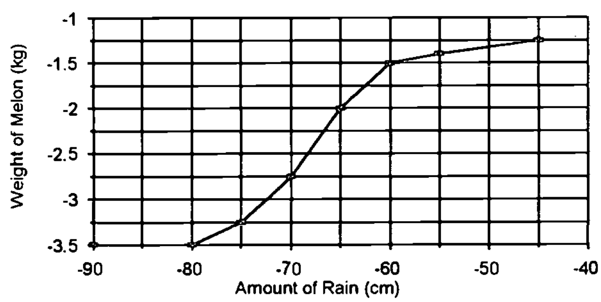
A.



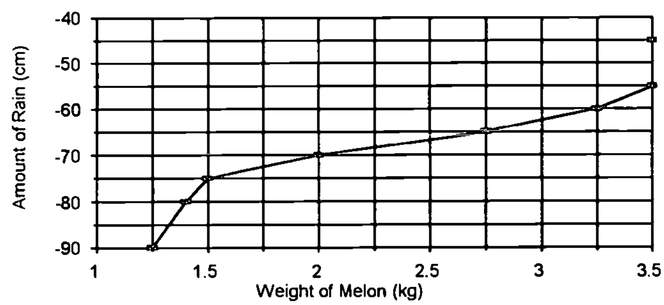
B.



C.



D.



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Demographics

Directions:
The last 9 items request information about yourself and your school environment. Please answer these as accurately as you can, selecting the answer choice closest to your situation.

1. My age is:
   (A) 15 (B) 16 (C) 17 (D) 18 (E) 19

2. My gender is:
   (A) female (B) male

3. My ethnicity is:
   (A) African American (B) Caucasian (C) Asian (D) Other

4. My classification is:
   (A) Freshman (B) Sophomore (C) Junior (D) Senior (E) Other

5. My current grade-point average [A = 4.0, B = 3.0, C = 2.0, D = 1.0] is:
   (A) less than 2.0 (B) 2.0—2.5 (C) 2.5—3.0 (D) 3.0—3.5 (E) 3.5—4.0

6. My school type is:
   (A) small rural (B) large rural (C) suburban (D) urban

7. The number of students in my school is:
   (A) less than 300 (B) 300—500 (C) 500—700 (D) 700—900 (E) More than 900

8. The frequency of science labs in the class I am taking is:
   (A) None (B) Once per quarter/semester (C) Once per month (D) Once per week
   (E) Once per day (F) More than once per day

9. About how many times during the year has your classroom been visited by the Science in Motion Chemistry Van?
   (A) None.
   (B) 1 – 5
   (C) 6 –10
   (D) 11 – 15
   (E) 16 – 20
   (F) More than 20.

Signature: Kimberly H. Lott	Printed Name/Position/Title: Kimberly Lott Doctoral Student	
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