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ABSTRACT

Recent efforts of the National Association for Research in Science Teaching (NARST) and the National Science Teachers Association (NSTA) have encouraged research between university researchers and classroom science teachers. In 1987 a longitudinal teacher research partners study was begun by the Middle and Junior High Division of NSTA and The University of Iowa. The second year of the study was funded by California State University, San Bernardino. This study examines characteristics of key teachers in exemplary middle/junior high science programs and student learning outcomes. The results have shown that in exemplary middle/junior high science programs: (1) teachers are highly professional; (2) students can learn both high levels of science knowledge and positive attitudes toward science; (3) students score higher on some items and lower on some items on the applications and connections questionnaire than those in the national sample; and (4) gender differences in science learning begin to appear. Following an abstract and introduction, the paper outlines the purpose of the study, describes the design, procedures, and results, and provides conclusions and recommendations. Also included are tables showing variables evaluated in the study, teacher classroom instructional practice characteristics, techniques used, ability composition of classes, student perceptions about science classes, and applications and connections responses. (RT)

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A Longitudinal Study of Student Outcomes and Teacher Characteristics in Exemplary Middle and Junior High Science Programs

A "Research Partnerships" Project

The University of Iowa; California State University, San Bernardino
and
The National Science Teachers Association

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ABSTRACT

Collaborative "research partnerships" between university researchers and classroom science teachers have been encouraged by recent efforts of both the National Association for Research in Science Teaching (NARST) and the National Science Teachers Association (NSTA). In 1987 the Middle and Junior High Division of NSTA and The University of Iowa began a longitudinal teacher research partners study to examine student outcomes and teacher characteristics in the NSTA/NSF identified middle/junior high exemplary programs. The second year of the study was funded by a grant from California State University, San Bernardino.

In the first year key teachers in the Search for Excellence in Science Education (SESE) Exemplary Middle/Junior High Programs examined their own seventh and eighth grade student outcomes in three domains of science education: 1) knowledge, 2) attitudes, and 3) applications/connections, using the Iowa Test of Basic Skills and National Assessment of Educational Progress (NAEP) items. Results were compared with national populations. The second year an additional applications instrument was included.

Teachers were surveyed using two questionnaires, one from the Report of the 1977 National Survey of Science, Mathematics and Social Studies Education, and another asking supplemental questions.

The first year results indicate that for exemplary middle/junior high science programs: 1) teachers are highly experienced (average 18.5 years teaching). All feel well qualified, are highly enthusiastic about science teaching, use professional journals as resources, and find other teachers their greatest professional inspiration. All make presentations at professional meetings, ninety one percent at national meetings. They use a rich mixture of teaching strategies allowing students active exploration of their natural world. 2) Students score far above the national norms, 87 percentile rank (year 1) and 81 percentile rank (year 2), on a standardized test of science knowledge. 3) Students have strong positive attitudes toward science in most areas. Science is the first or second favorite course for 48% compared to 29% for student generally. Compared with the national sample, students report significantly higher attitudes toward science classes with regard to comfort, success, curiosity and preparation to make decisions. 4) Students generally do not perform higher in the applications domain than students in general. 5) Boys show slightly higher scores than girls in most areas. In the second year, similar overall results were obtained.

This study has shown that in exemplary middle/junior high programs: 1) students can learn both science knowledge and maintain or develop positive attitudes toward science; 2) students need opportunities to make connections between what they learn in science and personal responsibility; 3) girls need specific assistance to enhance their involvement in science. The longitudinal research partnership study will continue in cooperation with the Middle/Junior High Division of NSTA and California State University, San Bernardino, to study student outcomes from outstanding science programs. An invitation for general voluntary participation from middle school science teachers will be issued in 1989. The study will increase the opportunity for teachers to join with other teacher researchers to monitor and evaluate their own curriculum goals and teaching strategies as professional science educators in partnership with a university researcher.

Introduction

In 1982 the National Science Teachers Association's Search for Excellence in Science Education identified 50 programs judged to exemplify best the stated criteria of excellence in five focus areas: elementary science, physical science, biology, science as inquiry, and science/technology/society. In 1983 the search for Excellence in Science Education (SESE) continued with three focus areas including **middle/junior high science**. Ten middle/junior high science programs were identified as national exemplars. In 1987 thirteen key teachers in ten exemplary middle/junior high programs were invited to participate in a study of student learning outcomes in their programs. Eleven teachers from eight programs administered three evaluation instruments assessing the domains of science education to one of their seventh or eighth grade classes: 1) The Iowa Tests of Basic Skills, Science Supplement, for the knowledge domain; 2) the Preferences and Understandings questionnaire, for the affective domain; and 3) the Science and Society questionnaire for the applications/connections domain. Each teacher was surveyed using two questionnaires: one from the Report of the 1977 National Survey of Science, Mathematics, and Social Studies Education and one asking specific supplementary questions related to the teacher exemplary programs. The second year of the study, eight teachers and their students at eight sites from Alaska to North Carolina participated. Three teachers in the second year group continued from year 1. The remaining five showed a teacher/instructional practice profile similar to the profile of the year 1 group. An additional instrument assessing Science/Technology/Society goals adapted from Faith Hickman's Global Science S/T/S assessment (1987), was also administered to each student.

Purpose of the Study

This study examines characteristics of key teachers in exemplary middle/junior high science programs and the learning outcomes of their students. The descriptive nature of the data is useful in creating a picture of the status of exemplary programs at this level. Four major hypotheses have been evaluated in this study.

1. Teachers associated with exemplary middle/junior high science programs have a different statistical profile in regard to characteristics, professional activity, and instructional practice than those in general.

2. Students enrolled in exemplary middle/junior high science programs perform at levels equal to or above national norms in the knowledge domain.

3. Students enrolled in exemplary middle/junior high science programs score significantly higher in the affective domain than students in national samples.

4. Students enrolled in exemplary middle/junior high science programs score significantly higher in the applications/connections domain than students in the national sample.

Design and Procedures

NSTA identified ten national exemplars in middle/junior high school science in 1983 as part of the NSF/NSTA Search for Excellence in Science Education (SESE) project. Criteria for selection were developed from the goals emerging from the NSF

funded Project Synthesis study. In the present study the characteristics of teachers associated with middle/junior high exemplary programs were evaluated using the Weiss (1978) instrument with supplemental questions by Bonnstetter (1983). Data obtained were used to develop a profile of teacher characteristics and their instructional practice for comparison with national data (Weiss, 1978).

A description of student learning outcomes in exemplary middle/junior high programs was developed from data obtained using three instruments: 1) the Iowa Tests of Basic Skills, (ITBS), Science Supplement, Levels 13 and 14, for the knowledge domain (content) and compared with national norms for grade equivalents, normal curve equivalents and percentile ranks; 2) the Preferences and Understandings instrument (Yager and Bonstetter, 1984) drawn from NAEP items in the affective domain; and 3) the Science and Society instrument (Dagher, 1986) developed from NAEP items in the applications/connections domain. Items on both the Preferences & Understandings and the Science & Society instruments were compared with NAEP items administered to general student populations in 1982, 1983, 1984. The second year the STS Assessment by Faith Hickman based on NSTA goals for scientific literacy (NSTA, 1982) was also administered. Results were compared with the STS Assessment 1983-84 pilot test, pre-test (N = 606) and post-test (N = 154). The instrument was validated with a sample of 414 students yielding a reliability coefficient (standardized item alpha) of 0.74 with no item reducing reliability significantly (Hickman, 1987).

Figure 1 provides a representation of the research design. Exemplary program (Group I), teacher characteristics and instructional practices were described by percent responses on questionnaire items and compared with percent responses for programs in general (Group II). Student outcomes in the knowledge domain (ITBS instrument) were compared by the normal curve equivalent (national norm = 50) and by percentile rank (national norm = 50). Student achievement in the attitude and applications domains were reported by percent responding positively to questionnaire item statements and compared with percent responses from national samples. Tests for significant differences between national samples and middle/junior high exemplary program data were made using the Z proportion statistic. Significance was identified at the 0.01 level of confidence, occasionally at the 0.05 level of confidence. Achievement in the attitude and applications domains was compared by gender for students in the exemplary programs.

Results

This research provides a middle/junior high school longitudinal science status study describing factors of teacher/instructional program and student outcomes in three domains of science education for exemplary programs with programs in general.

Teacher Characteristics

The teachers in exemplary middle/junior high programs are exemplary themselves. They are experienced, well prepared, enthusiastic about working with early adolescents, professionally involved, and use a multitude of resources and instructional strategies they have identified as appropriate for their active and rapidly maturing students (Tables 1, 2, 3). They consider science important for the education and lives of all of their students. They model enthusiasm, curiosity, and continuous learning. Their students perceive them as liking science, knowing a lot of science, yet willing to admit not knowing (Table 4). Their students are encouraged to questions and share ideas. Their

students enjoy the science learning environment the teachers have created for them (Table 5).

Eleven teachers in exemplary programs participated the first year and eight participated the second year. Three of the teachers in the second year group continued from the first year; their classes are identified as 902 and 802, 905 and 806, and 910 and 808 for years 1 and 2, respectively (Tables 6A and 6B). The remaining five showed a teacher/instructional practice profile similar to the profile of the year 1 group.

Student Knowledge

Each teacher administered the ITBS Science Supplement to each student in the class selected to participate in this study. Tables 6A and 6B show the results for each class by mean normal curve equivalent (NCE) for the class and by percentile rank (PR) derived from the mean NCE. Percentile rank represents that percentage of the distribution which falls below the given score. Therefore, using national norms, for test site 901, 94% of all students taking this test scored below the "average pupil" in the 901 class. NCE and PR scores were averaged to obtain the mean for the middle/junior high exemplary program students. For 280 students a mean NCE of 73.9 was obtained, a result considerably higher than the national norm of 50. The exemplar group NCE equates to the 87th percentile rank. Comparison with the national norm of 50 indicates an "extremely high" (H.D. Hoover, 1987) performance for the exemplar students in the knowledge domain. Using the pupil percentile rank from the mean NCE for a class, it is possible to say that for class 902 the average pupil in the class scored at the 91st percentile rank. Therefore for the 280 students in the middle/junior high exemplary science programs, the average pupil scored at the 87th percentile rank. Likewise considering the "average pupil" in this group, 87% of the scores in the national distribution fall below the "average exemplar pupil's" score. For the second year, 223 students in eight programs showed the "average pupil" scored in the 81st percentile rank.

Student Attitudes Toward Science

This study has shown that in the learning environment exemplary middle/junior high teachers have created their students develop strong positive attitudes toward science (Tables 4, 7A, 7B, 8A, 8B) while demonstrating high levels of achievement in scientific knowledge. Knowledge is improved rather than sacrificed when students study science in a supportive and interesting environment. Correspondingly, the acquisition of scientific knowledge does not necessitate suffering and hardship. Fostering success in science courses does not require sacrificing all but the most academically inclined students.

It is evident that the onset of adolescence does not automatically lead to negative attitudes toward science. There are science learning environments where a decline in attitudes is not experienced at the middle/junior high level. The students in the exemplary middle/junior high programs have demonstrated positive reactions toward science classes and their ability to function successfully in science.

Student Applications/Connections Abilities

Students in the exemplary middle and junior high programs demonstrated significant differences in regard to doing science related things (Table 9). Several items are significantly lower, several are significantly higher.

Table 10A shows student willingness to help solve world problems. In all but one case, separating trash, the girls are much more willing to help solve the problems indicated than are the boys. As encouraging as the responses may seen, it is interesting to note that the middle/junior high students are consistently less positive than those students in the national sample (Table 10B). Three of the differences are not statistically significant; however, four are significant. Table 10B shows the surprisingly significant differences between the middle/junior high student sample and the general population sample in regard to personal willingness to address pervasive social problems related to technology. The middle/junior high students are much less willing to save electricity, clean up litter, separate trash, and/or ride in a small car. Table 11 shows the students' perceptions of the connections of science with their world. The exemplary program students generally view the connections negatively.

The mean of the student responses regarding their perceptions of their science classes (Hickman, STS Course Assessment, Table 11) indicates that students in exemplary middle/junior high courses have perceptions of the scientific literacy orientation of their courses similar to students enrolled in courses identified as science /technology/society (S/T/S) oriented. Since a pre-test was not administered to the exemplary program middle/junior high students, no pre-post significance can be found. A cursory comparison of post-test means between groups is all that can be noted. Further consideration of the usefulness of the instrument for evaluating student applications/connections learning outcomes is indicated.

The levels of social consciousness and responsibility demonstrated by our middle/junior high students in this study mirror those in adult society (Tables 10A, 10B). Our national political climate and social values have apparently influenced our youngsters. It is therefore especially important that responsibility be an experienced value in school science.

Conclusions and Recommendations

This study has shown:

1. Teachers in exemplary middle/junior high science programs are highly professional and generally have the support systems requisite for their success.

2. In exemplary middle/junior high science programs, students can learn both high levels of science knowledge and positive attitudes toward science.

3. Students in exemplary middle/junior high science programs score higher on some items and lower on some items on the applications/connections questionnaire than those in the national sample.

4. Gender differences in science learning begin to show up on the middle/junior high even in exemplary programs.

It is apparent that teachers in outstanding middle/junior high programs should begin to look at curriculum adjustments to address weaknesses in the applications/connections domain and in girls' involvement in science. These teachers are leaders and have credibility with their colleagues. If they can show success, implementation will spread. Those who provide support for middle/junior high classroom teachers should facilitate the exploration of strategies to address these areas.

Further research should follow to track the middle/junior high student outcomes in knowledge, attitudes, and applications domains. Student creativity and process skills should also be evaluated. An attempt should be made to monitor the behaviors that result in measured student outcomes. Longitudinal research can provide a strong assessment of student learning in outstanding middle school science programs, and provide a baseline for other science teachers to engage in self evaluation of their own goals and instructional strategies. Collegiate research partnerships should be fostered among teacher researchers and university researchers.

The longitudinal teacher research partnership study will continue in cooperation with the Middle/Junior High Division of NSTA and California State University, San Bernardino, to study student outcomes from outstanding science programs. An invitation for general voluntary participation from middle school science teachers will be issued in 1989. The study will increase the opportunity for teachers to join with other teacher researchers to monitor and evaluate their own curriculum goals and teaching strategies as professional science educators in partnership with a university researcher.

Figure 1. Teacher and Student Research Factors Clusters

GROUP 1: **Exemplary Middle/Junior High Science Programs**

Teachers	Student Outcomes
- Characteristics - Instructional practice	- Levels of science knowledge (knowledge domain) - Attitudes toward science (affective domain) - Understanding of how science affects humankind (application domain)

Group II: **Standard Middle/Junior High Science Programs** (from national norms and assessments)

Teachers	Student Outcomes
- Characteristics - Instructional practice	- Levels of science knowledge (knowledge domain) - Understanding of how science affects human affairs (applications domain) - Attitudes toward science (affective domain)

Teacher Factors — Student Outcome Factors

Figure 1 shows the factors evaluated in the study. Teacher and student factors for each group are described by data collected and analyzed for between group correlations. Comparisons of student outcomes between groups are made. Student outcomes by gender are also described and compared.

TEACHER CHARACTERISTICS

Table 1. Secondary Science Teacher Classroom Instructional Practice

	7-12		
	SESE	NS	Ex M/JH
Have science supervisor	60%	-	73%
"Hands-on" daily	30%	18%	91%
Lecture (percent of the time)	20%	36%	21%
Discussion (percent of class time)	50%	54%	35%
Inservice very useful (percent agreement)	32%	22%	38%
Journals helpful in teaching (percent agreement)	80%	50%	100%
Attended NSF-funded institutes (percent agreement)	71%	40%	55%

SESE: N = 117; NS: N = 1121; Ex M/JH: N = 11

Table 2. Use of Various Techniques in Teaching Secondary Science

	Never			Less than Once a Month			At Least Once a Month			At Least Once a Week			Just About Daily		
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Lecture	4	6	0	4	3	27	7	17	1	46	54	36	36	20	36
Discussion	1	0	0	2	3	0	5	6	18	36	41	36	54	50	45
Student reports/ projects	11	8	0	40	33	36	25	27	45	17	24	17	4	9	0
Library work	20	18	0	53	39	55	18	19	27	5	19	18	1	3	0
Students working at chalkboard	36	4	27	35	26	73	17	21	0	9	9	0	1	1	0
Individual assignments	10	6	3	23	20	27	17	9	1	22	31	55	24	34	18
Students use hands-on manipulative or lab materials	3	1	0	11	2	0	18	9	0	49	59	73	18	30	27
Televised instruction	71	38	36	17	37	1	8	21	36	2	4	27	0	0	0
Programmed instruction	68	59	55	19	26	27	6	9	1	1	5	18	4	1	
Computer-assisted instruction	2	8	0	3	1	18	29	42	55	58	45	27	5	4	0
Tests or quizzes	2	8	0	3	1	18	29	42	55	58	45	27	5	4	0
Contracts	80	73	45	11	14	36	2	9	18	2	2	0	1	3	0
Simulations	73	46	27	19	34	73	5	7	1	0	11		0	1	0
Field trips, excursions	41	30	18	52	55	82	5	7	0	0	8	0	0	1	0
Guest speakers	52	26	0	44	56	82	1	16	18	0	1	0	0	1	0
Teacher demonstrations	2	5	0	15	21	18	38	42	1	36	24	45	6	8	36

Columns: A = NS (N = 1121); B = SESE (N = 117); C = M/JH (N = 11)

Table 3. Ability Composition of Classes by Program (in percent)*

	High Ability	Low Ability	Average or Mixed Abilities
NS* 7-12 (N = 1121)	23	15	60
SESE* 7-12 (N = 117)	27	3	68
Ex M/JH 7-8 (N = 280)	36	0	64

*Total percent may be less than 100 due to missing data.

Table 4. Comparison of General Population Middle/Junior High Students with Exemplary Middle/Junior High Program Students with Regard to Their Perceptions of Their Science Teachers (Percent Responding Positively)

My Science Teacher	NS	Ex M/JH		Z-Value		Significance	
		YrI	YrII	YrI	YrII	YrI	YrII
Asks Frequent Questions	55	88	91	9.58	9.590	*	*
Likes Student Questions	48	74	72	7.23	6.134	*	*
Likes Students to Share Own Ideas	52	84	89	9.104	9.703	*	*
Really Likes Science	76	75	87	-0.322	3.436	*	*
Makes Science Exciting	58	70	76	3.418	4.742	*	*
Knows Much Science	65	86	93	6.431	7.989	*	*
Admits to Not Knowing	30	72	79	11.692	12.587	*	*

NS: (N=600), Ex M/JH: (N=280)
* Significant at the 0.01 level.

T.ble 5. Percentage of Middle/Junior High Students Identifying Their Favorite Courses

	National Sample	Exemplary Program District	M/JH Exemplary Programs	M/JH Exemplary Male	M/JH Exemplary Female
Language Arts	15	5	4	2	7
Social Studies	13	5	8	8	8
Mathematics	30	16	14	12	16
Science	11	22	29	32	25

National Sample: Students included in random samples selected by NAEP (1982) (N = 2500)
Multiple Exemplary Program Distrist: Students from schools with multiple exemplary programs in Jeff rson County, Colorado (N = 630)
M/JH Exemplary Pro_ams across USA: 11 programs (N = 280)
M/JH Exemplary Progr ns: Male (= 146)
M/JH Exemplary Programs: Fema. (N = 134)

Table 6B. Year II (1988)
Middle/Junior High Program Students Performance on the Iowa Tests of Basic Skills, Science Supplement, Levels 13 and 14 (N = 223)

Class	Total		Male		Female	
	N	PR	N	PR	N	PR
801	33	89	19	89	14	86
802	19	93	11	93	8	93
803	26	73	15	70	11	80
804	21	73	9	70	12	80
805	32	81	9	92	23	76
806	42	92	18	94	24	90
807	26	70	9	73	17	65
808	24	76	13	76	11	76
Exemplars	223	81	103	82	120	81
Nat'l Norms		50		50		50

KNOWLEDGE

Table 6A. Year 1 (1987)
Middle/Junior High Program Students Performance on the Iowa Tests of Basic Skills, Science Supplement, Levels 13 and 14 (N = 280)

Class	Total		Male		Female	
	N	PR	N	PR	N	PR
901	19	94	12	94	7	93
902	38	91	19	90	19	92
903	29	94	17	94	12	93
904	26	98	11	99	15	97
905	26	90	10	92	16	88
906	23	87	14	89	9	83
907	15	77	8	80	7	76
908	21	46	9	53	12	39
910	25	74	17	79	8	60
911	27	83	10	87	17	79
912	31	91	19	93	12	90
Exemplars	280	87	146	90	13	85
Nat'l Norms		50		50		50

Table 7A. Middle/Junior High Student Perceptions of Their Feelings about Science Classes (Percent Responding YES).

Science Class Makes Me Feel:	A	B	C	D	Ex M/JH		Male Ex M/JH		Female Ex M/JH	
					YrI	YrII	YrI	YrII	YrI	YrII
Successful	42	36	40	59	52	46	56	57	48	46
Uncomfortable	36	20	22	9	8	7	6	5	10	10
Curious	36	30	24	71	69	75	71	76	66	74
Prepared to Make Decisions	40	32	31	63	47	47	56	51	37	43

A: Information from the 1977 Third Assessment of Science by the National Assessment of Educational Progress (N=600) (NAEP, 1978)

B: Information from the 1982 National Science Supervisors Association Follow-up Study (N=600) (Yager & Yager, 1984; Yager & Penick, 1986)

C: Information from the 1984 Study of Members of the National Science Teachers Association (N=750) (Vargas & Yager, 1986; Yager & Penick, 1986)

D: Information from students enrolled in four of NSTA's Exemplary Science Programs during 1986 (N=900)

YrI: Ex M/JH: (N=280), Male Ex M/JH: (N=146), Female Ex M/JH: (N=134)

YrII: Ex M/JH: (N=217), Male Ex M/JH: (N=101), Female Ex M/JH: (N=116)

Table 8A. Middle/Junior High Student Perceptions of Their Science Classes (Percent Responding YES)

Science Class Is:	A	B	C	D	Ex M/JH		Male Ex M/JH		Female Ex M/JH	
					Yrl	YrII	Yrl	YrII	Yrl	YrII
Interesting	42	52	51	85	83	83	83	88	83	97
Boring	36	27	29	14	15	9	16	8	14	13
Fun	36	41	40	81	77	81	75	85	78	96
Exciting	43	44	43	74	59	65	62	73	57	72

A: (N=600), B: (N=600), C: (N=750), D: (N=900)
Ex M/JH: Middle/Junior High Exemplary Program Students, 1987 (N=280); 1988 (N=217)
Ex (Male): Male Middle/Junior High Exemplary Program Students, 1987 (N=146), 1988 (N=101)
Ex (Female): Female Middle/Junior High Exemplary Program Students, 1987 (N=134); 1988 (N=116)

Table 8B. Comparison of General Population Middle/Junior High Students with Exemplary Middle/Junior High Program Students with Regard to Their Perceptions of Science Classes (percent responding positively)

My Science Classes are:	NS	M/JH	Z-Value Year I	Z-Value Year II	Significance Year I	Significance Year II
Interesting	42	83	11.371	10.456	*	*
Boring	31	15	-5.038	-6.463	*	*
Fun	33	77	11.891	12.257	*	*
Exciting	43	59	4.418	5.601	*	*

NS: Information from Third Assessment of Science by National Assessment of Educational Programs, NAEP, 1978 (N=600)

Ex M/JH: Middle/Junior High Exemplary Program Students, 1987, (N=280)

*Significant at the 0.01 level.

Table 7B. Comparison of General Population Middle/Junior High Students with Exemplary Middle/Junior High Program Students with Regard to Their Perceptions of Their Feelings About Science Classes (Percent Responding Positively)

Science Class Makes Me Feel:	NS	Ex M/JH YrI	Ex M/JH YrII	Z-Value YrI	Z-Value YrII	Significance YrI	Significance YrII
Successful	42	52	46	2.772	1.628	*	
Uncomfortable	36	8	7	-8.692	-8.207	*	*
Curious	36	69	75	9.128	9.950	*	*
Prepared to Make Decisions	40	47	47	1.955	1.806	**	

NS: (N=600), Ex M/JH: (N=280)
* Significant at the 0.01 level.
**Significant at the 0.05 level.

Table 9. Comparison of General Population Middle/Junior High Students with Exemplary Middle/Junior High Program Students with Regard to Doing Science-Related Things (Percentage Responding Positively)

How Often Do You:	NS	Ex M/JH YrI	Ex M/JH YrII	Z-Value YrI	Z-Value YrII	Significance YrI	Significance YrII
Try Your Ideas	40	46	49	1.678	2.041		*
Believe What you Read About Science	64	64	65	0.000	0.263		
Check School Work for Accuracy	50	48	45	-0.552	-1.260		
Read Labels Before Buying	62	38	42	-6.648	-5.086	*	**
Look at All Sides of a Question Before Deciding	78	65	71	-4.082	-2.069	*	**
Believe Events Have Logical Explanations	60	66	68	1.705	2.078		*
Prefer Being Told an Answer	59	35	39	-9.510	-7.751	*	**
Like to Figure Out How Things Work	69	56	59	-3.757	-2.666	*	**
Change Your Mind When Ideas Don't Fit Facts	45	57	56	3.312	2.774	*	**
Keep Working When Unexpected Problems Occur	52	52	54	0.000	0.505		
Feel Time Wasted When Idea Doesn't Work	58	30	28	-7.727	-7.560	*	**
Gather Variety of Information Before Deciding	46	42	43	-1.110	-0.759		

* Significant at the 0.01 level.
**Significant at the 0.05 level.

Table 10A. Middle/Junior High Student Perceptions with Regard to Their Willingness to Solve World Problems Percentage Responding Positiveiy)

I am Willing to, Even if Inconvenient:	NS	Ex M/JH		Male Ex M/JH		Female Ex M/JH	
		YrI	YrII	YrI	YrII	YrI	YrII
Use Less Electricity	87	79	83	76.6	79	82.1	85
Use Bikes or Walk More Often	87	82	86	77.4	86	86.6	85
Clean up Litter	69	50	67	47.3	57	53.0	76
Separate Trash	65	49	58	50.7	55	46.3	61
Ride in Small Economy Car	78	69	70	59.6	65	79.1	74
Use Less Heat to Save Fuel	56	49	57	47.9	52	50.0	61
Use Returnable Bottles	88	85	82	78.8	77	91.0	86

NS (N=2500)
Yr 1 EX M/JH (N=280), Male Ex M/JH (N=146), Female Ex M/JH (N=234)
Yr 2 Ex M/JH (N=217), Male Ex M/JH (N=101). Female Ex M/JH (N=116)

Table 10B. Comparison of General Population Middle/Junior High Students with Exemplary Middle/Junior High Program Students with Regard to Their Willingness to Solve World Problems (Percentage Responding Positively

I am Willing to, Even if Inconvenient	NS	Ex M/JH		Z-Value		Significance	
		YrI	YrII	YrI	YrII	YrI	YrII
Use Less Electricity	87	79	83	-3.046	-1.450	*	
Use Bikes or Walk More Often	87	82	86	-1.954	-0.371		
Clean Up Litter	69	50	67	-5.428	-0.542	*	
Separate Trash	65	49	58	-4.504	-1.828	*	
Ride in Small Economy Car	78	69	73	-2.873	-2.356	*	**
Use Less Heat to Save Fuel	56	49	57	-1.937	0.254		
Use Returnable Bottles	88	85	82	-1.233	-2.206		**

NS: (N=2500), Yr 1 ExM/JH: (N=280), Yr 2 ExM/JH: (N=217)
* Significant at the 0.01 level.
**Significant at the 0.05 level.

Table 11. Comparison of General Population Middle/Junior High Students With Exemplary Middle/Junior High Program Students With Regard to Their Perceptions of the Value of Their Science Classes.

Things I Learn in Science Class:	NS	Ex M/JH YrI	Ex M/JH YrII	Z-Value YrI	Z-Value YrII	Significance YrI	Significance YrII
Useful in Daily Living	78	69	72	-2.873	-1.798	*	
Useful in Future	74	66	75	-2.444	0.000	**	
Useful in Making Choices	52	38	46	-3.868	-1.527	*	

Ns: (N=600), Ex M/JH: (N=280)
* Significant at the 0.01 level.
**Significant at the 0.05 level.

Table 12. Mean of Student Responses: Hickman STS Course Assessment

Ex M/JH, 1988			Hickman, 1985				
Group	N	Post-Test Mean	Group	N	Pre-Test Mean	Post-Test Mean	Pre-Post Significance (T-Value)
1	34	33.6765	A	11	34.00	33.09	-
2	20	35.7000	B	10	32.10	33.42	-
3	25	33.8000	C	15	33.87	3..35	*
4	21	35.1429	D	16	32.06	34.40	**
5	31	34.7742	E	70	32.50	33.72	**
6	42	33.3092	F	12	30.67	55.62	*
7	26	33.9231	G	20	36.25	34.48	**
8	24	33.4583					
Total	223	34.0987		154	33.01	34.33	-

* Significant at 0.01
**Significant at 0.05

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