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ABSTRACT

A materials technology program was developed at Richland High School (Washington) and pilot tested at seven sites in Washington and Oregon. The program created partnerships between science and vocational education teachers at Richland High and Battelle Pacific Northwest Laboratories, and was then expanded to include other high schools, colleges, and other industrial laboratories. During the initial program, a steering committee was organized, a literature search was conducted, a curriculum was developed and validated, teachers were trained, and pilot sites were selected. More than 225 students were enrolled in the program. Teachers were selected and trained in workshops and through industry programs. An evaluation by Northwest Regional Educational Laboratory showed that the teacher training workshop and the program both received a majority of excellent or good ratings from teachers and/or students in all categories evaluated. The curriculum and project descriptions were disseminated through educators' and researchers' meetings and workshops. (KC)

FINAL PERFORMANCE REPORT

Materials Technology:
The Common Core Skills That Are Shaping the Future

Award No. V199A90105

Cooperative Demonstration Program (High Technology)

Project Period: January 1, 1989-June 30, 1990

Submitted by

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on behalf of the

Richland School District/Voc.Ed.
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and the following partners:

Battelle Pacific Northwest Laboratory
Central Washington University
Northwest Regional Educational Laboratory
and pilot sites in Oregon and Washington

September, 1990

CONTENTS

A. Summary

The Materials Technology project, funded by the Cooperative Demonstration Program (High Technology) has proven that high school, community college, vocational, and academic students alike can benefit from exposure to the study of materials which links both the scientific understanding of materials and their composition and the technological applications of materials in the world of work. While the project from the outset did not intend to prepare youth or adults for occupations called "materials technologists," we did validate earlier assumptions that persons in many vocational areas will be much better prepared after having this kind of background. Furthermore, we learned that traditional vocational programs which often emphasize only one material (e.g., metals, woods, plastics) can be strengthened by adding the broader framework of Materials Science and Technology. Rapid emergence of new kinds of metals, new wood products, unique polymers and ceramics and combinations of these (e.g., composites) requires that students understand the materials they will be facing in today's workplace.

Seven pilot sites in two states replicated the Materials Technology curriculum originally developed at the "parent" site at Richland High School in Richland, Washington. While the overall number of students served was lower than originally expected, the enrollment for the 1990-91 school year at both the original pilot sites and the new round of schools implementing the model after the project ended will exceed 300. One of the new school districts launching its Materials Technology program this year is installing the curriculum at the junior high school level as part of a technology education program. Columbia Basin College (CBC), our post-secondary test site in Pasco, Washington, was pleased with its offering of Materials Technology to an older student group already working in industry. Staff at CBC worked with a diverse class that included welders who are employed by the Hanford nuclear research facility and other major contractors such as Westinghouse.

The staff from pilot sites who field tested the original Materials Technology curriculum were trained in Summer, 1989 at a four-week workshop conducted both in Richland and at Central Washington University in Ellensberg. In each case, both a vocational and a science teacher were present and, in all but two sites, these same individuals team taught the curriculum during school year 1989-90.

Evaluation of the pilot site activities by Northwest Regional Educational Laboratory (summative) and of the project management and organization (formative) shows that project goals were met. The nature of the curriculum itself does not lend itself to a "packaged" approach since each new site must adapt to the community and industrial resources it finds locally. A separate document submitted with this report includes an overview of the curriculum and a summary of student and teacher reactions at each of the high school sites.

Dissemination of the Materials Science and Technology program (as it became known) began almost immediately after project start up. Presentations were made to at least 10 conferences and workshops. Articles appeared in a national magazine produced by the International Technology Education Association and a journal published by the Washington State Technology Education Association among others. Interest was so high in further implementation that a Summer, 1990 training experience was replicated--again at Richland and Central Washington University--for new schools interested in adapting the curriculum. This latter activity was self-supporting.

B. Accomplishments

Activities of the project can best be summarized by reviewing the objectives from the Baseline Management Plan submitted as the grant was initiated:

Objective 1: Create new partnerships in new settings

1.1 Build steering committee
1.2 Identify field test sites
1.3 Search literature
1.4 Secure agreements

The steering committee that oversaw the development of this project included the project director Bruce Hawkins; the assistant superintendent for curriculum of Richland Public Schools; three representatives of Battelle Pacific Northwest Laboratories who provided incentives and industry backing to develop the curriculum from its very inception; two professors from Central Washington University where much of the leadership in technology education in the state has emerged; and the evaluator from Northwest Regional Educational Laboratory who also assisted with dissemination and other technical assistance tasks.

The three high school sites selected in Washington state were Kennewick High School (near Richland), Sammamish High School in Bellevue (near Seattle), and North Thurston High School (near Olympia). The sites in Oregon included Churchill High School (Eugene), Corvallis High School (Corvallis) and Gladstone High School (near Portland). The Columbia Basin College is located in Pasco (also near Richland). Each site signed an agreement that specified exactly what it was expected to do in conducting local activities. Each site was granted approximately $26,000 to carry out agreed upon tasks.

Project staff and contractors conducted a review of literature and human resources in this emerging field. During the course of this review, Steve Piippo (the teacher who first initiated the course at Richland) made contacts that resulted in his being invited to attend a national materials science education seminar in Michigan that convened some of the nation's leading authorities in the field. He was invited to share his findings and won an endorsement of the MST curriculum from this prestigious group which includes engineers and scientists from organizations as diverse as NASA and Ford Motor Company.

Objective 2: Refine coursework

2.1 Validate course
2.2 Compile historical framework
2.3 Develop teacher's guide
2.4 Compile study units
2.5 Determine impact
2.6 Identify material requirements
2.7 Arrange staff internships

The steering committee carefully reviewed the coursework as it identified the pilot test sites. Battelle staff and CWU experts pored over each unit in the curriculum that had earlier been designed by Richland High School. In each case, the steering committee wanted full assurance that the suggested activities and processes were both safe and scientically correct. It was determined that MST teachers in the future will have to replicate the processes that were orginally employed in Richland if they are to be true to the original design. However, tested lessons are still being added to the storehouse as each successive school year sees new MST classes added. Each site adapting MST must recognize these basic assumptions:

- staff must have opportunities to work with materials in industry or laboratory settings before they begin teaching this course

- both academic and vocational teachers should work together to deliver this course; this integration is vital as students learn both theory and practice simultaneousely

- the course must utilize the tools of the trade to the greatest extent possible (this includes writing in a journal just as scientists do as they log each step of their experiements and as technicians do as they monitor complex equipment and provide quality assurance documentation to customers)

- the use of community experts is highly desirable as is the support of a business/industry advisory committee that can help locate resources, materials, equipment and internship opportunities for students and staff alike

- staff must utilize cooperative learning techniques

All teachers in the pilot sites had opportunities to work in materials laboratories both at Battelle and CWU obviating the original notion that they should be employed locally in a materials-oriented work setting before beginning the 1989-90 school year.

Objective 3: Train Students

3.1 Recruit students
3.2 Operate to serve 250 students

The key to successful recruiting for the 1989-90 school year was a special orientation session held at Richland in March, 1989 for pilot site administrators and counselors. The counselors were particularly impressed with what they heard and saw--both at the original school site, at Battelle and in local industrial settings. The school site team from each location was given time to strategize their approach to students, staff and parents back home. There was concern that since students had already forecast for their fall courses, it is difficult to fill new courses just being introduced. Most sites exceeded their expectations, and one district decided to add an additional school at second semester; however, this class only enrolled about 15 students. The College served 17 students during Winter Term and plans to continue the course in school year 1990-91. Obtaining curriculum committee and departmental sign-offs is a more tedious process at the post-secondary level; however, staff certification issues are more complicated at the high school level.

Overall, the goal of serving 250 students in school year was not met. Approximately 237 participated in MST courses with more scheduled for next year.

Objective 4: Evaluation

4.1 Gather evaluation data
4.2 Summarize results

Northwest Regional Educational Laboratory conducted the third party formative and summaive evaluation for the project. Dr. Larry McClure participated in all steering committee meetings, training events and conducted on site reviews with faculty and administrators. All students were administered a baseline data survey to gather demographic information and assess their understanding of materials science and technology concepts. One hundred thirteen students completed a student end-of-course survey. Sixty-one percent of the students had taken or were enrolled presently in vocational classes (Metals, 18%; Woods, Mechanics, Electronics 7%; Drafting 3%; and Graphics, 2%)

A complete summary of student, staff and administrator evaluation findings is included in Attachment A.

Objective 5: Dissemination

5.1 Prepare descriptive materials
5.2 Host visitors
5.3 Make presentations
5.4 Compile materials for others
5.5 Submit to dissemination network

A one-page flyer promoting MST for students has been acclaimed for its graphics and message. Pilot sites have used this short piece widely and also found it useful with adult audiences. A short curriculum overview was prepared to provide visitors to pilot sites and to mail to those inquiring about the project. At least ten presentations were made on the project ranging from a 45-minute session at the 1989 American Vocational Association convention to the Work Now and in the Future conference in Portland to the individual state professional meetings of vocational adminisrators, technology educators and science educators. Coverage of the project was included in professional journals, on three television stations and in various newsletters and newspapers. The document included in Appendix B was developed to provide both a curriculum overview and reactions of students and staff gathered as part of the evaluation process by NWREL.

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Materials Science and Technology External Evaluation Report

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June 30, 1990

Contents

Materials Science and Technology External Evaluation Report

1. Introduction

This external evaluation report of the Materials Science and Technology Project contains data collected and analyzed by the staff at the Northwest Regional Educational Laboratory (NWREL). Section 2 reports findings from the teacher workshop evaluation; Section 3, the Student Baseline Survey; Section 4 the Student End-of-Course Survey, Section 5 the Teacher End-of-Course Survey, and Section 6 the Project Director and Site Coordinator Survey. The report also includes more detailed information on tabulations of surveys.

2. Teacher Workshop Evaluation

A workshop evaluation form was used with participants attending the Materials Science and Technology workshop on March 21-22, 1989. Responses were received in the mail from 21 participants: four from North Thurston High School, two from Gladstone High School, Corvallis, Sammamish High School, Bellevue School District, and Columbia Basic College, and one each from Churchill, Eugene, Central Washington University, Kamiakin High School, Cottonwood School District, Kennewick High School, and Battelle.

Participants were asked to rate particular aspects of the workshop as excellent, good, fair, or poor. Table 1 shows the results. Highest ratings went to the Laboratory tours and the presentation on materials science and the classroom. Almost all features of the workshop were rated as excellent or good.

Table 1
Materials Science and Technology Workshop Evaluation Ratings

	Excellent	Good	Fair	Poor
Prior information about the workshop	3	13	2	2
Trends in technology education	12	9	0	0
Materials Science and the classroom	16	4	1	0
Handiness and creativity	9	11	1	0
Importance of Technology Education	14	7	0	0
Laboratory tours	19	2	0	0
Employer site tours	16	4	0	0
Food and housing	12	7	0	0
Understanding of what will be expected of me	9	7	5	0
Understanding of next steps planned	11	6	3	0

Participants were also asked to identify major strengths and limitations of the workshop and to identify additional information or help needed in carrying out their role. The tours of the lab and employer sites were among the most frequently mentioned strengths. Limitations included the inadequate advanced communications about the meeting and the poor timing of the workshop. Follow-up information needed included more on the equipment needed and more definitive curriculum. A list of the specific comments to these three questions follows.

What were the major strengths of this workshop?

Tuesday afternoon session, tour of Steve's lab, and Mike Schweige's presentation.

Organization

The understanding of what/how materials science can be made applicable to the mission/vision of education now and in the 21st century.

The employer site tours were most helpful in spotlighting the kinds of activities, materials, projects we might expect to see students working on.

To show what is expected and to show what industry needs out of our school system and the value of this class.

Visitation to labs/sites/Piippo's classroom. Opportunity to visit with educators from other schools. I learned much about what's new in technology and needs for the future.

General information about the project, answers to some of my specific questions, opportunity to meet people.

The respect demonstrated between the partners in this project—Battelle and Richland district folks. The informal, but substantive sessions.

Examples of what could be done.

Knowledgeable presenters, tours, professional presentation of the project.

Well prepared, practical information, good presentations, tour was excellent. Good foresight as to what we need for our students. Reception was good.

Lab tours.

Networking with others.

Diversity of group attending, enthusiasm of presenters, involvement of local business/agencies.

Began building of the project team, participants were able to see industry support, teachers gained a better idea of the scope of the project.

To show a new application of classroom material and equipment. To present science in a practical sense and more easily understood by more students.

Steve Piippo-discussion/tour of school, tour of Battelle labs, and Western Sintering.

Good grasp of materials science course.

<u>What were the major limitations of the workshop?</u>

I felt that the one of the employer site tours could have been eliminated to allow more time for small groups at the end!

Some lab sessions too long.

I believe the tours were important--but perhaps more time could/should have been provided participants to collegially work together.

It would have been instructive to see some student working on projects—have a chance to talk to them about how they view the course, support materials, etc.

Lack of organized lesson plans but this gives us the flexibility to develop our own program tailored to our strengths.

Poor timing--spring break in Oregon. Info should have gone directly to those planning to attend. Principal and superintendent received information. It was <u>not</u> forwarded. Those attending had <u>no</u> idea what to expect as we had seen nothing!

It was a long way to go for one day's worth of meeting (from Eugene). It could have been longer. Also, the time was bad (spring vacation) for us. The advance notification of the meeting was very short. People already had made plans for spring vacation so some could not go.

We should have had our signals "a little straighter" upon going into the 2-day session, as far as steering committee goes.

Teachers are still looking for more specifics.

I received minimal information prior to the workshop. This was an in-district problem. I would like to have had something in writing describing the activities and calendar for our summer work.

Time limitations. I would have liked to see more actual hands-on uses of what is being done. Some of the tour information was way over my head, mainly the molecular science information.

Late notification of dates. I did not attend the second day c/o "tuned in" to the nuts and bolts.

Timing for us - teachers had previous arrangements.

Could have used a little more time to have teachers become involved in the program and classroom activities. Steve Piippo's lab did not show off too well--it was a mess.

Not enough time to gain many of the specifics required to teach/present the course.

Time - as expected-hopefully this summer I will be able to ask and discover questions/answers.

What additional information or help do you need to carry out your role in this project?

A week by week sequence of material presented at Richland High School to help eliminate those too large or too small expectations when it comes time to begin. Also list of tools and equipment as soon as possible in order to make wise use of money and time!

None

I believe our role is well defined and we will take the next appropriate steps.

I feel the need to see a more stable set of curriculum materials (e.g., resource books, back-up information, lab guide sheets on the handling of hazardous materials, etc. The Richland High School instructors' approach to the handling of hot glass, ovens, etc., made me uncomfortable! There is an issue here of supervision/liability regarding student injury.)

The summer workshop should answer all questions. Would like information on a fall "inservice" after a month or so to "compare notes."

Still unclear about budget restrictions, limitations, and expectations. Can we pay for things from our funds here, then submit bills?, or should all purchases be P.O'd through the project? What is a reasonable stipend for the two teachers who will be at Battelle and CWSU this summer? Guess we need better guidelines for use of project funds.

We need the updated equipment list ASAP. I know whc to call if we have questions or need advice. It would be helpful to get the brochure/other materials to help advertise the program ASAP also.

None so far

Most of what I need must be done within my district. More specifics of exactly what will be done in Richland would be helpful.

A calendar of activities for work at Battelle and CWU. A list of supplies or materials I need to have on the first day at Battelle.

More information as to what exactly I will be doing and how that will help me in the classroom. I really don't understand what will be going on this summer, but I guess when July comes, I will find out.

Other curriculum adapted to adult-employed audiences. Schedule of activities and expectations for the summer. Copy of the Richland High School Curriculum Handbook.

Nothing. Great session!

I think I know what needs to be done. The ball is now in our court.

Need: 1) many more specifics for the course, 2) minimum of a general outline, 3) types and operations of equipment, and 4) "Hands-on" type of instruction with some guidance.

Most of the details are to be forthcoming. I do need a resource text or two prior to this summer's work - but I have confidence that our vocational director will have that for me.

Brochure coming from the group.

3. Student Baseline Survey

In October, 1989 a three page student background survey was administered to participating students by materials technology teachers in seven pilot schools. Surveys were completed by 184 students. The purposes of the survey were to determine some demographic information regarding students participating in the project, related courses they had taken, prior experience with processes related to the curriculum, reasons for taking the course, prior grade point average, and future plans after high school. Of the students completing the survey, approximately 80 percent were in grades 11 or 12. Students had a grade point average of 2.64. For a detailed tabulation of the survey see Appendix A.

Seventy-eight percent of the students taking materials technology are male and 22 percent female. Seventy-two percent had taken or were currently taking Algebra I and 41 percent Algebra II.

Seventy-two percent had taken biology and about a third had taken general science, physical science, and chemistry, while only nine percent had taken physics. Sixty percent of the students indicated they had a career choice in mind after high school, and 55 percent said some of their high school classes helped prepare them for these career choices.

Sixty-four percent of the students had previously taken metals or woods classes; 58 percent had technology education; and 24 percent, electronics.

Prior to this school year, about half of the students had often worked with other students as part of a team and had experience "building things.". About a third had considered a career in science, technology, or engineering.

Students were asked why they decided to take the materials technology class. The most frequently given response was because it sounded interesting and because of recommendations by a teacher or counselor.

Students also rated their interest in basic school subjects. Vocational classes were most popular followed by science, math, social studies, and lastly, English.

After completing high school, the largest number of students (43 percent) plan to attend a four year college or university, 27 percent to attend a junior or community college, and 17 percent to attend a vocational, trade, or business school. Twenty-four percent plan to work full-time and 34 percent part-time. Fifty-seven percent plan to graduate from college while 11 percent plan only to graduate from high school without further formal training.

4. Student End-of-Course Survey

The MST Student End-of-Course Survey was administered to 113 students in six participating high schools. The tabulated responses are shown in Appendix B.

Eighty percent of the students were male and three-quarters were in grades 11 or 12. Approximately one-third of the students reported an average MST course grade of A, one-third B, and 25 percent C. Average high school GPA was 2.89. Prior to taking MST 6C percent of the students had taken biology, 43 percent general science, 39 percent physical science, 36 percent chemistry, and 13 percent physics. Sixty-one percent had taken vocational education classes with 40 percent of that number having taken three or more vocational classes. The most common vocational classes taken were metals (18 percent), woods, mechanical and electronics (7 percent each), secretarial (5 percent), drafting (3 percent), and graphics (2 percent).

The major reasons students gave for taking MST were interests in materials science and the opportunity for hands-on activities.

Participants were asked to rate eight areas of the course as excellent, good, fair, or poor. Table 1 shows these ratings. Areas rated as excellent by over 40 percent of the students were: the hands-on approach to learning, overall rating, and quality of instruction.

TABLE 1
Student Ratings of Course Characteristics

Area	Rating			
	Excellent	Good	Fair	Poor
a. Interesting course content	38	45	17	1
b. Understanding of what was expected of me	30	53	14	3
c. Quality of instruction	43	41	16	0
d. Availability of needed equipment and materials	32	32	24	11
e. The hands-on approach to learning	52	37	10	1
f. Learning about related careers	25	46	28	2
g. Suitability of textbook and materials	22	45	24	9
h. Overall course rating	45	42	13	0

Three quarters of the students indicated interest in taking further study in materials science and half indicated the course influenced their possible career choices. Less than 10 percent viewed the course as too easy or too hard and 92 percent would recommend it to a friend.

Students were asked to rate the course in terms of the extent to which it caused them to improve in certain areas. Table 2 indicates their ratings on six areas. Over half of the students felt they learned a lot about materials science.

TABLE 2
Student Rating of Improvement in Selected Areas

Area	Improvement			
	A Lot	Some	A Little	None
a. Knowledge about materials science	54	41	4	1
b. Occupational skills needed in different jobs	19	55	24	2
c. Attitude toward work	27	43	16	25
d. Ability to solve problems	21	46	24	8
e. New opportunities for employment	32	32	25	12
f. Change in my desired occupation	15	21	21	43

Finally, students rated 12 program delivery strategies as excellent, good, fair, poor, or not used. Table 3 shows their ratings. Rated as excellent by a third or more of the students were: student projects, teacher demonstrations, group work, the journal or log, student experiments, and field trips.

TABLE 3
Student Ratings of Delivery Strategies

Area	Excellent	Good	Area Fair	Poor	Not Used
a. Lectures	19	44	29	5	4
b. Demonstrations by teacher(s)	36	50	12	3	0
c. Experiments to students	35	52	9	3	1
d. Projects by students	45	44	7	1	2
e. Field trips	32	28	25	10	6
f. Use of outside speakers	28	44	17	6	6
g. Working by myself	30	52	15	3	0
h. Working in a group	36	50	13	2	0
i. Keeping a journal or log	36	29	21	13	1
j. Videos/films	16	43	33	7	1
k. Articles and handouts	31	39	27	4	0
l. Using other school facilities (e.g., pottery room)	19	32	21	9	0

Over 90 percent of the students plan to obtain additional education immediately after high school, with 47 percent planning to attend a college or university, 35 percent going to a community college, 16 percent into the military, 13 percent on the job, and 10 percent attending a trade or vocational school.

Students were also asked what job they would like after graduation, perceived strengths and weaknesses of the MST course, and recommendations for improving the course. Their comments are in Appendix C. Among the most frequently mentioned program strengths were: the hands-on experiences, good teachers, and the MST content. Commonly cited weaknesses were the textbook, field trips, and the lectures. Recommended changes included eliminating the journal, and more activities.

5. Teacher End-of-Course Survey

The MST Project Teacher Survey was completed by 7 participating teachers from five high schools. A tabulation of responses to this survey is shown in Appendix D.

Participating teachers averaged 20 years of prior teaching experience with three each certified in science and in vocational education, and one certified in industrial education. Prior to hearing about this course, four teachers were unfamiliar with materials science and three were somewhat familiar. Each of the teachers viewed MST as helping students gain a good understanding of science, an increased interest in science, and viewed it as serving as a good science alternative for students not ready for chemistry or physics.

Teachers were asked to rate eight aspects of the curriculum as excellent, good, fair, or poor. Table 4 shows the responses. As with the students, the hands-on approach to learning was rated highest and availability of needed equipment and materials lowest.

TABLE 4
Teacher Ratings of Course Characteristics

Area	Rating			
	E	G	F	P
a. Scientific content of the course	2	4	1	0
b. Interest level of course	4	3	0	0
c. Ease of ability to teach the course	1	6	0	0
d. Availability of needed equipment and materials	0	0	6	1
e. The hands-on approach to learning	6	1	0	0
f. Learning about related careers	1	5	1	0
g. Seeing the course in relationship to the work world	3	4	0	0
h. Overall course rating	2	5	0	0

Teachers also indicated how they feel about teaching the MST course next year. All seven had an enthusiastic response. Teachers completed some open-ended responses to questions related to the types of students helped most and least by the course, the best and weakest units, greatest strengths and weaknesses of the course, and recommended changes. Their responses to these questions are included in Appendix D.

Teachers felt the course could help all students, although a few felt it was less helpful with the less mature student. The units on plastics, glass, and metals were good. The greatest strengths of the course were the range of activities and hands-on nature. The weaknesses included the lack of adequate materials available when needed.

6. Project Director and Site Coordinator Survey

The Project Director and Site Coordinator Survey was administered and returned by mail to NWREL for analysis in May-June 1990. The survey centered around the following 17 questions:

1. What caused you to want to start the MST Project?
2. When did you first become involved in MST?
3. What is your role in the project?
4. How do you see the course benefiting students?
5. How do you see the course benefiting the participating high schools?
6. How do you see the course benefiting the employers?
7. What were the biggest obstacles to overcome in beginning this project? How were they reduced or overcome?
8. What factors were most important in contributing to the successful implementation of the project?
9. Would you recommend this project to other school districts? If yes, under what conditions?
10. Have you had inquiries about the project from other districts? If yes, what types of information are they asking for?
11. Based on your experience to date, how satisfied are you with the project?

12. What do you see as its major strengths?

13. What do you see as its major weaknesses?

14. Are there any changes you would suggest?

15. What training and support for the project have you and your staff received?

16. What additional support, if any, is needed?

17. How much did it cost to get the program operational?

Responses to these questions are contained in Appendix E.

The project administrators saw the MST Project as a good opportunity to help students learn more about science and technology, integrate applied academics with vocational education, and enable students to become better at analysis and problem solving. They saw the course as allowing students to encounter science through hands-on experiences for which they could receive science credit. It was also seen as providing the participating high schools with an important relevant option for the non-college bound students. The course also has payoff to employers by generating a more knowledgeable and technologically literate person.

Some of the obstacles identified by the administrators were: the need to disseminate information to students and staff concerning benefits of the program, funding for teacher release-time, the need for larger student enrollments, inadequate classroom space and equipment, and staff assignments so as to allow for team teaching.

For administrator recommendations regarding overcoming these barriers, the training and support needed, and descriptions of cost-items, please see Appendix E.

c. Have you taken any high school classes to help you prepare for this career area?

55 Yes   45 No. If YES, which classes?

The only courses identified by more than 3 students were: materials science (9 students), drafting (7), and biology (5), and 4 each in career education, math, psychology, wood, and auto shop.

6. How many courses have you had in the areas listed below:

Percent of Students		Average courses per area
58	Industrial arts, technology education	1.60
64	Metals or woods	1.51
24	Electronics	1.43
43	Art (pottery, painting, jewelry)	1.42
33	Drafting	1.26

7. For each experience below, please indicate the extent to which you have already done it before this current school year: (Circle one rating for each experience)

	Never	Sometimes	Often
a. Worked with other students as part of a team	5	45	50
b. Planned my own learning or experiments	19	56	25
c. Built things	3	47	49
d. Used problem solving processes	5	49	46
e. Studied about metals, glass, or plastics	24	53	24
f. Worked in school with a business or community volunteer	67	22	11
g. Considered a career in science, technology, or engineering	30	40	31
h. Helped another student learn something	7	60	33
i. Maintained a journal or log of what I learned	27	44	29

8. Why did you take this Materials Technology class? (Check all that apply)

27 A friend is taking it
45 Recommended by a teacher or counselor
82 It sounded interesting
33 It relates to a career interest of mine
39 I needed credit in science
15 It sounded like an easy class
32 It fit into my schedule
22 Other (please describe________________________________)

9. Please rate how well you liked studying the following subjects before this school year by circling one response for each subject area:

	Liked It	Was OK	Disliked It
a. Science	45	48	7
b. Math	35	42	23
c. English	25	48	27
d. Social Studies	30	43	27
e. Vocational classes (like auto mechanics or business occupations, etc.)	65	25	10

10. Before this year, what was your high school grade point average (on a 4 point scale of 0 to 4.0, i.e., 2.7)?

2.64 Average

11. What do you expect to be doing one year after completing high school? (Check one or more answers)

24 Working full-time
5 Entering an apprenticeship or on-the-job training program
15 Going into regular military service or to a service academy
17 Attending a vocational, technical, trade, or business school
27 Attending a junior or community college
43 Attending a four-year college or university
34 Working part-time
15 Other (travel, take a break)
16 I have no idea what I'll be doing

12. How far do you plan to pursue your formal education? (Check one)

1	Don't plan to finish high school
11	Graduate from high school
17	High school plus one or two years of college, community college, or special training
15	High school plus three or more years of college, community college, or special training
37	Graduate from four-year college
20	Graduate or professional training beyond college

Thanks for taking time to complete this survey.

APPENDIX B

APPENDIX B

MATERIALS SCIENCE & TECHNOLOGY PROJECT

Student End-of-Course Survey

Student Name ____ , Students ____ *School* Sammamish 9, Richland 29, Churchill 18, Thurston 20, Corvallis 20, Kennewick 13
First Last

Social Security No. ________ *Date* ________

Please check the appropriate response(s) for each question

1. Sex: 80% Male 20% Female

2. Grade Level: 6% 9 20% 10 32% 11 42% 12

3. Race: 5% Asian 3% Black 3% Hispanic 3% Native American 85% White 2% Other

4. What is your average grade so far in the Materials Science Technology (MST) course?

   37% A 32% B 25% C 7% D 0% F

5. What is your high school grade point average (GPA) *(i.e. 1.0 to 4.0)* Average 2.89

6. Please check which science courses you have already taken, or are now taking, in addition to the Materials Science and Technology class:

   69 Biology
   36 Chemistry
   43 General Science
   13 Physics
   39 Physical Science
   25 Other *(please specify)* ________

7. Have you taken any vocational education classes while in high school, such as office occupations, metals, auto mechanics? 61 Yes 39 No

   If yes, how many classes? one 28, two 33, three 16, four +24

   In which vocational areas? Metals 18, woods 7, mechanical 7, electronics 7, secretarial 5, drafting 3, graphics 2

8. What were your main reasons for taking the Materials Science and Technology class?

   29 Needed a science credit
   52 Opportunity for hands-on activities
   25 Opportunity to explore related occupations
   59 Interested in materials science
   19 Friends were taking it
   18 Other *(please state)* ________

9. Please rate th course in the following areas. *(Circle E for Excellent, G for Go d, F for Fair, and P for Poor.)*

	E	G	F	P
a. Interesting course content	38	45	17	1
b. Understanding of what was expected of me	30	53	14	3
c. Quality of instruction	43	41	16	0
d. Availability of needed equipment & materials	32	32	24	11
e. The hands-on approach to learning	52	37	10	1
f. Learning about related careers	25	46	28	2
g. Suitability of textbook and materials	22	45	24	9
h. Overall course rating	45	42	13	0

10. Would you be interested in taking further study in materials science? 74 Yes 26 No

11. Has the course i luenced your possible career choices? 53 Yes 47 No

12. Do you feel the course was: 5 too hard 9 too easy 86 about right

13. Would you recommend this class to a friend? 92 Yes 8 No

14. Please rate the course in terms of the extent to which you feel it has caused you to change or improve in the areas listed below. *(For each area check A Lot, Some, A Little, or None.)*

	A Lot	Some	A Little	None
a. Knowledge about materials science	54	41	4	1
b. Occupational skills needed in different jobs	19	55	24	2
c. Attitude toward work	27	43	15	15
d. Ability to solve problems	21	46	24	8
e. New opportunities for employment	32	32	25	12
f. Change in my desired occupation	15	21	21	43

15. Please rate the following strategies that may have been used in your class. *(Circle E for Exellent, G for Good, F for Fair and P for Poor. If a strategy was not used, circle NO.)*

	E	G	F	P	NO
a. Lectures	19	44	29	5	4
b. Demonstrations by teacher(s)	36	50	12	3	0
c. Experiments to students	35	52	9	3	1
d. Projects by students	45	44	7	1	2
e. Field trips	32	28	25	10	6
f. Use of outside speakers	28	44	17	6	6
g. Working by myself	30	52	15	3	0
h. Working in a group	36	50	13	2	0
i. Keeping a journal or log	36	29	21	13	1
j. Videos/films	16	43	33	7	1
k. Articles and handouts	31	39	27	4	0
l. Using other school facilities (e.g., pottery room)	19	32	21	9	0

16. Do you plan to obtai additional education immediately after high school? 93 Yes 7 No
If yes, where will you obtain it? *(check one or more)*

13 On the job

35 Community College

47 College or university

10 Trade or vocational school

16 The military

17. What job would you most like to have after completing your education? Be as specific as possible. For example, state 'lab technician' rather than 'hospital or medical work'.

18. What do you feel were the major *strengths* of this course?

19. What do you feel were the major *weaknesses* of this class?

20. What changes would you recommend in this class to make it better for students next year?

THANKS FOR YOUR TIME IN COMPLETING THIS SURVEY
(Please return to your teacher)

NWREL
5/90

APPENDIX C

OPEN-ENDED STUDENT COMMENTS

17. What job would you most like to have after completing your education? Be as specific as possible. For example, state "lab technician" rather than "hospital or medical work."

Not decided

A buyer for a clothing store

Computer programmer

Own my own computer graphic company

Auto mechanic in a speed shop or just a good shop

Working with cars to fix them mechanically as well as bodily

Business

Cosmetologist

Airline engine mechanic

Juvenile counselor

Business owner or aerodynamics engineer

Criminal justice, leaning to law enforcement

Medical lab technician

Fighter pilot/navigator

Artist or material scientist (split between 2)

Child psychologist

A jeweler

Marine biologist

Nuclear engineer

Pro-contractor

Environmental engineer

Materials science engineer or architect

Interior designer, fine artist, architect, psychologist, jewelry maker

Military aviation mechanic or heavy machinery operator

Engineering, either mechanical or production

Sound technician, computer programmer

Technology research (NASA if possible), sports medicine, physical therapy

Police officer

Computer architectural drafting

Troubleshooter for computer firm

Repair computers and other electrical devices

Work in the art business as an entrepreneur or free-lance artist

Electrical--chemical engineer

I don't know, but it has to pay a lot

Automobile designer

Civil engineer, architecture, mechanical engineering.

Mechanical or electrical engineering

Park ranger

Naval aviator

Working as head of construction crew, making $15/hr.

I'm really not sure, possibly a veterinarian or an environmental scientist, or a career in art.

Physical therapist.

Something to do with chemistry

Business manager

Fashion merchandising

State security guard or cop, not this state though, New York probably.

Material engineering or aeronautical engineering

I would like to get into the travel business, more in the line of a travel agent.

Counselor at a detention center (example Maple Lane or Echo Glen), then after that opening a half way house

Day care director or preschool teacher or counselor for deaf

Work for the state. Work in a parts store.

Auto technician

Engineer

Science/technical related job in the aviation field

Business executive

Reprographics (printing)

Architect

Auto tech (at dealership)

Arthitectural Engineer

Pro drummer

Ditch digger/garbage man

Welding instructor out at the power plant

Secondary teacher (Hist/Eng)

Architect, contractor

Work in a golf shop

Welding

18. What do you feel were the major strengths of this course?

The speakers

Project

On hand work

Teaching you how rapidly technology changes

The speakers

Getting speakers, they got a lot of good speakers.

Hands-on learning (lab work)

The hands-on experience

In-depth study of materials and where they are used, and the lab

Field trips for hands-on experience, use of movies and handouts

Definitely the labs, and the field trips

The hands-on work was a definite strength

Lab time

Imagination—creativity, using the right side of thought

Opportunities to use labs

The opportunity to use hands-on activity, the amount of stuff in our lab

Experiments

Lab, outside speakers, instructor

Hands-on work

To build different things that you thought you couldn't have done

Having a chemistry background and knowing a little bit about materials

Lab work, hands-on, not stressing math so much

The hands-on opportunity available to work on materials of the future and present for understanding the possibility of professions that would strengthen the industrial world

Learning about materials and composites, the real world items, THE TEACHER!!

The strengths of the course was the hands-on activities.

Lab work, hands-on experience, leave a longer impression of the experiment

The teacher--he's the BEST!!!

The hands-on experience and learning new things

Learning many things about metals, glass, ceramics, and fun experiments

Hands-on, use of labtime, experiments, trips

Having a room and equipment to use when needed (project and experiments)

The hands-on learning

Use of the lab and encouragement to log data

Learning to work with chemicals and other objects to produce something else. Excellent way of learning

Hands-on

We did lots of lab work. Teachers did a great job presenting new materials.

The chance to try new things—work by myself: accomplished and tried things I never imagined doing, basic outline and general knowledge gained

The experiments done to support what was learned in the classroom

Labs and lecture

Science background

The lab work

Labs & materials

Use of hands-on labs

The metals work was entertaining with the torches, etc.

Knowledge of new material uses

Excellent concept

The teachers, the labs, and the use of a journal, teachers showed lots of enthusiasm and made us want to learn and get involved

Strong lab-orientated instruction, good field trips, good use of school facilities

Understanding crystal organization, amorphous things, I like the range of topics discussed and experimented on, opening up and exploring new materials, learning about plastics was very interesting.

Learning about new materials, labs, journal helped me to remember more

The hands-on experience.

The experimentation, hands on experience, letting us go on our own

Hands-on work

Interesting concepts—wish we would have explored more, possibly even exploring new materials

It was very well planned and help was where we needed it (in the lab).

Hands-on work, got to try our own ideas

Having furnaces that were available to students

Hands-on activities, knowledge of mechanics

Hands-on labs and the comparative freedom we had in doing them; we were allowed to use our imagination while following certain rules

The hands-on experience

Hands-on work

Hands-on lab time

The glass unit was extensive and interesting

Lets us experiment with just about anything

None

Learned about glass

Science comes easy for me

A lot of hours of experience and interaction, information was put across well so we could understand it

Lectures

Teachers, hands-on work

Knowledge

Learning of composites

Notebook was emphasized

A chance to learn new things

The hands-on was a major strength in this course

The hands-on experience

Working on worksheet better than a lot of lectures; hands-on experiences; teachers helping me

The way things were explained, it was usually very clear

Journals

The major strength of this course is its emphasis on lab/shop time compared to other science classes

Labs and learning through trial and error

Being able to wo k on different things and a lot of hands on projects

Hands-on work

Hands-on work

Hands-on Experiments

Hands-on

The work

We got hands-on experience

The individual "hands-on" projects

Sciences, learning properties

Hands-on work, all round strong

Jewelry making, glass making

Hands-on lab

Learning new things

Glass and ring making

19. What do you feel were the major weaknesses of this class?

The journal

Not enough materials

Quality of instruction

Lack of equipment (highly technical equipment is needed), like materials to make electronics and superconductors

This year the shop was a mess from the croncretion

Students & journal

I thought we would do different things.

Lack of organization, no class room, no equipment, materials

Text book

Text book

That there was not enough time for the teacher to help in the in-depth way he wanted to

Too many students, limited offerings of the class

No weaknesses

The main weaknesses were the worksheets

None

Nothing

We need a high energy microscope

Movies

None

Not a lot of kids know about it

Nothing

No desire to get into a long and involved project, I liked changes or short projects

No equipment

The ancient films, the class needs present day films to study present day materials

Needed more time each day and needed some chemicals

Unavailability of the materials and equipment needed, lack of time needed

Too hard for me

Some things were too hard to understand

Test were difficult

None

Time, not as much time as needed to spend on a project in a day

The lack of some equipment

None that I can see.

Lectures

We should have had more field trips

Inconsistent amount of time spent on each section, lack of materials

Lack of proper amount of time to thoroughly cover the possible areas

Field trips and project time

The videos

Not enough time (ran out)

Field trips

Not enough time in labs

Unorganized, expectations unclear, skipping back and forth among subjects

Not enough time for projects at end of class

Poor execution

The field trips were not a major weakness, but I found it difficult to completely tie them in.

Teachers had too many favorites. I didn't get the help I needed.

Not enough time for projects (need 5 weeks)

I think more people need to know about this class as an option for science, so that not just the brainy nerds and computer kids enroll in it. Let everyone know about it.

Sometimes disorganized. I think it was put together very well thorough

The amount of field trips

The journals had too much emphasis

Not enough time

Not enough information on "new" things — technology

Lack of equipment and materials

Took too long to get equipment, videos old and outdated, would like more advanced equipment

Teachers attitude toward some students, they seem to choose and give breaks to the brains, and all the athletic people are always being picked on

Journal writing, because I never wanted to stop and do it when I was working on an activity

The major weakness may have been the slowness of the materials delivery.

The journals

The students doing the teachers work

Use of student time to do teacher grunt work

Equipment and textbook arrived late. In the future this won't apply.

Not really knowing what we're supposed to do

Lack of equipment

Teachers left a lot of dead time in class that we didn't do anything

Being a senior

The textbook was incomprehensible

Not enough materials, and lab work, need a little more hands-on

Book, a few students

Disciplining of the students

Lack of organization

Availability of materials

It got real boring sometimes

The book and some lectures were the weaknesses

Long lectures, needed more lab time

Lecture from one subject to different subject each 10 minutes, not very much demonstration

All materials were not there at the right time and textbooks were impossible

Lectures

The inexperience of the instructors during the first year of teaching

Materials and the knowlege of the teachers

Not well organized

No materials, not hard enough

Book very advanced

Text book work

Having to do projects you don't want to do

The time

The teacher was learning as we were. It would have been better if he knew more before we went to work.

Discipline

All of the people that mess around and destroy equipment

Class to large, too little time

Other students

Not everybody was entrusted.

Classroom work

Nothing at all

Book work

20. What changes would your recommend in this class to make it better for students next year?

No journal

More participation, more students, more materials

More Projects

Have a definite curriculum set down for students, and provide a lot of on-hand training. Follow the leads of some vocational schools. They work.

Have more of a plan of what we're going to do

No journal

More hands-on stuff, less stupid subjects, and let the kids decide what they want to know.

Have more facilities to work with

New text books and more speakers

More class availability

More field trips to see different technologies

None

More equipment and suplies

More lab time

Well, a microscope, bigger classroom, more jewelry books on techniques, and anything anybody wants to give us

Mandatory full year class

Advanced course

More publicity, bigger room

Nothing

A microscope in which you can look more closely at the structure of materials, a machine that can measure strength (Ex. kevlar vs string Gr. Fishing Line)

More speakers

No changes, just more modern machines and technology devices, we had a $300,000 grant and never obtained a new machine, or any highly advanced materials that we haven't had before.

Allow more time, get additional chemicals needed for experiments, more equipment, fewer students (Otherwise an excellent class! I LOVE IT!!)

More assistance in the lab from engineers and material scientists from the nearby Battelle Labs

Fewer students

Nothing

Bigger room, more class activities

Bigger classroom, more lab time

Get some equipment.

Use of more outside information, the stuff thats going on today

More lab and work days, more worksheets out of book, less lectures—no one really listens anyway

More lab

I think our teachers did a great job and they don't really have to change anything

More organization/planning, more specific ruling with experiment, maybe a course outline for the students

Try to arrange use of time better or to get more time to include more areas

More experiment time and more cover areas that are new such as carbon fiber and lexan plastic, nylon

To give less homework and get more lab time in rather than a quick overview

A few more field trips for more experiences

More help to understand material

More time

Needs to be better organized

Give students 8 weeks for project (5 weeks for seniors)

More teacher training

A faster pace would help to get through all of the necessary labs and sections

Everybody should have an equal opportunity, and teachers need to be a little more understanding.

Move project to end of year (7 weeks), less emphasis on metals, etc. and more emphasis on useful things--plastics, etc., where we can use what we make, use of computers in class

A little less time on metals, not so much time annealing and quenching

I think that chemistry should be a mandatory prerequisite. I haven't taken chemistry and I was very confused during that time. We need more materials.

Have more field trips and labs to keep students interest

Lay back on the journals, more field trips and more experiments

Moved to a different perio . in the day

Need to explore "new" things, need to have help from NASA, etc.

I wouldn't

Increase the budget to allow more equipment and materials

More $, more hands on work, more interesting field trips, better facilities

Different teachers

Less importance on the journal

I think this year's experience will lend some facility to the next years group

Forget the journals

Always have a lesson plan so there is always something for the students to do.

This class will be better next year no matter what, because this year has been kind of unorganized, since this is the first year.

Better organization, less films and videos

Have more material for the students instead of making things up as we go

Better organized, more experiments

Having a different period to allow the students more time

A NEW BOOK!!! We spent too much time on metals.

More labs would be nice, lectures were fine, videos were kind of old but all right

Teachers should go through the material a little quicker. Get a new book!!!

No comment.

I think it will come together as the class is taught more

Have materials on hand when the projects are started

More work!!

Newer films, better books, and better equipment

Buy a new book. It's too difficult to understand. Don't let Mr. Nelson do lectures.

He's a great guy, but you can't understand the point he's trying to make.

More lab time, maybe more worksheets, need different books for this class besides the books we have which are engineering technology and material technology. I think the least informing book is engineering technology. The National Geographic books SHOULD be used as they were very helpful in our learning process.

More work

Not much I feel it works real good

More hands-on

When doing lab, everyone should know exactly what they are doing. More time to end a subject.

Harder, get the right materials

New text

More activities

Extra teachers & more time!

More discipline

More facilities

Nothing

Start early on some fun stuff

No book work

APPENDIX D
Materials Science and Technology Project Teacher Survey

Name___7 Teachers___ School___5 Schools___

1. Grade level of your students (check one or more): ____9th ____10th ____11th ____12th

2. Total years of teaching experience: Average 20 years, range 8 to 31

3. Area(s) of teacher certification? vocational 3, industrial ed 1, science 3

4. Prior to hearing about this course, how familiar were you with materials science?
   _0_ Very familiar _3_ Somewhat familiar _4_ Unfamiliar

5. What do you see as the major benefits of this class to students? (check one or more)

   _7_ a) Good understanding of science
   _6_ b) Preparation for the workplace
   _6_ c) College preparation
   _7_ d) Good science alternative for students not ready for chemistry or physics
   _7_ e) Increases interest in science
   _3_ f) Other (please specify)________

6. Please rate the following characteristics of the course. Circle E for Excellent, G for Good, F for Fair, and P or Poor.

	E	G	F	P
a. Scientific content of the course	2	4	1	0
b. Interest level of course	4	3	0	0
c. Ease of ability to teach the course	1	6	0	0
d. Availability of needed equipment and materials	0	0	6	1
e. The hands-on approach to learning	6	1	0	0
f. Learning about related careers	1	5	1	0
g. Seeing the course in relationship to the work world	3	4	0	0
h. Overall course rating	2	5	0	0

7. With which types of students do you feel this course is most helpful? Why?

8. With which types of students do you feel this course is least helpful? Why?

9. Which were the best units in the course? Why?

10. Which units were the weakest? Why?

11. What is the last unit you have covered or expect to cover with your class this year?

12. What are the greatest strengths of the course?

13. What are the greatest weaknesses?

14. What changes would you recommend in the course? (Use additional sheets if necessary)

15. How would you feel about teaching this course next year:

_7_ Enthusiastic
_0_ Would like to
_0_ Willing to if necessary
_0_ Would prefer not to

PLEASE RETURN THE COMPLETED SURVEY TO YOUR PROJECT COORDINATOR FOR MAILING TO NWREL.

NWREL
5/90

APPENDIX E

Materials Science and Technology Project

Project Director and Site Coordinator Survey

1. **What caused you to want to start the MST Project?**

   Increased science graduation requirements initially! Secondly, it is relevant good stuff that helps students learn how to better analyze and problem solve.

   The philosophy of "applied academics" is an integral part of our Center for Applied Technology goals.

   The desire to include additional science/technology in the vocational programs.

   We were invited to attend an introductory session at Battelle Research Laboratories in March 1989. A science and an industrial/technology teacher attended the session. Later in the spring, the secondary curriculum coordinator and the vocational/technical coordinator attended an orientation session.

   The grant opportunity.

2. **When did you first become involved in MST?**

   Work Now and in the Future conference and O.T.E.A. state conference in Salem.

   We became interested through a presentation made at the Work Now and in the Future conference; Northwest Labs assisted us in pursuing our interests.

   Winter 1989.

   In March 1989

   Spring 1989

3. **What is your role in the project?**

   Oregon pilot site! 1 of 3

   Project director at Churchill High School

Supporting the classroom instructors.

Project coordinator for Corvallis School District 509J.

Coordination with instructional directors, business office, faculty, advisory committee, and grant administrators, Kennewick School District.

4. How do you see the course benefiting students?

Generates growth in creativity, career awareness, (i.e., now industry and job awareness), fulfills a science requirement for graduation from high school.

Students can experience first-hand what it's like to be a scientist—through experimentation, notekeeping/journal recording, pursuing topics of interest at a more intensive level. At the same time, students obtain a sound scientific base in the science of materials.

Provides a different approach to chemistry that can be applied in areas relevant to students.

Students are excited about learning the chemistry of materials in a different way. The "hands-on" approach coupled with the science and technology team-teaching is a dynamic teaching/learning combination for students.

Since half were employed, they could immediately apply content to their work. Integration of new knowledge with real work, acquaintance with chemistry faculty.

5. How do you see the course benefiting the participating high schools?

Creates a relevant option for the middle 60% of students.

Without the funding received through the grant, it is very unlikely that our school could have afforded to launch into the program at the level we did.

The high school will be able to offer a quality science program to students who normally do not do well in science.

The integration of science and technology is of great importance if students are to have a thorough understanding of how science operates in the real world of industrial technology. Teachers of different disciplines working together is very powerful. It enables teachers to become facilitators of learning.

Not applicable.

6. **How do you see the course benefiting the employers?**

Generates a more knowledgeable and technologically literate person, thus better qualified.

Employers are looking for students that go beyond what is expected of them to anticipate--then solve--potential problems and solutions to problems. MS instills this curiosity in students as well as promotes a work ethic necessary for success.

Students will have a better understanding of materials and how they react to different forces.

Students should be graduating form high school with a much better understanding of the composition of materials out of which our technological wonders are made. We must prepare a technological literate population. All disciplines will have to work together to make this possible.

Improved on-the-job performance, potential innovation.

7a. **What were the biggest obstacles to overcome in beginning this project?**

Political monster commonly referred to as Oregon Department of Education. Principles of Technology is not about to be out done by MST at this time.

1) Potential student enrollment, 2) funding for teacher release-time, and 3) disseminating information to students and staff concerning benefits of program.

Classroom space.

Work out the details of team-teaching without cutting staff from their regular assignment. Staff was cut one class each from their regular assignment. Informing other staff at the building level and administration understanding the differences in this class and a chemistry and shop class was also a challenge.

Time, increased publicity needed, space, and equipment.

7b. **How were they reduced or overcome?**

Local support, principals, superintendents, and school board. Also Art Thesis--head guy for the Science Department.

1) was overcome by an intensive in-school advertising campaign, 2) funding for sub-time was provided through vocational funds, and 3) was, in part, provided through brochures printed for project. Our biggest problems for next year have not been overcome. They are: 1) getting state colleges and universities to accept Materials Science as a college prep class, and 2) getting sufficient enrollment for the 90-91 school year.. #2 is highly dependent on #1.

Use of multi-classrooms.

The MST teachers talked with teacher groups and involved administration in ways in which they developed a better understanding of the course. Administrators are invited to advisory committee meetings and usually attend.

Moved the class to appropriate industry and classroom sites. Used advisory committee members to individually recruit students from their industry.

8. **What factors were most important in contributing to the successful implementation of the project?**

Summer workshop at Battelle

Extremely high interest level/energy level of teachers involved.

Inservice training for staff.

An advisory committee was formed and they have been absolutely great in providing support, resources, supplemental materials, and summer internships for the instructors.

Expert faculty and industry controls, flexibility, space and coord. keep it going, advisory committee input.

9. **Would you recommend this project/course to other school districts? If yes, under what conditions (i.e., availability of a teacher with materials science background, etc.)?**

Not necessarily! Yes, staff inservice, some support from ODE, $4,000 for centrifugal casting equipment and glass supplies.

Absolutely. I would recommend that: a) the course be team-taught by a science teacher and technology teacher, b) strong advisory council be developed right from beginning; c) both teachers receive preliminary training.

Yes, but willing to support teacher inservice and extra days for lab set-up.

Funding must be provided to buy teacher time to develop the program. The team-teaching approach is very dynamic. Each teacher brings to the curriculum the strengths of their own area. If this course is to be integrated into the technology education curriculum, an integrated model should be developed and piloted in local schools. Teacher preparation institutions should be including an integrated science/chemistry of materials approach within the teacher preparation programs.

Yes.

10. a. Have you had inquiries about the project from other districts? b. If yes, what types of information are they asking for?

1) What kinds of activities, 2) time needed to cover material, 3) budget, 4) how much equipment, 5) team taught and/or important, 6) type of lab, 7) certification requirement.

Yes. Basic curriculum content; "how-to" implement course.

Yes. Teacher background and cost.

Cost and teacher requirements are the most frequently asked questions. How does a science and industrial-technology teacher team teach the materials?

No.

11. Based on your experience to date, how satisfied are you with the project?

Very

Extremely satisfied.

Very satisfied.

It has been a very successful project. We would like to start an MST class at Crescent Valley High School. However, we do not have the capability of paying for staff.

On a scale of 1-10, 8.5

12. **What do you see as its major strengths?**

Variety of things to do and great vehicle for introducing new industry and jobs. Good motivation.

High student involvement because of activity-based curriculum.

Students of different abilities working together. Students who normally would not take chemistry are being successful in Materials Science.

Team-teaching approach is very strong. The hands-on with chemistry and making/experimenting with materials is a real interest item with students.

Team teaching, built on specialty skills, flexibility.

13. **What do you see as its major weaknesses?**

Lack of scope and sequence, time (one semester), good videos, software, and test equipment.

The course is not as appealing to the lower-level students.

We chose to team-teach the class which results in facility problems.

Funding at this time of decrease in secondary enrollments. Cut-backs have been consistent each year for the past two years and will continue to be with us for at least two more years.

Time. Regular teaching load plus materials science is a lot to ask. More experiments need to be developed.

14. **Are there any changes you would suggest?**

Separate class for metals and glass and one for composites and polymers, (MST II.)

I think that a wood science component should have been developed, especially for the sites with heavy wood products industries in their immediate areas.

None.

Staff did not receive notices or information in a timely manner. Such a project must have tightly coupled management procedures. The time commitment on the part of staff is almost overwhelming. It might be better to approach it from a two year implementation process.

Do it again. Reorganize curriculum (minor change)

15. **a. What training and support for the project have you and your staff received? b. Do you feel it was adequate?**

Yes

For one teacher, yes; for another, no. That was by choice, however; one teacher did not participate in the summer workshop.

Yes. We have received summer inservice and periodic staff meetings with other instructors.

Yes. Please refer to #14. I check yes because I understand it is very difficult to coordinate such a large project. I believe staff were very disappointed in the outcomes and lack of consistency of meeting together as a staff.

Yes

16. **What additional support, if any, is needed?**

Reference material for videos, software, and inexpensive test equipment.

Substitute time and teacher preparation (workshop) time for teachers involved in the project.

Continue one week inservice during the summer.

A once a term meeting with staff to share concerns, errors in experiments, ideas for new experiments, etc., would be very helpful. These meetings occurred without much advance notice and very little organization. Staff felt that they were just thrown together and had little time to secure substitutes and plan for sharing.

Keep the administrative support and leadership

17. How much did it cost to get the program operational in terms of:

a. Extra Staffing	$ 6,000
b. Equipment	$10,000
c. Materials & Supplies	$ 7,000
d. Space/Facilities	$ -0-
e. Staff Training	$ 4,000
f. Other Costs? (Please list)	$ 4,000
1. Modify storage of projects	
2. Modify accessibility of tools	

a. Extra Staffing	$ 1,000
b. Equipment	$ 6,600
c. Materials & Supplies	$ -0-
d. Space/Facilities	$ 7 50
e. Staff Training	$ -0-
f. Other Costs? (Please list)	$ 5,800—used for grant match

a. Extra Staffing	$ -0-
b. Equipment	$ 5,028
c. Materials & Supplies	$11,577
d. Space/Facilities	$ -0-
e. Staff Training	$10,782
f. Other Costs? (Please list)	$ -0-
g. Textbooks & Copyrighted	$ 2,314
h. Contracted Services	$ 1,739
i. Travel	$ 2,223

a. Extra Staffing	$ 16,000
b. Equipment	$ 8,695
c. Materials & Supplies	$15,786.14
d. Space/Facilities	$ 3,000
e. Staff Training	$ 8,000
f. Other Costs? (Please list)	$ -0-

All in-kind costs in addition to the grant for staffing/supplies, and materials.

END

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