THE SMARTE ENRICHMENT PROGRAMS: PERCEPTIONS OF MIDDLE SCHOOL STUDENTS ABOUT SCIENCE AND TECHNOLOGY

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SUMMARY

The Southeast Michigan Alliance for Reinvestment in Technological Education (SMARTE) is a consortium of community colleges, school systems, Wayne State University, and businesses in southeast Michigan formed in September 1993. The alliance exists to promote communication and cooperation among its partners to address needs pertaining to the education of technological workforce. One of the goals of this virtual center is to collaboratively focus on promoting the technical career as viable and exciting endeavor among general population and in particular the middle school students and their parents.

During the period 1995-97, the consortium carried out several enrichment activities. During the summer, 2-week sessions were held for students promoted to 8th grade. During the Fall and Winter semesters, two consecutive weekend sessions were held for students enrolled in the 8th grade. Students were selected based on recommendations from the science teacher, counselor, or principal and the quality of the student essay. Parents and students attended information sessions and award ceremonies. At the 1997 ASEE Annual Conference, we reported on the structure of the enrichment program, course contents, teaching pedagogy, and student evaluation of the curriculum. As a part of the enrichment program, we requested the 8th grade boys and girls to share their perceptions of their abilities in science and technology, possible career choices in sciences, engineering, and technology, and the support received in from parents to study in these areas. This paper summarizes results of 70 students' responses and provides some insight about adolescents on engineering and technical education.

INTRODUCTION

The engineering professional community has begun to realize that there is a direct link between economic growth in the United States and the skills and abilities of the people who contribute to that growth. The under-represented groups, including women, are depicted to comprise about 70% of the new entrants into the labor force by the year 2000. Further more, non-White racial/ethnic groups will constitute an increasing percentage of the total US population. Demographic realities dictate an urgent need for intervention to assist and promote the representation of all people and especially under represented ethnic and racial groups and women in technical workforce.

America faces a shortfall of scientists and engineers in a near future. It has been mentioned in several forums that the average age of technical workforce in Michigan is in its fifties. This represents a challenge for businesses and educational institutions to prepare a spectrum of technical workers for continued industrial productivity.

The Southeast Michigan Alliance for Reinvestment in Technological Education (SMARTE) is a consortium of community colleges, school systems, WSU, and businesses in southeast Michigan formed in September 1993. The alliance exists to promote communication and cooperation among its partners to address needs pertaining to education of the technological workforce. The mission is to work collaboratively in a virtual center that focuses on restructuring of technical curricula and teaching practices in mathematics and science with integration of authentic activities in an application mode [1,2,3,4,5,6,7].

ENRICHMENT PROGRAMS

During the years 1995-97, six enrichment programs for middle school students were organized by the consortium. Rathod and Gipson presented the curriculum components, teaching pedagogy, recruitment of students, interactions with parents, impressions of students, and other lessons learned to address the pipeline issue of the technical workforce [8].

The engineering professional community has begun to recognize the importance of reaching out to K-12 with interesting ways to invite students in the field. Some examples of such activities are the following: Middle school programs include introducing engineering to the Girl Scouts at 6th, 7th, and 8th grades organized at Miami University [10], and introducing middle school students to Civil Engineering Technology in a summer camp at Western Kentucky University [18]. High school programs exclusively for girls include a summer internship program in science and engineering at Iowa State University [9], and a summer curriculum for students from the City of Pittsburgh Schools organized by Carnegie Mellon University [16].

A number of programs for high school students are organized under Tech Prep initiative at Purdue University - Anderson [11] and Penn State University [17]. Other examples of high school programs include topics in computers, microprocessors, mechanical design, U.S. FIRST competition [12,13,14,15]. Also, there have been attempts to involve K-12 teachers in engineering practice [19]. These programs provide important avenues for technical educators to promote our profession.

The SMARTE Enrichment Program was developed and currently being taught jointly by a team of faculty and educators from WSU, Oakland Community College (OCC), Schoolcraft College, and Detroit Public Schools. The primary focus of the project is to increase student interest in technical disciplines. The curriculum is designed for 8th grade students to explore applications in engineering and technology. A total of 144 students participated in six sessions organized at Auburn Hills Campus of OCC, Schoolcraft College, and WSU. The Summer program is daily for two weeks. During the academic year, the program is organized over two consecutive Saturdays. The summer program is limited to students who have completed 7th grade. The academic year program is designed for 8th grade students. The curriculum includes four 90 minute long lab-based sessions on computer programming, electrical/electronics, CAD/CAM, and manufacturing.

STUDENT PERCEPTIONS

At the conclusion of the 1996-97 academic year and the 1997 summer program, each student completed an assessment of the curriculum for the program [8]. Seventy students completed a self perception instrument consisting of 37 items. The first part of the instrument consisted of eight items that were used to obtain demographic and general school information. These items included: age of students, gender, ethnic background, gender of mathematics and science teachers, father's and mother's occupation and place of employment. The second part of the instrument consisted of 27 items designed to obtain data in the following categories: personal perceptions about mathematics, science engineering, beliefs about parents' and teacher's attitudes about their involvement in mathematics, science and engineering.

The majority of students were 13 years of age with boys (75%) and girls (70%). The largest ethnic group for the students was African American with boys (60%) and girls (48%). The majority of boys (56%) and girls (50%) had female science teachers. Seventy-three percent of the girls had male mathematics teachers. The occupation of the father was known by more girls (65%) in contrast to less knowledge of the location of the employment of the father (45%). More than 75% of the boys and girls knew the occupation and location of the mother's employment.

From Table 2, it is observed that 67% more boys strongly disagree that math is a hard subject while 30% of the girls strongly disagree that science is a difficult subject. Seventy-nine percent of the girls strongly disagree that girls were better at math problems than boys in contrast to 55% of the boys who strongly disagree. Almost three times more boys than girls strongly agree about being excited about becoming scientist/ engineer.

Almost three times more boys than girls strongly agree about being excited about becoming a scientist/engineer. This is where engineering professionals have a challenge. More than 80% of boys and girls respond that their parents believe they can become engineers. At the same time 69% of girls and 44% of boys respond that their parents believe they can become scientists. A large majority of the students responded that going to college is important to them and they could become doctors, mathematicians, engineers, astronauts, or physicists.

More boys (30%) than girls (4%) strongly agreed with the statement, "I get really uptight when I take math tests." Seventy eight percent of the girls and 33% of the boys strongly disagree with the statement, "I have to work harder in math classes for A's than the other gender." About 77% of the boys and 30% of the girls indicated they felt good about science/engineering and the same holds true about being able to create new designs. About 26% more girls than boys believe that being an engineer is a job for both the genders and 25% of the boys believe it to be for boys as compared to only 5% girls. Is this perception being carried on to the adult life?

CONCLUSIONS/RECOMMENDATIONS

In the era of declining enrollments and a growing need for technically trained personnel, the engineering and technology faculty should assume the responsibility of spreading the message that technical education provides viable and interesting career opportunities. A major challenge today is that a need to reach out to boys and girls at middle school levels to promote these types of professions. Eighth grade students believe that they can become astronauts, physicists, doctors, mathematicians, or engineers reaffirming the thesis and beliefs that introducing challenging careers at middle school level can interest students to learn.

In conclusion, the middle schools should teach professional engineering subjects that are lab-based, and reaching students at early experience can allow the U.S. to maintain its technological edge as a society. The faculty should continue to work with middle school teachers to address and explore techniques for models to be used in school systems.

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Table 1. Student Personal Information

		Boys N	Boys %	Girls N	Girls %
1. Student age	12 years	4	20%	5	10%
	13 years	17	75%	29	60%
	14 years	1	5%	13	27%
	15 years	0	0%	1	2%
	Total	22	100%	48	100%
	Mean age, years	13		13	
2. Racial/Ethnic background					
	Black/African American	13	60%	23	48%
	White	9	40%	22	46%
	Asian	0	0%	3	6%
	Total	22	100%	48	100%
3. My science teacher last year was a:					
	Male	10	44%	24	50%
	Female	12	56%	24	50%
	Total	22	100%	48	10%
4. My math teacher last year was a:					
	Male	10	44%	35	73%
	Female	12	56%	13	27%
	Total	22	100%	48	100%
5. Father’s job (what he does), students who knew		12	55%	31	65%

6. Location where he works, students who knew	17	77%	21	45%
7. Mother's job (what she does) students who knew	17	77%	41	86%
8. Location where she works, students who knew	17	77%	40	83%

Table 2. Student Perception Information

		Strongly Disagree 1		2		3		4		Strongly Agree 5	
		N	%	N	%	N	%	N	%	N	%
9. Math is a hard subject	Boys	15	67	2	11	5	22	0	0.0	0	0.0
	Girls	21	43	10	22	17	35	0	0.0	0	0.0
10. I can do anything as long as I am willing to work hard	Boys	0	0.0	0	0.0	0	0.0	2	11	20	89
	Girls	0	0.0	0	0.0	6	9.0	7	14	35	73
11. Science classes are difficult	Boys	5	22	5	22	8	34	2	11	2	11
	Girls	14	30	19	39	8	17	7	13	0	0.0
13. Girls are better at math problems than boys	Boys	12	55	0	0.0	10	45	0	0.0	0	0.0
	Girls	38	79	2	4	4	9	0	0.0	4	9
14. I am excited about becoming a scientist/engineer	Boys	0	0.0	0	0.0	7	33	3	12	12	55
	Girls	7	9	2	4	12	26	17	35	10	20
15. I get really uptight when I take math tests	Boys	9	40	4	20	2	10	0	0.0	0	0.0
	Girls	19	39	11	22	14	30	2	4	2	4
16. I will make A's in my science classes this fall	Boys	0	0.0	0	0.0	5	23	5	22	12	55
	Girls	0	0.0	3	5	8	17	8	17	29	60
17. I have to work harder in math classes for A's than girls/boys do	Boys	8	33	2	11	5	22	2	11	5	25
	Girls	37	78	2	4	0	0.0	0	0.0	9	18
18. My parents believe I can become a scientist	Boys	2	11	0	0.0	11	44	1	11	33	7
	Girls	2	4	2	4	11	22	8	17	25	53
19. My parents believe I can become an engineer	Boys	0	0.0	0	0.0	5	11	7	33	12	56
	Girls	0	0.0	2	4	6	13	11	22	29	61

20. Going to college is important to me	Boys Girls	0 0.0 0 0.0 0 0.0 0 0.0 22 100 0 0.0 0 0.0 0 0.0 2 4 46 96
21. I tend to avoid math	Boys Girls	16 78 3 11 0 0.0 3 11 0 0.0 36 74 8 17 2 4 0 0.0 2 4
22. I believe I can be a Doctor, Mathematician, Engineer, Astronaut, or Physicist if I want	Boys Girls	0 0.0 0 0.0 0 0.0 0 0.0 22 100 0 0.0 0 0.0 0 0.0 2 4 46 96
23. Sometimes I doubt whether I will become a scientist or an engineer	Boys Girls	10 44 2 12 10 44 0 0.0 0 0.0 15 31 12 26 10 22 9 18 2 4
24. My mother could have been a scientist or an engineer if she wanted	Boys Girls	5 22 0 0.0 3 12 0 0.0 14 66 4 9 2 4 11 22 12 26 19 39
25. Scientist/Engineers are smarter than I am	Boys Girls	7 33 0 0.0 10 44 0 0.0 5 23 6 13 8 17 8 17 6 13 20 39
26. I feel good about math	Boys Girls	0 0.0 2 11 0 0.0 5 22 15 67 2 4 0 0.0 2 4 14 30 30 61
27. Sometimes I worry about what others will say, if I become a scientist/engineer	Boys Girls	15 67 5 22 0 0.0 5 22 15 67 35 74 11 22 2 4 0 0.0 0 0.0
28. When I grow up, I can become a scientist/engineer	Boys Girls	0 0.0 0 0.0 7 33 0 0.0 15 67 0 0.0 3 4 6 13 8 17 31 65
29. I feel that I can help other 8th graders with their math homework	Boys Girls	0 0.0 0 0.0 3 12 3 12 16 77 0 0.0 2 5 4 9 8 17 34 70
30. I feel that I can help other 8th graders with their science homework	Boys Girls	0 0.0 0 0.0 2 12 44 10 10 44 0 0.0 0 0.0 13 26 8 17 27 57
31. If I were a girl/boy, I would have a greater chance of becoming a scientist/engineer	Boys Girls	15 70 0 0.0 4 20 3 10 0 0.0 34 70 6 13 2 4 2 4 4 9
32. I feel good about science/engineering	Boys Girls	0 0.0 0 0.0 0 0.0 5 23 17 77 0 0.0 0 0.0 17 35 17 35 14 30
33. I am able to create new designs	Boys Girls	0 0.0 0 0.0 0 0.0 2 11 20 18 3 7 0 0.0 12 25 15 31 18 38

34. I am able to work puzzles	Boys Girls	0 89 0 52	0.0 0.0	0 0	0.0 0.0	0 11	0.0 22	2 12	11 26	20 15
35. I like playing computer games	Boys Girls	0 100 0 52	0.0 0.0	0 0	0.0 0.0	0 11	0.0 22	0 12	0.0 26	22 15
36. My math teacher thought I was a good math student	Boys Girls	0 100 0 52	0.0 0.0	0 0	0.0 0.0	0 11	0.0 22	0 12	0.0 26	22 15
37. My science teacher thought I was a good science student	Boys Girls	0 89 2 65	0.0 4	0 0	0.0 0.0	0 4	0.0 9	2 11	11 22	20 31
		Strongly Disagree 1 N %	% 	N 2	% 	N 3	% 	N 4	% 	Strongly Agree 5 N %

BIOGRAPHY OF AUTHORS

Mulchand S. Rathod: Mulchand S. Rathod Ph.D., P.E., joined WSU as Director and Professor of Division of Engineering Technology in 1987. He earned B.E.(Mechanical) degree from Sardar Patel University in 1970; and M.S. in 972, Ph.D. in 1975, both in Mechanical Engineering from Mississippi State University. At WSU, he has been instrumental in starting three new under graduate and an MSET degree program. He established student chapters of SME and Tau Alpha Pi and is the founding leader of the Professional Order of Engineering Technology.

His prior appointments include State University of New York at Binghamton, Tuskegee University, Jet Propulsion Laboratory, and IBM. A registered Professional Engineer, he is active in ASME, SME, ASHRAE, and ASEE. He served as a Commissioner on the TAC of ABET during 1989-95 period. A holder of numerous publications and inventions, he is listed in several Who's Who publications. He was awarded the 1995 Dedicated Service Award by ASME and is a recipient of Certificates of Recognition from NASA and IBM for technical innovation. Also, a recipient of numerous grants and contracts and recently elected Fellow of ASME, Dr. Rathod is a nationally known leader in Engineering Technology community.

Joella Gipson: Joella Gipson, Ph.D., is a professor in the College of Education at Wayne State University since 1972. Her special academic areas include mathematics education, curriculum and instruction and computers. She serves as a Co-Director of Students' Opportunities in the Sciences, a program for 7th grade girls in mathematics, computers, physics and astronomy funded by the National Science Foundation. She is a member of the SMARTE Project for parents and 8th grade students in computers and engineering principles.

Dr. Gipson served as an administrator, mathematics department chairperson and teacher in the Los Angeles Unified School District during the period 1960-69. She received a baccalaureate degree from Mount Saint Mary's College, a master's degree from the State University of Iowa, and a doctorate degree from the University of Illinois. A Fullbright Scholar, Dr. Gipson is a member of several professional organizations for mathematics teachers.