Students' Beliefs about Science and Sources of Influence Affecting Science Career Choice

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Abstract

This study was designed to describe rural middle school students' beliefs about science and sources of influence affecting science career choice. The population for the study was all students (N = 402) who participated in the Partnership for Environmental Educational and Rural Health (PEER) scientist visits program. A 98% response rate was achieved. Data were collected by visiting scientists using a paper instrument. PEER is a collaboration between the Texas Rural Systemic Initiative; Center for Environmental and Rural Health; and Texas A&M University's Department of Agricultural Education, College of Veterinary Medicine, and College of Education. The purpose of PEER is to develop math and science rich and integrated curricular materials for dissemination across a middle school's curriculum. Results show students' beliefs about science were positive. Parents or guardians, teachers, and other family members were the information sources most positively affecting students' science career choice. Positive relationships between parents/guardians, teachers, other family members, school guidance counselors, and church leaders and beliefs about science were found. The results of this study are being used by PEER to refine and enhance the program and to guide the development of additional research projects focused on the effects of inquiry-based methods and integrated curricular materials on student achievement.

Introduction

Young middle school adolescents are undergoing rapid physical growth, moving from concrete to abstract thinking, forming self-concepts, , and developing social skills (Kerka, 1994). At the same time, "most individuals significantly fashion their attitudes about learning, work, and other enduring adult values during early adolescence" (Toepfer, 1994, p. 16). Middle schools play a key role in helping students develop their attitudes about future career choices. If middle school teachers promoted science-related programs, then one could expect that students would develop a positive attitude toward these careers.

Factors Influencing Students' Beliefs about Science Careers

Research shows many factors influence students' beliefs about science careers. Although research findings point to only one consistent gender-based difference in mental abilities: spatial abilities (Jacklin, 1989), many youth have stereotyped and limited views of science-related careers (McDonald and Jessell, 1992). Recent studies (AAUW, 1999) revealed that young women were significantly less likely to spend time using computers for academic purposes. Cannon and Lupart (2001) found that working on challenging projects was important for males and females to learn new skills. Both females and males felt that important characteristics for future career choices were earning a great deal of money and having high status in society. Jensen and McMullen (1994) explored relationships between grade level and science interests and found that students' interest in careers involving science developed between fifth and sixth grade. Further, the authors found a significant relationship between gender and science career interest.

For some students, especially Hispanic females, perceived gender roles affect career choice. When Hispanic females do not perceive the likelihood of doing well in school and possibly entering college, they more often quits school to start a family (Romo, 1998). Marriage and/or pregnancy are the most frequent factors affecting Hispanic female dropout rates. Blacks, Hispanics, and women are underrepresented in colleges at all levels and are even more underrepresented in science majors (Fouad, 1995). Fouad and Romo both found that minority students are underrepresented because of: 1) poor academic preparation and lack of career planning, 2) social-psychological factors such as poor or no role models, and 3) perceptions of careers in science.

Family plays an irreplaceable role in an adolescent's formulation of attitudes about life and their future careers. Parental influence, depending upon social status, establishes context in which certain occupational choices are encouraged and others discouraged (Kohn, 1977). Adolescents from intact, middle-class families are more likely to have jobs

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during high school, and have earlier and greater exposure to the world of work (Schill et al., 1985). Additional studies show that parents and siblings often serve as models for adolescent work and occupational choices (Barber and Eccles, 1992). Daughters who have mothers happily working outside the home are more likely to seek careers in addition to marriage and family (Leslie, 1986). Both sons and daughters are less likely to have gender-stereotyped attitudes about work if they come from dual-career homes (Barber and Eccles, 1992).

Another important influence on students' career choices are extracurricular activities. Students' free activities can influence their interests about science and their perspectives about career choice. For example, science clubs, links with local industries, invitations of speakers, and scientists' school visits encourage students to enter science careers (DeAlmeida et al., 1998). Social groups or crowds in middle school and high school represent distinctive peer cultures. Adolescents select and are selected by social crowds. Peer social crowds can be organized on a continuum from involvement with, to alienation from, adult institutions, and involvement with peer culture (Brown, 1990).

Mass media is the primary source of scientific information for most Americans. Studies of primary sources of information about the nursing profession found almost one-third of the nurses stated television as the information source for nursing careers, while only 3% cited information presented to them in school (Law and Arthur, 2003).

Partnership for Environmental Education and Rural Health

The Partnership for Environmental Education and Rural Health (PEER) was established using a Web-based integrated curriculum to increase knowledge, interest, and awareness among middle school students in the areas of environmental science and health. The main objectives of PEER are to: 1) increase the number of public school students who enter and remain in science tracks; and 2) to integrate environmental health science topics into science, math, English, language arts, and social studies curricula. The objectives were achieved by three activities: Web-based curricula modules, professional teaching development programs, and scientists' visits to rural middle schools.

Curricular modules constitute six multimedia learning units and six integrated curriculum modules specifically addressing environmental and health science education needs for rural middle school students. The professional development programs introduced and trained teachers on various ways to implement the PEER program curriculum and the associated instructional technology. Scientists' visits were conducted in-person or via telecommunications systems.

Students experience many physical, emotional, and intellectual changes during their middle school years. This is also a time when some students begin to seriously consider their future careers. Parents, siblings, peers, teachers, and the school play a significant role in helping students chose a career path. If emphasis is placed on the importance of science throughout the middle school years, students may be influenced to choose science-related careers. Although many agricultural educators stress the application of science in their secondary school curricula, students are often not taught the importance of science during middle school. To better influence students to choose science-related careers, information about what do middle school students believe about science and who has the greatest influence on middle school students' science career choices is needed.

Purpose

The purpose of this study was to describe Texas rural middle school students' perceptions about science and sources of influence affecting science career choice. Specific objectives included:

1. Describe students' perceptions about scientists' presentations.
2. Describe students' beliefs about science.
3. Describe information sources affecting students' science career choices.
4. Explore the relationship between students' beliefs about science and information sources affecting science career choices.

Methods

The research design used for this study was descriptive in nature. The population for this study was middle school students from El Paso, Harlingen, and Edcouch, Texas. The target population included all students of teachers who have participated in the PEER scientist visits program. The accessible population included 402 students who attended the in-school scientist visit. Of these 402 students, 395 completed the instrument for a response rate of 98%. Nonresponse error was not a threat to the generalizability of research findings to the target population (Lindner et al., 2001).

A questionnaire was designed by the researchers to address the objectives of the study. The questionnaire was divided into three parts. The first part was designed to measure the participant's perceptions about the effectiveness of scientist visits presentation (six questions). The participants were asked to indicate their reactions to the presentations using a four-point Likert-type scale. The points on the scale were: 1 = strongly disagree, 2 = somewhat disagree, 3 = somewhat agree, and 4 = strongly agree. The second part was designed to describe participants' beliefs about science (eleven questions—four were reverse coded). The participants were asked to indicate their attitudes towards math and science using a similar four-point Likert-type scale. A "belief about science" score was calculated by averaging

participants' responses to the second part. The third part was designed to describe information sources affecting students' scienc career choices. The participants were asked to indicate their response by using a four-point Likert-type scale. The points on the scale were: 1 = not influential, 2 = somewhat influential, 3 = influential and 4 = very influential. Data were collected by the visiting scientist using a paper instrument.

A panel of eight experts at Texas A&M University established instrument validity. Two of the instrument scales, beliefs about science and information sources, were originally developed one of the researchers and validated by 24 Mississippi agriculture science and biology teachers in the National Science Foundation project, Mississippi's Information Technology Workforce. A year before the PEER program was launched, the instrument was pilot tested with 30 middle school students not included in the target population. Instrument reliability was estimated by calculating a Cronbach's alpha coefficient (Cronbach, 1951). Reliability for the scales were: Perceptions about scientists' presentations (0.77); Beliefs about science score (0.67); and Information sources (0.82). The alpha level for statistical significance was set a priori at .05. Effect sizes were calculated, interpreted, and reported according to Cohen's (1988) convention for analysis of variance: small effect size f=0.10; medium effect size, f=0.2; and large effect size, f=0.40. Cohen noted that small effect sizes are not readily observable, medium effect sizes are readily observable, and large effect sizes are evident.

Findings

The first objective of the study was to describe middle school students' perceptions about the scientists' presentations. Students were asked to indicate their level of agreement on six items (see Table 1). Overall, students tended to agree that the PEER scientist presentations were effective. Students tended to strongly agree with the statement "I plan to share what I have learned with others" (M = 3.59, SD = 0.66). Students tended to somewhat agree with the following statements: "I would recommend this presentation to other students" (M = 3.44, SD = 0.78); "the presentation changed my thinking about environmental health science" (M = 3.21, SD = 0.75); "my understanding of science was improved" (M = 3.18, SD = 0.85); "the presentation was easy to follow" (M = 3.15, SD = 0.80); and "the presentation contained useful information" (M = 3.09, SD = 0.92).

The second objective of the study was to describe students' perceptions on beliefs about science. Students were asked to indicate their level of agreement on 11 statements (see Table 2). Overall, students had a variety of beliefs about science. Students tended to strongly agree with the statement "science careers are not just for males" (M = 3.65, SD = 0.79). Students tended to somewhat agree with the following statements: "A career in science would not be boring" (M = 3.16, SD = 1.00); "ethnic minorities can have successful science careers" (M = 3.12, SD = 0.86); "science careers are exciting" (M = 2.98, SD = 0.95); "a science career does not mean you have to work in a lab" (M = 2.9, SD = 0.98); "females should seek careers in science-related areas" (M = 2.9, SD = 0.93); "a career in science means not having to work in a laboratory" (M = 2.68, SD = 0.99); "science careers are not for people with really good math skills" (M = 2.67, SD = 1.01); and "it is possible that I could become a scientist" (M = 2.53, SD = 1.00). Students tended to somewhat disagree with the following statements: "Science is more enjoyable than all other subjects in middle school" (M = 2.31, SD = 1.00); and "the U.S. population does not know enough about science" (M = 2.31, SD = 0.98). A mean summated belief about science score was computed by averaging individual student responses about their responses to beliefs about science. The mean summated belief about science score was 2.84 (SD = 0.4).

Table 2. Middle School Students' Perceptions of Beliefs about Science (N = 402)

Statements	N	M[zy]	SD
Science careers are not just for males.	387	3.65	0.79
A career in science would not be boring.	387	3.16	1.00
Ethnic minorities can have successful science careers.	387	3.12	0.86
Science careers are exciting.	387	2.98	0.95
A science career does not mean you have to work in a lab.	387	2.90	0.98
Females should seek careers in science-related areas.	387	2.90	0.93
A career in science means not having to work in a laboratory.	387	2.68	0.99
Science careers are not for people with really good math skills.	387	2.67	1.01
It is possible that I could become a scientist.	387	2.53	1.00
Science is more enjoyable that all other subjects in middle school.	387	2.31	1.00
The U.S. population does not know enough about science.	387	2.31	0.98

Note. [z]1 = Strongly Disagree, 2 = Somewhat Disagree, 3 = Somewhat Agree, 4 = Strongly Agree; [y]Mean Summated Belief about Science Score = 2.84, SD = 0.4

Table 1. Middle School Students' Perception about Scientist Presentations (N = 402)

Statements	N	M[z]	SD
I plan to share what I have learned with others.	393	3.59	0.66
I would recommend this presentation to other students.	394	3.44	0.78
The presentation changed my thinking about environmental health science.	391	3.21	0.75
My understanding of science was improved.	392	3.18	0.85
The presentation was easy to follow.	395	3.15	0.80
The presentation contained useful information.	395	3.09	0.92

Note. [z]1 = Strongly Disagree, 2 = Somewhat Disagree, 3 = Somewhat Agree, 4 = Strongly Agree

The third objective of this study was to describe students' information sources affecting science career choices. Parents or guardians (M = 3.20, SD = 0.93), teachers (M = 3.02, SD = 1.02), and other family members (M = 2.92, SD = 0.92) tended to be the information sources that most affected a student's science career choice. Also influencing students' science career choices, but to a lesser degree, were celebrities (M = 2.59, SD = 1.18), school guidance counselors (M = 2.54, SD = 1.15), and friends (M =

2.52, SD = 0.99). The following information sources influenced students' science career choices the least: government leaders (M = 2.33, SD = 1.13); church leaders (M = 2.27, SD = 1.08); and fellow classmates (M = 2.25, SD = 0.97).

Table 3. Information Sources Affecting Middle School Students' Science Career Choice (N=402)

Information Sources	N	M[z]	SD
Parents or guardians	387	3.20	0.93
Teachers	384	3.02	1.02
Other family members	383	2.92	0.92
Celebrities (TV, movie, sports, etc.)	377	2.59	1.18
School guidance counselor	383	2.54	1.15
Friends	385	2.52	0.99
Government leaders	383	2.33	1.13
Church leaders	386	2.27	1.08
Fellow classmates	385	2.25	0.97

Note. [z]1 = Not Influential, 2 = Somewhat Influential, 3 = Influential, 4 = Very Influential

The fourth objective of the study was to explore the relationship between students' beliefs about science and information sources affecting science career choices. When subjected to an F-test (ANOVA), Table 4 shows a statistically significant difference between mean beliefs about science scores and the level of parent or guardian influence F(3, 382) = 3.53. A small effect size (f = .16) was found. Students that indicated their parents or guardians were somewhat influential (M = 2.84, SD = .38), influential (M = 2.81, SD = .36), or very influential (M = 2.88, SD = .41) had higher beliefs about sciences scores than those students who indicated their parents or guardians were not influential (M = 2.60, SD = .51).

Table 4. Parents or Guardians' Influence on Middle School Students by Beliefs about Science Score (N=402)

Parents or guardians	n	M[zy]	SD	F	p
Not Influential	23	2.60	.51	3.53	.02*
Somewhat Influential	67	2.84	.38		
Influential	106	2.81	.36		
Very Influential	190	2.88	.41		

Note: [z]1=Strongly Disagree, 2=Somewhat Disagree, 3=Somewhat Agree, 4=Strongly Agree; [y]Mean Summated Belief about Science Score =2.84; *p<.05; small effect size, f=.16

As shown in Table 5, a statistically significant difference between mean beliefs about science scores and the level of teacher influence F(3, 380) = 11.0. A medium effect size (f=.28) was found. Students that indicated their teachers were influential (M = 2.84, SD = .38), or very influential (M = 2.95, SD = .39) had higher beliefs about sciences scores than those students who indicated their parents or guardians were somewhat influential (M = 2.68, SD = .35), not influential (M = 2.65, SD = .42).

Table 6 shows a statistically significant difference was found between mean beliefs about science scores and the level of other family member influence F(3, 379) = 5.28. A medium effect size (f=.20) was found. Students that indicated other family members were somewhat influential (M = 2.80, SD = .33), influential (M = 2.86, SD = .38), or very influential (M = 2.90, SD = .44) had higher beliefs about sciences scores than those students who indicated that other family members were not influential (M = 2.58, SD = .44).

Table 5. Teachers Influence on Middle School Students by Beliefs about Science Score (N=402)

Teachers	n	M[zy]	SD	F	p
Not Influential	42	2.65	.42	11.0	.00
Somewhat Influential	67	2.69	.35		
Influential	115	2.84	.38		
Very Influential	160	2.95	.39		

Note: [z]1=Strongly Disagree, 2=Somewhat Disagree, 3=Somewhat Agree, 4=Strongly Agree; [y]Mean Summated Belief about Science Score =2.84; *p<.05; medium effect size, f=.28

As shown in Table 7, a statistically significant difference was found between mean beliefs about science scores and the level of school guidance counselor influence F(3, 379) = 3.65. A small effect size (f=.17) was found. Students that indicated school guidance counselors were or very influential (M = 2.90, SD = .44) had higher beliefs about sciences scores than those students who indicated that school guidance counselors were somewhat influential (M = 2.75, SD = .39), or not influential (M = 2.79, SD = .41).

Table 8 shows a statistically significant difference between mean beliefs about science scores and church leaders influence F(3, 382) = 3.65. A small effect size (f=.17) was found. Students that indicated church leaders were or very influential (M = 2.95, SD = .46) had higher beliefs about sciences scores than those students who indicated that church leaders were somewhat influential (M = 2.80, SD = .37), or not influential (M = 2.77, SD = .42).

Level of influence on science career choices by celebrities F(3, 379) = .68, friends F(3, 381) = .73, government leaders F(3, 379) = .78, and fellow classmates F(3, 381) = .21 were not significantly related to belief about science scores.

Conclusions, Implications, and Recommendations

As middle schools strive to improve student performance in science and increase interest in science-related careers, programs like PEER may help. Because the discipline of Agricultural Education has its philosophical roots in both the fields of education and agricultural sciences, it can have a central role in helping universities develop, deliver, and evaluate the effectiveness of integrated curriculums.

The results of this survey show that the students responded positively to the PEER Program's scientists' visits presentations. The students strongly agreed that they plan to share what they learned with others and to recommend the presentation to other students. The findings show that the students positively believed the presentations were easy to follow and contained useful information. An implication exists that programs such as the

Table 6. Other Family Members Influence on Middle School Students by Beliefs about Science Score (N=402)

Other Family Members	n	M[zy]	SD	F	p
Not Influential	28	2.58	.44	5.28	.00
Somewhat Influential	94	2.80	.33		
Influential	143	2.86	.38		
Very Influential	118	2.90	.44		

Note: [z]1=Strongly Disagree, 2=Somewhat Disagree, 3=Somewhat Agree, 4=Strongly Agree; [y]Mean Summated Belief about Science Score =2.84; *p<.05; medium effect size, f=.20

PEER scientists' visits can have a positive impact on both students' beliefs about science and interest in science related careers. This finding is consistent with those of Romo (1998), Fouad (1995), and Ogbu (1978) who found that programs on career-choice had positive effects on both student performance and interest in math and science. Additional research should be conducted to describe the academic impact of the PEER program on middle-school students.

Table 7. School Guidance Counselor Influence on Middle School Students by Beliefs about Science Score (N=402)

School Guidance Counselor	n	M[zy]	SD	F	p
Not Influential	98	2.79	.41	3.65	.01
Somewhat Influential	86	2.75	.39		
Influential	92	2.87	.36		
Very Influential	107	2.92	.41		

Note: [z]1=Strongly Disagree, 2=Somewhat Disagree, 3=Somewhat Agree, 4=Strongly Agree; [y]Mean Summated Belief about Science Score =2.84; *p<.05; Small effect size, f=.17

Students, overall, had positive beliefs about science. This finding is tempered, however, by the findings that student had doubts about their own competence to become a scientist and the perception that science courses were not enjoyable. An implication exists that middle school students, who are impressionable and beginning to fashion lifelong opinions about career choices (Toepfer, 1994), need increased positive and enjoyable academic and personal experiences with science in order to increase their opinions about the excitement levels in science related careers and their own possibilities of pursuing a science related career. Parents, teachers, and family members need to work together to develop more positive and enjoyable academic and personal experiences for middle school students.

Table 8. Church Leaders Influence on Middle School Students by Beliefs about Science Score (N=402)

Church Leaders	n	M[zy]	SD	F	p
Not Influential	120	2.77	.42	3.76	.01
Somewhat Influential	109	2.80	.34		
Influential	89	2.88	.37		
Very Influential	68	2.95	.46		

Note: [z]1=Strongly Disagree, 2=Somewhat Disagree, 3=Somewhat Agree, 4=Strongly Agree; [y]Mean Summated Belief about Science Score =2.84; *p<.05; Small effect size, f=.17

Many factors influence a student's ideals on math and science and their future career choice. These factors can be placed into four categories: individual differences (Fouad, 1995; McDonald and Jessell, 1992; Loehlin, 1992), family factors (Ferry et al., 2000; Kohn, 1977), school influences (DeAlmeida et al., 1998; Ogbu, 1978), and social environments (Law and Arthur, 2003). The findings show that parents or guardians, teachers, and other family members are the three most influential information sources affecting students' science career choices. Government leaders, church leaders, and fellow classmates were the least influential information sources affecting students' science career choices. An implication exists that while students have multiple influences affecting their career choices, a student's parents, teachers, and family members play a central role in shaping student's choices. Similar findings were reported by Ferry et al (2000), Wilson and Wilson (1992), and Grotevant et al (1988). Recognition of the level of influence parents, teachers, and family members have on students is a powerful concept. Continued and additional outreach efforts should be made with these groups to enhance their capabilities in guiding students' career exploration.

The findings show parents' or guardians', teachers', other family members', school guidance counselors', and church leaders' levels of influence as an information source about science career choices were related to students' beliefs about science. While parents or guardians, teachers, other family members were shown to have high levels of influence; school guidance counselors, and church leaders were not.

The results of this study are being used by PEER to refine and enhance the program and guide the development of additional research projects focused on the effects of inquiry-based teaching methods and integrated curricular material on student achievement. In order to develop more positive and enjoyable academic and personal experiences additional research is needed on relationships between gender, race, personality, socio economic status, extracurricular activities, technology, and mass media by factors influencing science career choices and beliefs about science. By maximizing parents, teachers, and family members participation in middle school students' academic and personal experiences with science and letting students know they can have successful careers in science, students may be more willing to explore and consider academic and career path associated with science.

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