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Culturally Important Issues and Science: A Gender and Science-Interest Investigation

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Abstract

Elementary science methods students nearing completion of their preservice teacher preparation are an important source for gauging views about science and its relation to culture. This research investigates gender and science interest as correlates of the valuation of science vis-à-vis nine culturally important categories as measured by the Thinking About Science Survey. Over one thousand male and female students at a large midwestern university took part in this study. One gender effect and an interest effect were found. Significantly more males expressed a high degree of interest in science, and males were more supportive of the assertion that race and gender are irrelevant in science. Interest in science, however, showed the more pronounced effect. Interest in science for both male and females was directly related to how science was valued with respect to six of the nine culturally important categories. Results suggest science interest might be improved by more contextual teaching approaches that seek to develop the valuation of science within a cultural context

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INTRODUCTION

For twenty years or more educators and the public have had a strong interest in making sure that there is gender equity in science education. Much has been accomplished during that time. The research reported in this article is a continuation of a project that examines the thoughts people have about science with respect to other important ideas in modern American society. Specifically, the research investigated gender as a factor in science-interest and the valuation of science vis-à-vis several culturally important ideas. The research thus provides some insight on progress toward a gender equitable science education.

LITERATURE REVIEW

To celebrate 40 years of publication, in 2003 the *Journal of Research in Science Teaching* (*JRST*) published a special 40th anniversary issue. The special issue featured 13 articles beginning with Novak's *A Preliminary Statement on Research in Science Education* published in the 1963 inaugural issue of *JRST*. Bill Holliday, who edited the special issue, explained that articles were chosen because currently active researchers had judged these articles to have "the greatest influence among the many published during the first 40 years of the journal's publication" (2003, p. v). Two of the 13 articles deal with equity issues in science education. The Kahle and Lakes (1983) article titled *The Myth of Equality in Science Classrooms* is the oldest. The second equity article included in the special issue was originally published 12 years later. This is the Baker and Leary (1995) article titled, *Letting Girls Speak Out About Science*. The Kahle and Lakes article is by all accounts a seminal work of far reaching influence. It both raised

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awareness of gender bias in science education and precipitated a fruitful line of inquiry seeking to elucidate, understand and redress gender inequities. Much of this work was summarized in the 1994 *Handbook Of Research On Science Teaching And Learning* by Kahle and Meece (p. 542-557) and in the 1998 *International Handbook Of Science Education* by Baker (p. 869-895). For her pioneering work, the National Association for Research in Science Teaching named Jane Butler Kahle as the 2000 recipient of the NARST Distinguished Contributions through Research Award.

In 1983, Kahle and Lakes examined the results from the 1976-1977 NAEP survey of science attitudes for differences between girls and boys. They noted that by:

- "age nine, females… had consistently fewer experiences in science than boys of the same age";
- "ages 13 and 17, girls again reported fewer classroom and extracurricular science activities than boys"; and
- [the girls'] "responses indicated narrow perceptions of science and of the usefulness of scientific research", and
- "they displayed generally negative attitudes toward science classes and careers" (p. 131).

In 1992, the American Association for University (AAUW) women published *How Schools Shortchange Girls,* which brought gender equity to the forefront of educational reform. By 1995, Baker and Leary (p. S196), though still addressing gender inequities such as career choice, were able to say that the girls in their study:

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> took a strong equity position and rejected most cultural stereotypes about women… liked science and were confident in their ability to do well in science… did not appear to be avoiding science… expected to take science in high school and believed they needed science to get into college.

Six years after *How Schools Shortchange Girls*, and having reviewed "approximately 1,000 research documents published between 1990 and 1998", AAUW announced the "good news and bad news. Girls have made great strides in education and probably receive a fairer education today than in 1992" (AAUW, 1998, p. 1). And, more recently, the 2002 *Science and Engineering Indicators* (National Science Board) show further progress toward gender equity. For example:

- High school girls are as likely as boys to take advanced math and science courses, and more likely than boys to take biology and chemistry (p. 1-22)'
- The number of women receiving bachelor degrees in science rose steadily between 1977 and 1998 (p. 2-21); and
- The percentage of the scientific workforce made up by women is steadily increasing (p. 3-12).

Though much has been accomplished in the years since 1983, remaining tasks are important. For example, women remain underrepresented in several science and engineering fields (Lawler, 1999; 2003).

The research we are reporting contributes to the ongoing gender equity dialogue. by providing insight on a possible gender factor with regard to how people understand and value science vis-à-vis other culturally important ideas. One might conjecture from the literature that in

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the past men and women likely would have had very different perspectives on science due to the gender inequities of school science. With improved gender equity in science education, one might also conjecture that any gap will have narrowed. On this point, the 2002 *Science and Engineering Indicators* are somewhat ambivalent. Our research provides an additional way to examine interest in and valuation of science for a gender factor.

Instrumentation

The *Thinking about Science Instrument v1* (TSSI-v1) is used to assess valuation of science vis-à-vis culturally important ideas (Cobern & Loving, 2002 & 2005). TSSI-v1 is composed of 35 items grouped by nine categories: 1) Epistemology, 2) Science & the Economy, 3) Science & the Environment, 4) Public Regulation of Science, 5) Science & Public Health, 6) Science & Religion, 7) Science & Aesthetics, 8) Science, Race & Gender, and 9) Science for All (see Table 1). The items are assertions that either defend science or object to science with respect to important issues in modern American society. The categories are not intended to represent an authoritative scientific worldview (Cobern, 1991), but a scientific worldview version commonly found in both the popular media and the popular literatures of science and science education. We refer to this public image as the *Model*. Subjects respond to the survey items on a scale of one to five. The "1" is labeled "strongly disagree." The "3" is labeled "uncertain," and the "5" is labeled "strongly agree." Category means are calculated on the basis of item responses. Means of about "4" and "5" for the categories indicate agreement with the *Model*. Moreover, a category mean of "5" for all nine categories would be indicative of scientistic thinking. On the other hand, scores of "2" and "1" for the categories indicate disagreement with the *Model*; and a category

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mean of "1" for all nine categories would be indicative of anti-science thinking. Based on the data, profiles are developed with respect to the categories of the *Model*. Category means based on the composite of category items are calculated to form the profiles.

For a cursory indication of science interest, students are asked to respond to the following question: Based on all your experiences with school science, is science a subject you like? The poles of the 5-point response range are marked "dislike" for the number one and "like very much" for the number five. The underlying assumption is that a valid indicator of science interest ties interest to a *particular* science event or science activity rather than leaving the question open ended. In our case the particular events are the science courses of the elementary preparation program at a large mid-western university. Since these courses were specifically designed to teach scientific processes and concepts, our opinion is that for those students who have had these courses, these courses make a good referent with respect to how interesting one finds science. This cursory indicator suffices for our purposes as we are only interested in the general categories (i.e., more science interest, less science interest) into which a person might fall.

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Table 1. Thinking about Science Instrument

Category 1: Epistemology (EPIST)
Scientific knowledge is the most objective form of knowledge.
We can be certain that scientific knowledge is reliable.
The methods of science are the most reliable source of true, factual knowledge.
Science is the best source of reliable knowledge.
Scientific knowledge is the truest form of knowledge.
Alpha = 0.7475
Category 2: Scientific & the Economy (ECON)
Science helps develop our natural resources such as coal, gas, oil, and solar energy.
Scientific knowledge is useful in keeping our national economy competitive in today's world.
There are many good things we can do today because of scientific knowledge.
The development of our natural resources, such as coal, gas, oil, solar energy, is dependent upon having adequate scientific knowledge.
Scientific knowledge is useful for only a few people. (Scored in reverse)
Developing new scientific knowledge is very important for keeping our country economically competitive in today's world.
Scientific knowledge is useful.
Alpha = 0.7528
Category 3: Science & the Environment (ENVIR)
Our natural environment would actually be helped by the absence of scientific knowledge. (Scored in reverse)
Science can help us preserve our natural environment and natural resources.
Without science we will not be able to preserve our natural environment and natural resources.
Alpha = 0.4772
Category 4: Public Regulation of Science (POLY)
There is little need for the legal regulation of scientific research.
Scientists should not be allowed to research anything they wish. (Scored in reverse)
Scientific research should be carefully regulated by law. (Scored in reverse)
Alpha = 0.7757
Category 5: Science & Public Health (HEAL)
Scientific research makes important contributions to medicine and the improvement of public health.
Scientific knowledge contributes little to good health. (Scored in reverse)
Alpha = 0.5652
Category 6: Science & Religion (RELIG)
Science is a more important source of knowledge than religion.
Religious knowledge contributes more to the well being of a person's life than does science. (Scored in reverse)
Alpha = 0.5463
Category 7: Science & Aesthetics (BEAUT)
Scientific explanations tend to spoil the beauty of nature. (Scored in reverse)
Science can contribute to our appreciation and experience of beauty.
Alpha = 0.4129

Table 1. Thinking about Science Instrument (continued)

Category 8: Science, Race & Gender (RACE)
Women are welcome in science just as much as men are.
The scientific community is mostly dominated by white men and is often unfriendly to minority people. (Scored in reverse)
African Americans and other minority people are just as welcome in the scientific community as are white people.
The scientific community is mostly dominated by men and is often unfriendly to women. (Scored in reverse)
Alpha = 0.7686
Category 9: Science for All (For_All)
Students should not be forced to take science courses at the university. (Scored in reverse)
Science should not be made an important subject for the elementary school grades. (Scored in reverse)
Understanding science is a good thing for everyone.
All students should study science during the secondary school grade levels.
Most people really do not need to know very much science. (Scored in reverse)
Even at the university level all students should study at least some science.
Science should be taught at all school grade levels.
Alpha = 0.8031

Previous Findings

Our work to date primarily has been with preservice elementary teachers. Elementary teachers are not what one would usually think of as "science types." They are, however, much like the educated public with regard to science knowledge and attitudes about science. The concerns that some scientists have about anti-science sentiment in the public give rise to questions about elementary teachers (Holton, 1994; also see Scientific American, 1997). Given their position as teachers of children, anti-science sentiment among elementary teachers would be a significant concern. In contrast, our research has found that preservice elementary teachers clearly favor science education for all students. They believe that science is a positive force for public health and in the economy. They are a little more uncertain about the role science plays with respect to the environment and resource development, and about the relationship between science and aesthetic issues. The preservice elementary teachers clearly do not place science at the top of some epistemological pyramid nor do they consider science more important than religion. We found no hint that they are in any way opposed to science but rather that the elementary teachers have a judicious view of science that is an appropriate foundation for their further development as teachers of science (Cobern & Loving, 2002; also see Sulikowski et al., 2003). We thus concur with Levitt's finding that: "teachers are moving in a direction consistent with science education reform" (Levitt, 2001, p. 22). However, Cobern and Loving (2002) also found that preservice elementary teachers are skeptical about the openness of the science community to women and minorities. Picking up with this observation, the possibility of a gender factor is the subject of the current research report.

METHODOLOGY

Subjects

The subjects in the study were 1040 students in an elementary science methods course between 1997 and 2001. These preservice elementary teachers were either seniors or second semester juniors in a degree program that includes the elementary science methods course as a part of a 21-hour, mathematics/science minor at a large midwestern university. At the time of the survey, the students had each taken at least three courses in science and two in mathematics. The vast majority were between the ages of 20 and 35. A few were non-traditional older students. Less than 10% of the students were persons of color. Most of the students were women (see Table 2).

With regard to ACT scores and grades in general education, university required courses, the students compared very well with the rest of the university.

Table 2. Gender Count amongst Respondents

		Count	Percent
Valid Cases	Women	853	82.0
	Men	160	15.4
	Total	1013	97.4
Missing Cases		12	1.8
Total		1025	100.0

Method of Analysis

A 2X3 factorial design was used with the nine TSSI-v1 category means as the dependent variables, and gender and science interest as the two independent variables. The analyses tested four Null hypotheses:

1. There are no significant differences regarding science interest between women and men preservice elementary teachers.
2. There are no gender main effects vis-à-vis the categories of the *Thinking about Science Survey Instrument*.
3. There are no science-interest main effects vis-à-vis the categories of the *Thinking about Science Survey Instrument*.
4. There are no gender by science-interest interaction effects vis-à-vis the categories of the *Thinking about Science Survey Instrument*.

FINDINGS

Null Hypothesis 1: *There were no significant differences regarding science interest between women and men preservice elementary teachers.* The first null hypothesis was tested by a correlation procedure (Table 3).

Table 3. Science Interest by Gender Correlation

		Gender	Interest
Gender	Pearson Correlation	1	-.154
Interest	Pearson Correlation	-0.154	1

There were 1006 cases with both the gender and science interest data available. Though the correlation was low (-0.154) in favor of men, the Null hypothesis was rejected at $p<0.01$. To better visualize how gender breaks out by science interest, science interest responses were categorized as: Low Science Interest (1, 2), Neutral (3), or High Science Interest (4, 5). Forty-three percent of the women preservice teachers, as opposed to 64% of the men, indicated a high interest in science. About 28% of the women reported low interest in science compared to only 13% of the men (see Table 4).

Table 4. Science Interest broken out by Gender (percentages/count)

Science Interest	Gender		Total
	Women (%/#)	Men (%/#)	#
High	43.3/375	63.8/102	477
Neutral	27.3/231	23.8/38	269
Low	28.4/240	12.5/20	260
Totals:	100/846	100/160	1006

Null Hypothesis 2: *There are no gender main effects vis-à-vis the categories of the Thinking about Science Survey Instrument.* The profiles for women and men preservice elementary teachers are shown in Figure 1. The Null hypothesis was sustained for eight of nine categories. It was rejected, however, for the “Science, Race & Gender” category at $p < 0.01$.

Null Hypothesis 3: *There are no science-interest main effects vis-à-vis the categories of the Thinking about Science Survey Instrument.* The profiles for teachers with high and low science interest are shown in Figure 2. The Null hypothesis was sustained for six of nine categories; it was rejected for the “Science & Religion”, “Science & Aesthetics” and “Science for All” categories at $p < 0.01$.

Null Hypothesis 4: *There are no gender by science-interest interaction effects vis-à-vis the categories of the Thinking about Science Survey Instrument.* The Null hypothesis was sustained. There were no significant interactions amongst the six means in the 2X3 factorial design for any of the nine survey categories.

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DISCUSSION

At a time when there are great concerns about anti-science attitudes (e.g., Holton, 1994), it is significant that this study found no evidence of anti-science attitudes amongst the preservice elementary teachers. As previously reported (Cobern & Loving, 2002), the teachers have a judicious estimation of science. They support the importance of science with respect to health, the economy, and the environment. They clearly affirm the importance of science education at all grade levels. They, however, are not committed to the general superiority of science as an epistemology. They do not think that science has rendered religion obsolete, and they do think that science needs some public oversight. These findings comport well with the public attitudes toward science reported by the *Science & Engineering Indicators-2002*; and, as previously reported (Cobern & Loving, 2002), there are scientists who hold the very same views.

Regarding gender, it is of considerable interest that there was little evidence of a gender effect with regard to the categories of the *Thinking about Science Survey Instrument*. This is evident in the similar profiles seen in Figure 1. For five categories (Science & Public Health, Science for All, Science & the Economy, Science & the Environment, Science & Aesthetics), both men and women preservice elementary teachers held views consistent with the *Model*. They endorse the teaching of science at all school levels and affirm that science is a valuable contributor to public health, the economy, the environment, and to aesthetics. Again, these findings comport well with the *Science & Engineering Indicators-2002*.

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In contrast to the *Model*, both men and women preservice elementary teachers were much less sanguine about science as an epistemology, science and religion, and the ability of science to exercise self-oversight. Most of the teachers do not agree that science acting in the public interest is capable of policing itself. Neither do most of the teachers agree that science must be protected from religion. With regard to the epistemological privilege of science, both men and women preservice elementary teachers were virtually neutral.

As noted earlier, Cobern and Loving (2002) found that preservice elementary teachers are skeptical about the openness of the science community to women and minorities. In the current study, it turns out that the one significant difference between the men and women teachers was over the Science, Race & Gender category. With a mean of 3.06, the women teachers were neutral whereas the men were more supportive of the *Model*, although the men's mean was still within the neutral range (3.33). This difference is consistent with other research findings (see Jones & Levin, 1994).

As seen in Figure 2, it is the profiles of the teachers with high and low science interest that show more contrast. Bearing in mind that teachers responded to a question about their attitude toward science based on their science course experience, the high science interest teachers are consistently more in line with the *Model*. For three of nine categories, the category means for the high and low science interest teachers are significantly different (at $p< 0.01$). Nevertheless, the difference between these two groups is not that the low science interest teachers do not value science. For both groups, five of nine categories have means above 3.50. For both groups, only one of nine categories has a mean less than 2.50. The difference is in the

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magnitude. The low science interest group simply does not value science at the same level as does the high science interest group.

Overall, the data suggest that among elementary teachers there are two distinct species but they are not men and women as one might think. The species are high and low science interest teachers. The good news is that neither the men nor women elementary teachers, nor those teachers with low science interest show signs of being anti science. However, the teachers with low science interest were, to no one's surprise, less supportive of science. Given that elementary teachers are mostly women (Fulp, 2002), the bad news is that the women teachers were disproportionately represented in the low science interest group (see Table 3). The issue of science interest vis-à-vis the valuation of science suggests two questions:

1) Is a low valuation of science vis-à-vis important cultural categories because of low interest in science? Or,

2) Is lower interest in science due to the low valuation of science vis-à-vis important cultural categories?

The first question assumes that how well science is valued is a function of science interest. The second question assumes that science interest is a function of how well science is valued. The first question suggests an inherent interest factor (likely due to some other unknown factors) that directly influences the valuation of science, though the hay day of science interest research seems to have passed. See Ramsden (1998) for a recent reappraisal of science interest research issues.

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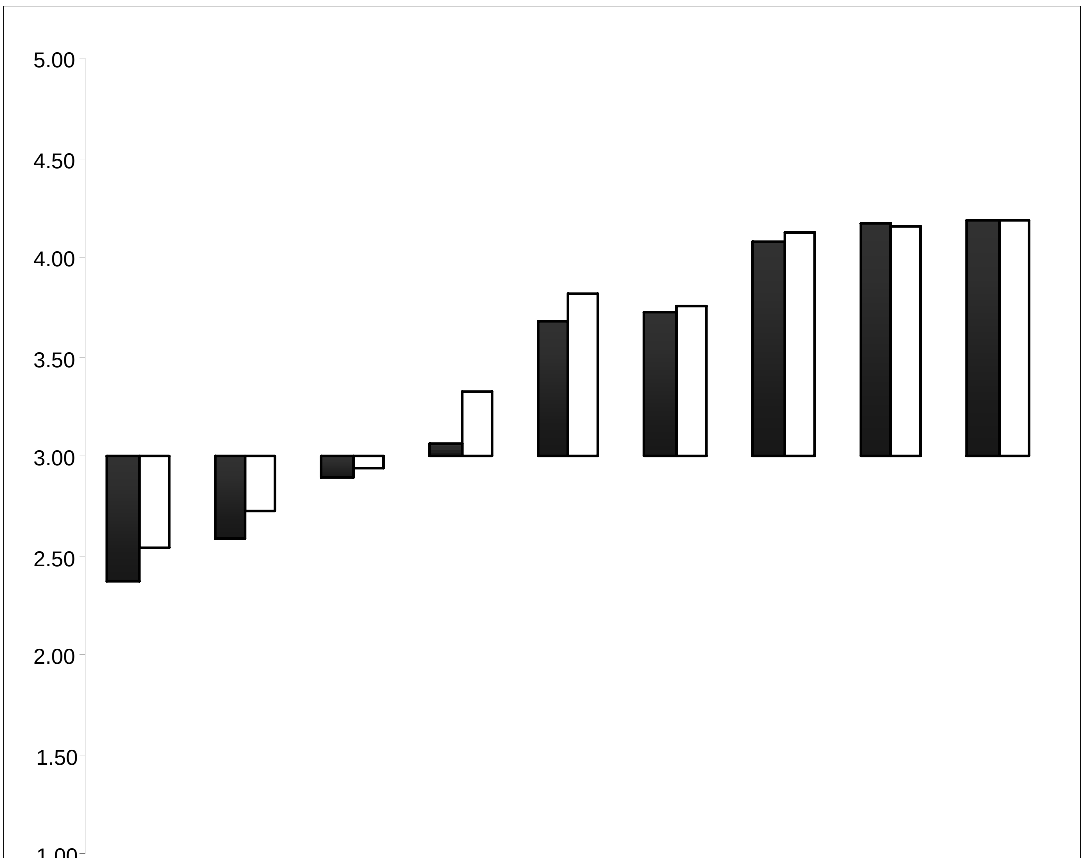
Figure 1. Women & Men Elementary Teachers Profile Comparison

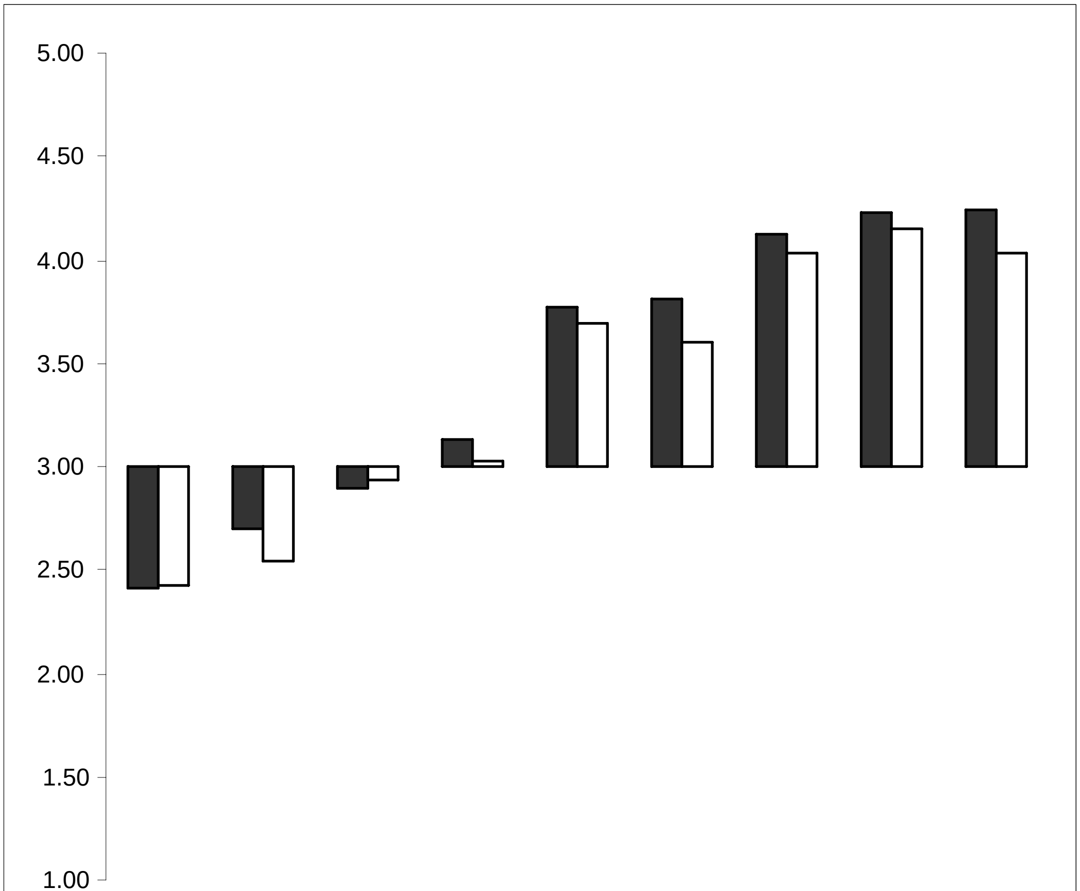


	POLY	RELIG	EPIST	**DIVER**	BEAU	ENVIR	ECON	For_All	HEAL
Men	2.53	2.72	2.94	**3.33**	3.82	3.76	4.12	4.15	4.18
SD	0.756	1.037	0.729	**0.819**	0.776	0.750	0.579	0.629	0.673
Women	2.38	2.58	2.89	**3.06**	3.68	3.73	4.08	4.17	4.19
SD	0.689	0.932	0.625	**0.869**	0.734	0.635	0.522	0.630	0.660
diff.	0.16	0.14	0.05	**0.27**	0.14	0.03	0.04	0.02	0.01
sig.	0.118	0.996	0.908	**0.000**	0.507	0.387	0.546	0.234	0.509
Partial Eta Squared	0.002	0.000	0.000	**0.015**	0.000	0.001	0.000	0.001	0.000

bold type: p< 0.01

Poly	Category 4: Public Regulation of Science
Relig	Category 6: Science & Religion
Epist	Category 1: Epistemology
Diver	Category 8: Science, Race & Gender
Beau	Category 7: Science & Aesthetics
Envir	Category 3: Science & the Environment
Econ	Category 2: Science & the Economy
For_All	Category 9: Science for All
Heal	Category 5: Science & Public Health

Figure 2. Profile Comparison of Elementary Teachers with High & Low Science Interest



	POLY	**RELIG**	EPIST	DIVER	ENVIR	**BEAU**	ECON	HEAL	**For_All**
High	2.41	**2.70**	2.90	3.13	3.77	**3.81**	4.12	4.23	**4.24**
SD	0.721	**0.969**	0.662	0.852	0.681	**0.762**	0.551	0.666	**0.636**
Low	2.42	**2.54**	2.93	3.03	3.69	**3.61**	4.04	4.15	**4.03**
SD	0.690	**0.973**	0.661	0.892	0.637	**0.762**	0.504	0.629	**0.654**
diff.	0.01	**0.16**	0.03	0.11	0.08	**0.20**	0.08	0.08	**0.21**
sig.	0.061	**0.001**	0.559	0.607	0.018	**0.000**	0.016	0.128	**0.006**
Partial Eta Squared	0.006	**0.015**	0.001	0.015	0.008	**0.029**	0.008	0.004	**0.010**

bold type: p< 0.01

POLY	Category 4: Public Regulation of Science
RELIG	Category 6: Science & Religion
EPIST	Category 1: Epistemology
DIVER	Category 8: Science, Race & Gender
BEAUT	Category 7: Science & Aesthetics
ENVIR	Category 3: Science & the Environment
ECON	Category 2: Science & the Economy
HEAL	Category 5: Science & Public Health
For_All	Category 9: Science for All

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The second question suggests a competition among competing values that directly influences science interest. People come to be interested in science because they see its value. Researchers addressing the first question would likely want to replicate the current study using a more detailed measure of science attitudes and interest (e.g., see Moore & Foy, 1997). A more detailed measure might offer insight on how the valuation of science develops. It is not clear, however, that any of the science attitude inventories in the current literature of science education research could serve this purpose. On the other hand, if we invoke Ockham's Razor, we will be more inclined to address the second question. The second question suggests that the teaching of science should treat cultural categories "head on" as a way of promoting interest in science, which of course is the position taken by the quite substantial body of literature on multicultural and contextualized science teaching (e.g., see Brickhouse, 1994; Cobern & Aikenhead, 1998; Thompson & Windschitl, 2002).)

CONCLUSION

The survey trends in this study suggest that one should be careful not to conclude that men and women preservice elementary teachers need different approaches to science, let alone that either group might be considered anti-science. Both groups support "Science for All" goals and see the value of science for society, but they do so from a qualified perspective. Given that women show less interest in science and that low science interest among both men and women correlates negatively with "Science for All" goals, efforts should be made to address this lack of interest. One approach suggested by the findings of this study is that rather than science boosterism, science education efforts to promote science interest ought to adopt a more contextual perspective on science that seeks to develop the valuation of science within a cultural context of many important ideas and beliefs

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