The *Thinking about Science* Survey Instrument (TSSI)

An Instrument for the Quantitative Study of Socio-Cultural Sources of Support and Resistance to Science (SLCSP #151)

(Revised January, 2001)

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An Instrument for the Quantitative Study of Socio-Cultural Sources of Support and Resistance to Science (SLCSP #151)

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Abstract

Many scientists and science educators are concerned about the public's ambiguous relationship with science and this public includes elementary teachers. Like many citizens, too many elementary teachers find science disconnected from everyday life and thinking. Science is a "school" subject – not an important part of everyday life. Some may believe that science conflicts with important personal beliefs they hold about other areas of life such as religion and art. Elementary teachers who feel this disconnection with science will at best approach science teaching as something one does if school authorities demand it. Given that we are now promoting constructivist approaches to science teaching among teachers who frequently face the challenges of multiculturalism, and in addition the rising challenges to science itself, society's demands of elementary teachers is all the more greater. The demands increasingly require of teachers an engagement with science at a significant level of depth and sophistication. The research reported here is about developing new insight on the processes of elementary science teacher education and development, and in general the development of the public understanding of science, vis-à-vis social and cultural factors that contribute either to science resistance or affirmation of science. This document reports on the development of a quantitative instrument for assessing socio-cultural resistance to, and support for, science that can be employed in efforts to quantitatively document the presence or absence of significant cultural concerns.

The solution which I am urging is to eradicate the fatal disconnection of subjects which kills the vitality of our modern curriculum. There is only one subject-matter for education, and that is Life in all its manifestations.
Alfred North Whitehead

Upon this gifted age, in its dark hour,
Rains from the sky a meteoric shower
Of facts… they lie unquestioned, uncombined.
Wisdom enough to leech us of our ill
Is daily spun, but there exists no loom
To weave it into fabric.
Edna St. Vincent Millay

Many scientists and science educators are concerned about the public's ambiguous relationship with science and a general level of <u>public</u> <u>alienation</u> with science (*Scientific American*, 1997). This public includes elementary teachers and indeed the elementary grades are often a weak point in science education (Gardner & Cochran, 1993). Like many citizens, too many elementary teachers find science disconnected from everyday life and thinking. Science is a "school" subject – not an important part of everyday life. Some may believe that science conflicts with important personal beliefs they hold about other areas of life such as religion and art. Elementary teachers who feel this disconnection with science will at best approach science teaching as something one does if school authorities demand it.

It is critical to keep in mind what is to be expected of elementary teachers as teachers of science. If all one wants is for elementary teachers to regularly involve their students in science activities, such as growing and observing plants or rolling carts down inclined planes, that is a minimal engagement with science. Perhaps it requires only what Wallace & Louden (1992: 508) characterized as "getting the 'formula' right, trying harder, doing it better, spending more money." Wallace & Louden (1992: 508) go on to say that,

> There is an alternative view which questions why, after more than three decades on the reform agenda, elementary science teaching continues to disappoint. Is it because we haven't found the right 'formula' or could it be that we have an imperfect understanding of the problem and unrealistic expectations for the solution?

Given that we are now promoting constructivist approaches to science teaching among teachers who frequently face the challenges of multiculturalism, and in addition the rising challenges to science itself, society's demands of elementary teachers is all the more greater. The demands increasingly require of teachers an engagement with science at a significant level of depth and sophistication — a critical engagement with science.

It certainly goes without saying that elementary teachers would benefit from more exposure to science. Having teachers do scientific investigations, gathering data and arguing about its meaning, and rubbing shoulders with scientists are valuable things to do. Indeed, if science on the whole is <u>non-problematic</u> for a group of teachers (i.e., they are not at all alienated and not disconnected), then such experiences are quite appropriate for helping teachers develop a deeper understanding of the processes of science. Where people have questions and reservations about the enterprise known as science, however, that is a situation requiring a very different pedagogical approach. One may think of the two situations in terms of Kuhnian paradigms. Resolving issues from <u>within</u> the paradigm of science requires more experience and practice with elements <u>within</u> the paradigm science. But, if there is an issue about the paradigm itself, any attempt to address the issue from within the paradigm simply begs the question. It is our conviction that very many elementary teachers, and many in the public at large, do resist the "paradigm" we call science. Thus we are led to the conclusion that within paradigm efforts alone will always be insufficient for meeting the need. Our research is about understanding the resistance and finding ways to resolve it. Our research purpose is to develop new insight on the processes of elementary science teacher education and development, and in general the development of the public understanding of science, vis-à-vis social and cultural factors that contribute either to science resistance or affirmation of science. However, it is not uncommon to find within the established community of science the view that “within-the-paradigm interventions can be successful without needing a special intervention explicitly outside the paradigm” (NSF/REPP, personal communication). Our sense is that out-of-paradigm concerns are insufficiently documented and thus not perceived in some quarters as a significant problem in science education. Thus, in this document we report on the development of a quantitative instrument for assessing socio-cultural resistance to, and support for, science that can be employed in efforts to quantitatively document the presence or absence of significant out-of-paradigm concerns.

THEORETICAL BACKGROUND

It is common knowledge that too few teachers at the elementary grades have strong backgrounds in science and too many lack a solid sense of science teaching self-efficacy to be proficient teachers of science. And, among science teacher educators and policy officials it is common to hear that what elementary teachers really need is to learn more science and to spend more time with actual scientists; and if they do this, their science anxiety and phobias will be relieved. This argument has prima facie appeal of parsimony and reasonableness. A clear lesson from the history of science, however, is that Ockham’s Razor notwithstanding many scientific explanations are exceedingly complex and anything but self-evident. We, of course, agree that most elementary teachers need to know more science; and that activity and inquiry oriented college science courses significantly contribute to preservice teacher understanding of science and help to alleviate the anxiety that some students have about science. Our concern is that this is not enough. Science courses on many university campuses have now been designed specifically for the needs of elementary teachers; but, it needs to be recognized that many students still would not take the courses if they were not compelled to do so. This is indicative of a deeper problem. In our view, the “more science” approach to improving elementary science teaching will always meet with *limited* success because it rests on three problematic assumptions.

Assumption 1: The first assumption is that elementary teachers who need more science will avail themselves of learning science when opportunities are present. Undergraduates can be compelled to take more science but typically that cannot be done with inservice teachers. A large scale elementary science teacher development program in Arizona and funded by NSF as part of a systemic initiative found that science teaching self-efficacy did correlate positively with science background (Cobern, 1994). This supports the argument for more science. The program also found that the majority of participants were veterans of other science inservice programs. Very few were first time science inservice participants. All came to the program expressing a strong interest in science. The point is that most of the elementary teachers in the location of the program opted not to participate; and the ones who did participate were for the most part the ones who least needed the program. This is not an unusual occurrence regarding inservice programs even those under the umbrella of systemic initiatives. Unfortunately, it is also not a phenomenon that has been well researched.

Assumption 2: The second assumption is that learning more science will increase elementary teachers' interest in science, approval of science, and science teaching enthusiasm and effectiveness. On that point it is interesting to note that university students drop out of science majors at a much higher rate than out of other majors (Seymour & Hewitt, 1996). More to our concern is that even with having learned more science, people struggle with the meaning of science. It is a philosophical and cultural type of restraint distinguishable from sociological restraints (Cobern & Aikenhead, 1998). As clarification, sociological restraints against learning science (or anything else) can include religious factor leading to anti religious prejudice, gender factors leading to prejudice against women in science, race factors leading to racism, or class factors leading to economic and social elitism. There are also sociological factors that are not restraints *per se*. The education of a scientist is in part a process of socialization into the norms and practices of professional scientists. Our concerns are about culture and science learning where we take the concept of culture to be about meaning. We are following the lead of anthropologist Clifford Geertz who spoke of humans as beings who are suspended in webs of significance that we have spun for ourselves. He says, "I take culture to be those webs, and the analysis of it is not an experimental science in search of law but an interpretative one in search of meaning..." (Geertz, 1973: 5). The sociological/cultural contrast can be illustrated this way. It is well known that in the past achievement in science and entrance into science fields has been restricted for women by the sociological impediments of gender bias and chauvinism of men in the fields of science. In addition, there has been a cultural restriction albeit a tacit one. According to many feminist scholars, the strong object/subject ethos of scientific work is far less compatible with femininity than it is with masculinity (e.g., Whatley, 1989). The result for women is a subtle cultural barrier to full participation in science.

These cultural barriers have to do with meaning and by meaning we refer to the composition (or webs) of values and ontological and epistemological commitments one holds at a fundamental level. "Meaning" is important with regard to the meaning established by the learner. "Meaning" is also important with regard to the meaning given to science by the various aspects of science education. This second perspective on meaning suggests that science education should address the ways science can be compatible with, and integrated with, other domains of knowledge. Where this fails to occur one hears the non-science major exclaim, "Scientists do not ask interesting questions!" (Paraphrased from Tobias, 1990) because concern for the context of the science was missing — "the tyranny of technique robbed them of the profound intellectual experience they had expected from science" (Tobias, 1993: 300). Even more worrisome is the recent report from George Gaskell (1996) of the London School of Economics on *Eurobarometer* survey findings. The surveys showed that in several European countries more knowledge in science was *not* reflected in increased interest and approval of science. To the contrary, there were data that some people who knew more about science were actually troubled by what they knew of science. Science policy expert, Sheila Jasanoff (1996) makes a similar observation.

Assumption 3: The second influence of meaning with regard to science teaching and learning is the influence upon how a communicator of science interprets the science being communicated. This leads to the third assumption supporting the "more science" approach to improving elementary science teaching, that science itself is unproblematic - it is in other words a simple, self-evident good. We as a research team are science enthusiasts, but our reading of both the history and sociology of science suggests that science is not unproblematic. It cannot be because science ultimately like anything else has to be communicated within the public square; and, a communication is always an interpretation of what is meaningful and valuable to the communicator, the accuracy of the science content notwithstanding. We suggest that in this sense of being problematic, the problematic aspects of science are a source of friction, concern, and alienation for many people, including elementary teachers.

The problematic nature of how science is to be communicated and with what values is at the heart of C. P. Snow's "Two Cultures" metaphor (Snow, 1963). C. P. Snow's 1959 Rede Lecture, "The Two Cultures and the Scientific Revolution," captured attention for a debate that began in the 19th century between T. H. Huxley (1881/1963) and Matthew Arnold (1882/1963). "Shall science be the guiding principle for social development? Or are there values that science cannot deal with, some higher values?" (Hultberg, 1997: 2). Huxley (1881/1962: 45) argued the affirmative noting that, "Not only is our daily life shaped by it, not only does the prosperity of millions of men depend upon it, but our whole theory of life has long been influenced, consciously or unconsciously, by the general conceptions of the universe, which have been forced upon us by physical science." Though Arnold appreciated the value of scientific knowledge, he considered that knowledge to be coldly rational, disintegrated, lacking any aesthetic dimension, and utterly incapable of enlightening what it means to be human or humane. Scientists and humanists, as Snow would later say, dwell in different cultural worlds. A sense of that difference is captured in the contrast between the following two passages from Walt Whitman and Charles Darwin:

Whitman	**Darwin**
When I heard the learn'd astronomer, When the proofs, the figures, were ranged in columns before me, When I was shown the charts and diagrams, to add, divide, and measure them, When I sitting heard the astronomer Where he lectured with much applause in the lecture room, How soon unaccountable I became tired and sick, Till rising and gliding out I wandered off by myself, In the mystical moist night-air, and from time to time, Look'd up in perfect silence at the stars.	I have said that in one respect my mind has changed during the last twenty or thirty years. Up to the age of thirty, or beyond it, poetry of many kinds... gave me great pleasure, and even as a schoolboy I took intense delight in Shakespeare... I have also said that formerly pictures gave me considerable, and music very great, delight. But now for many years I cannot endure to read a line of poetry: I have tried to read Shakespeare, and found it so intolerably dull that it nauseated me. I have also almost lost my taste for pictures or music... I retain some taste for fine scenery, but it does not cause me the exquisite delight which it formerly did... My mind seems to have become a kind of machine for grinding general laws out of large collections of facts ...

Unlike Huxley, C. P. Snow was actually quite sympathetic to the humanities (he was himself an author of novels) and very supportive of placing science within the liberal arts – Sheila Tobias (1994) is certainly correct to use Snow's arguments in her plea for <u>liberal</u> education that integrates the natural sciences. Snow was concerned that the dispassionately objective knowledge of science be counterbalanced by knowledge that reflected humanity and values. Snow's arguments, however, were more motivated by an outmoded British scientific/industrial system in contrast to Soviet accomplishments exemplified by Sputnik. He wanted the public to understand that science had transformed the modern world including society, and that 19th century values were obsolete. He unabashedly called the humanists who demurred, "modern Luddites." And just as Huxley was challenged by Matthew Arnold, Snow was challenged by F. R. Leavis who charged that Snow was simply echoing the ideology of scientists at the expense of the humanities and of human dignity (Leavis & Yudkin, 1962). Nonetheless, the impact of Snow's lecture is such that it has been axiomatic since the lecture's publication for anyone discussing the issues of science vis-à-vis culture, the humanities, or liberal education to invoke the "Two Cultures" metaphor. There is the sense that Snow recognized the existence of a critical gap between natural scientists and others of a more humanist bent, and that he profoundly addressed what needed to be done about it within the context of a liberal education. If that is so, one has to wonder what F. R. Leavis was so upset about?

To the contrary, what is lost in these discussions is that Leavis had a legitimate criticism of Snow's perspective: Snow *overestimated* scientific power and epistemological privilege. As if to emphasize this overestimation, twenty years later the eminent neuro-physiologist John Eccles wrote that,

> There has been a regrettable tendency of many scientists to claim that science is so powerful and all-persuasive that in the not-too-distant future it will provide an explanation in principle for all phenomena in the world of nature, including man, even of human consciousness in all its manifestations…. Popper has labeled this claim as *promissory materialism*, which is extravagant and unfulfillable. Yet on account of the high regard for science, it has great persuasive power with the intelligent laity because it is advocated unthinkingly by the great mass of scientists who have not critically evaluated the dangers of this claim false and arrogant claim. (Eccles, 1979: i)

Of course, not all scientists make the claim of *promissory materialism* but some very well known scientists certainly have. Francis Crick offers his Astonishing Hypotheses that, "'You,' your joys and your sorrows, your memories and your ambitions, your sense of personal identity and free will, are in fact no more than the behavior of a vast assembly of nerve cells and their associated molecules" (1994: 3). Eccles presciently cautioned in 1979 that the danger risked by indulging in such extravagant claims for science is the precipitation of anti science sentiment. Thus, Eccles would not be surprised by Sheila Tobias (1994), noting the rise of anti science sentiments, telling us that the gap between the "Two Cultures" is greater today than it was when Snow gave his seminal lecture over 30 years ago. As if in planned emphasis of her observation, the "Science Wars" between scientists and post modernists broke out in 1997 (see Nature, 1997).

What one should learn from the arguments between Huxley and Arnold, Snow and Leavis, and to a lessor extent the recent clash between some very vocal scientists and equally vocal post modernists, is that resistance to science cannot be reduced to the simplicity of "science versus anti science." There are competing worldviews across which communication remains difficult. Thus, even though granting the power and significance of science as many lay citizens do, science in the public square remains problematic for many people.[1]

By problematic nature of science vis-à-vis the public square that we have in mind is not about attitudes toward science as usually understood in the science education community (Kaballa, 1992). Nor do we have in mind nature of science (NOS) issues, which tend to involve a more internalist perspective on science (Lederman, 1992). There are many existing instruments in both of these areas but these instruments do not address the public place of science with respect to society and culture. Closer to our interests is the VOSTS instrument (Ryan & Aikenhead, 1992; Aikenhead & Otsuji, 2000), which is about science and society but the VOSTS provides insight on student views pertaining to specific STS issues. What we have done is to draw upon the widely read work of high profile scientists, science popularizers and science educators for the development of an instrument that addresses the broad relationship of science to important areas of society and culture (see Table 1).

INSTRUMENT DEVELOPMENT

Specifically, the *Thinking about Science* instrument is composed of items developed on the basis of objections to science (as discussed in the previous section) and defenses for science.

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1 The cultural sources of resistance to science in the 1990s include at least all of the following:

1. The tradition of science in the 20th century has been to view science as neutral with regard to values except for values internal to science such as those identified by Merton (1968). Those outside of science often wonder how perceptive this position really is. In recent years the alleged values neutrality of science has been challenged by scholars in the social study of science (e.g., Young, 1995) who argue that science both supports and suppresses a wide range of values and that Merton's values are more ideology than ideals. Fourez (1988), for example, has similarly criticized science education.

2. Science often appears as scientism (Appleyard, 1992) with excessive emphasis on empiricism, materialism, naturalism, objectivity, and reductionism (Berkowitz, 1996; Settle, 1990). As values these all have a rightful place in science. In extreme form (such as Crick's *promissory materialism*) they are scientistic and harmful to other values. They defy common sense and are simply not credible for many. They offend people who, like Walt Whitman, are more socially, aesthetically, and spiritually minded.

3. Especially in school science textbooks, science is often presented in a manner many consider philosophically naïve. Philosophical controversies such as the demarcation of science from other disciplines are either muted or ignored in textbooks and curricula. The nature of inference is blurred. The role of presupposition and theory with regard to observation, experiment and analysis is minimized or ignored (Duschl, 1985; Matthews, 1994; Smolicz & Nunan, 1975; Stinner, 1995).

4. Much of post modernism rejects meta narratives chief among which is science (Lyotard, 1995). This is the problem about which Gross & Levitt (1993) and Sokal (1996) are so vexed. The greater issue, however, is the general rejection of expertise that has become widespread in late 20th century American society. This includes the rejection of science as an expert system (Jasanoff, 1996).

5. Perceived conflicts of science with religious knowledge and religious convictions leads to anxiety regarding science and sometimes to outright rejection. To the extent that science takes on an ideological form, the conflicts are more real than perceived. For example, in an interview with *USAToday* (Grossman, 9D, 1999) Steven Weinberg commented that "Religion is an insult to human dignity. With or without it, you'd have good people doing good things and evil people doing evil things." (Irzik, 1998; Jackson et. al., 1995; Larson & Witham, 1998; Polkinghorne, 1994).

6. Rejection of science education by naïve pragmatists who question whether knowledge of science is all that necessary – after all, they are living successful lives without much know-ledge or interest in science. This sentiment is nicely captured by Sherlock Holmes' response to an incredulous Dr. Watson upon hearing Watson's explanation of the heliocentric solar system: "What the deuce is that to me?" Unlike Holmes, teachers typically agree to statements affirming the importance of science, but then teachers know what they are expected to say. It is unfortunate that little research has investigated the sincerity and depth of such affirmations since the affirmations seem so contrary to what actually happens in many elementary classrooms.

7. Science has always been accompanied by those who see a danger posed by science to nature and society (Merchant, 1989). Some of these people, even today, consider that the dangers outweigh any possible benefits (*Science & Engineering Indicators -- 1996*). In our own research that preceded this report there was evidence amongst ninth graders of this very sentiment (Cobern, Gibson, & Underwood, 1999).

8. Gender and race related resistance to science is a widely acknowledged problem. As described earlier, we have in mind gender and race related cultural factors (Harding, 1993; Turkle & Papert, 1990; Whatley, 1989), rather than sociological factors, and which are not yet satisfactorily resolved.

The items are grouped in nine categories described in Table 1, with from four to ten items per category. These categories are not intended to represent an *authoritative* scientific world-

A Common Image of Science		
#	**Category**	**Category Description**
1	**Epistemology**	Science is a superior, exemplary form of knowledge that produces highly reliable and objective knowledge about the real world. (Feynman, 1995; Gross & Levitt, 1993; Leone, 1987; Monod, 1971; Wilson, 1998).
2	**Science and the Economy**	Modern industrial, commercial, and information-based economies depend on scientific developments for increasing production, wealth and general public welfare. (Alperts, 2000; Hurd, 1989; Lawler, 2000).
3	**Science and the Environment**	Science is necessary for the discovery, development, and conservation and protection of natural resources and the environment in general. (Bond, 1999; Knopman, 1997; Polkinghorne, 1996)
4	**Public Policy and Science**	Science acts in the public interest. Science should thus be supported by public funds, however, the science community is more than capable of policing scientific activity. (Gross & Levitt, 1993)
5	**Science and Public Health**	The conquering of disease and physical affliction and the great advances in public health are made possible by science and will not continue without science. (Clark, 1989)
6	**Science, Religion and Morality**	People make moral choices about the use of scientific findings but science itself is morally neutral. Science is also neutral with regard to religion. The importance of science, however, is such that science must be protected from the intrusive activities of some religions. (Gould, 1987 & 1997; Larson & Witham, 1998; NAS, 1998; Weinberg, 1999)
7	**Science, Emotions and Aesthetics**	Scientists are often passionate about their work but the work of science best proceeds on the basis of objective reason and empiricism. There is a beauty to science. Indeed, "elegance" is often required of scientific ideas. (Dawkins, 2000; Polkinghorne, 1996; Shlain, 1991)
8	**Science, Race and Gender**	Science is an "equal opportunity employer." Race, gender and other personal factors are irrelevant in science.
9	**Science for All**	The importance of science is such that it should be taught at all levels of schooling. Every citizen should have attained at least a minimal level of science literacy. (AAAS, 1990)

Table 1. Instrument Categories and Category Descriptions

view, but a scientific worldview *version* commonly found in both the popular media and the literatures of science and science education.

The original list of potential item statements was sent to 40 scientists and science educators for comment. Subsequently, a revised set of 60 items was randomly assorted in the format that appears in Appendix A. Three to six preservice elementary teachers were then asked to interpret in writing the meaning of each item. The students were randomly assigned to each review several items (see Appendix C). This was done to further insure that students would generally interpret the items as intended. Many students found this to be an awkward task and tended to respond to items rather than simply interpret what the items were saying. Nevertheless, even such responses gave a good indication of how the students interpreted each item. Based on the students' written comments, the researchers judged that most readers of the survey items would interpret each item closely to the intended meaning.

The survey responses are in the form of a 1-5 scale with the number one labeled "strongly disagree," the number three labeled "uncertain," and the number five labeled "strongly agree." During the academic years from 1997 to the Fall of 2000, 398 preservice elementary teachers completed the survey. The students were in their third and fourth years at Western Michigan University. They were enrolled in a science methods course that is part of a 21-hour minor in mathematics and science, when they sat for the survey. At the time of the survey, the students had each taken three courses in science and two in mathematics. The Alpha reliability coefficient was calculated at 0.7790, and the Category item alpha coefficient was calculated at 0.7930. The descriptive statistics for each item are reported in Appendix D. Survey item means organized by categories are shown Table 4. The categories in Table 3 are presented in the same order as shown in Table 1. The descriptive statistics for the category means are presented in Table 2. The category means are presented in rank order in Table 3. The five-point scale used for each item and category means is interpreted as follows:

1.00 to 2.50	Disagree/Disaffirm vis-à-vis Model[2]
2.51 to 3.50	Neutral vis-à-vis Model
3.51 to 5.00	Agree/Affirm vis-à-vis Model

The results can be read as a composite profile or pattern (see Figure 1), based on the nine categories given in Table 1 that depict how subjects view science with respect to other areas of culture and society. As noted above, Table 1 is not to be taken as an *authoritative* scientific worldview but a commonly presented image of science in the scientific and science education literature. Hence, interpretation of results should be about the ranks, magnitudes and balance within profiles and the comparison of such amongst profiles for different groups and against the *common image* model.

DISCUSSION OF PRELIMINARY DATA

The nine categories are discussed below in rank order beginning with the highest ranked category: Science for All. There are four categories in the "Consistent with the Model" range

[2] The model refers to the scientific worldview *version* commonly found in both the popular media and the literatures of science and science education, as summarized in Table 1.

and six in the "Neutral" range. In this discussion, the item means have been rounded to the tenths place.

Table 2. Descriptive Statistics for the Category Means									
	N	Min	Max	Mean	Std. Dev.	Skew	Std. Error	Kurtosis	Std. Error
EPIST	398	1.4	4.2	2.80	0.509	0.138	0.122	-0.079	0.244
ECON	398	1.8	4.9	3.75	0.402	-0.546	0.122	1.956	0.244
ENVIR	398	1.5	5.0	3.49	0.588	-0.032	0.122	0.352	0.244
POLY	398	1.9	4.3	3.03	0.366	0.149	0.122	0.504	0.244
HEAL	398	1.3	5.0	3.80	0.544	-0.525	0.122	1.338	0.244
RELIG	398	1.3	4.1	2.60	0.459	-0.094	0.122	0.242	0.244
EMOT	398	1.5	4.8	3.33	0.484	-0.212	0.122	0.509	0.244
RACE	398	1.0	5.0	3.09	0.838	-0.122	0.122	-0.319	0.244
FOR-ALL	398	1.3	5.0	4.09	0.587	-1.253	0.122	2.880	0.244
TOTAL	398	2.5	4.2	3.31	0.251	0.189	0.122	0.567	0.244

Table 3. Rank Ordered Category Means

Category	Min	Max	Mean	Std. Dev.	
Science for All	1.4	5.0	4.09	0.587	Consistent with Model
Science and Public Health	1.3	5.0	3.80	0.544	
Science and the Economy	1.8	4.9	375	0.402	
Science and the Environment	1.5	5.0	3.49	0.588	
Science, Emotions and Aesthetics	1.5	4.8	3.33	0.484	Neutral vis-à-vis the Model
Science, Race and Gender	1.0	5.0	3.09	0.838	
Public Policy and Science	1.9	4.3	3.03	0.366	
Epistemology	1.4	4.2	2.80	0.509	
Science, Religion and Morality	1.3	4.1	2.60	0.459	

Science for All (Category 9): The category mean for "Science for All" was 4.09. There are eight items in this category and the item means ranged from a low of 3.5 for Item 37 to a high of 4.5 for Item 15; hence no items were below the "Consistent with the Model" level. As can be see in Figure 2, the student responses to this category clustered at the high end of the scale. These preservice teachers appear to believe that science should be taught at all levels of schooling and that every citizen should attain at least a minimal level of science literacy. They strongly affirm the importance of science in school.

Science Is A Positive Force for Public Health (Category 5): With a category mean of 3.80, the preservice teachers affirmed the relationship of science to health – the conquering of disease and physical affliction and the great advances in public health are made possible by science and will not continue without science – though not at the level of affirmation for literacy. Figure 3 shows the students tending toward the upper end of the scale. There are four items in this category and the item means ranged from a low of 3.0 for Item 9 to a high of 4.4 for Item 48. Only one of the four items was below the "Consistent with the Model" level. The students were neutral on whether scientific knowledge is more important to good health than commonsense (Item 9).

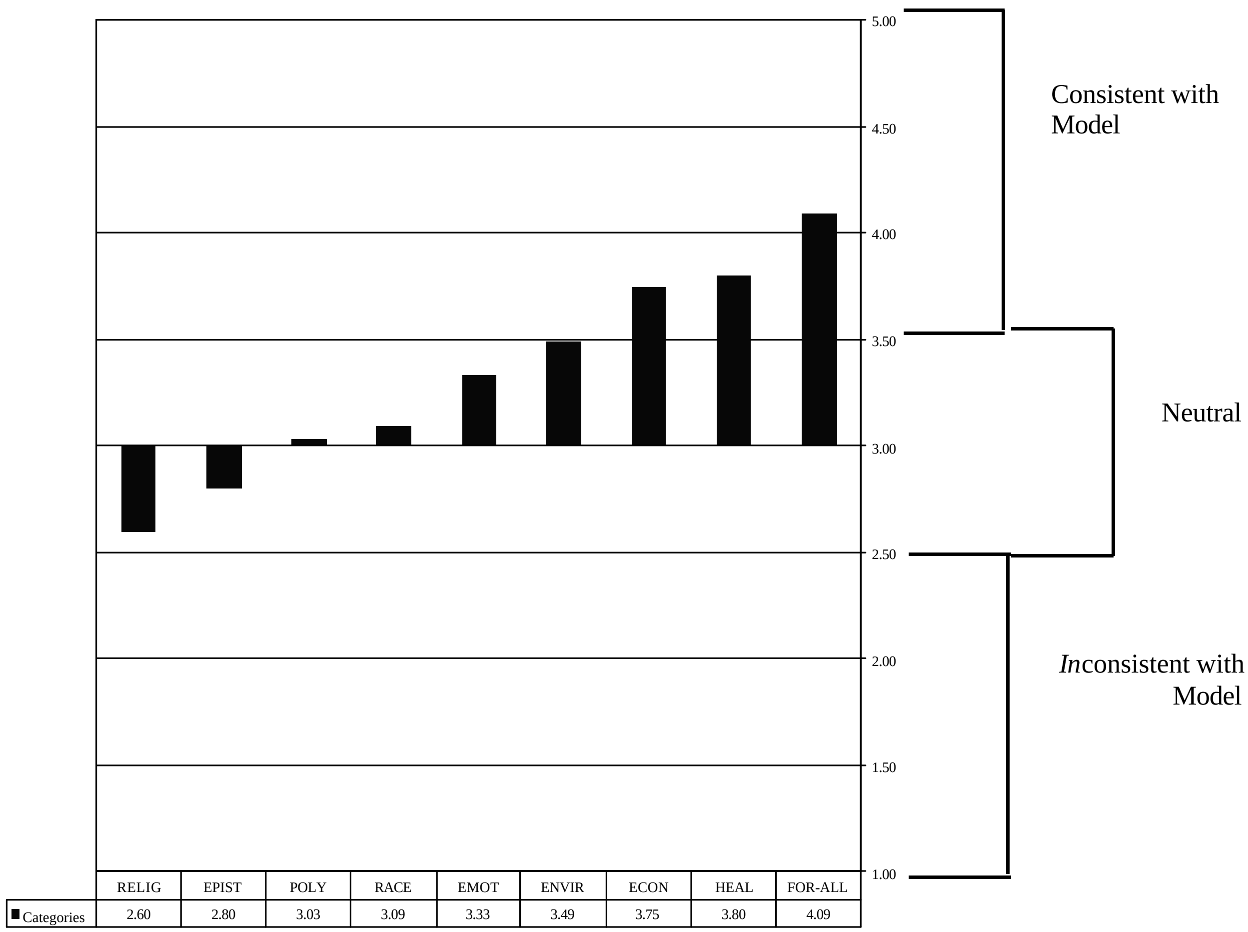
Table 4. Category and Item Means

Item #	Polarity	Category Description	Means
		Strong view of scientific knowledge (Epistemology)	**2.8**
2	**R**	No source of knowledge provides absolute truth – not even science.	2.8
17		Scientific knowledge is the most objective form of knowledge.	3.1
27	**R**	No form of knowledge can be completely certain – not even scientific knowledge.	2.2
29		We can be certain that scientific knowledge is reliable.	2.8
33		The methods of science are the most reliable source of true, factual knowledge.	3.1
34		Science is the best source of reliable knowledge.	2.9
44	**R**	No form of knowledge – including science – can ever be completely objective.	2.3
46		The methods of science are objective.	3.3
60		Scientific knowledge is the truest form of knowledge.	2.7
		Scientific progress is vital to the Economy	**3.8**
14	**R**	The strength of our national economy does not depend on scientific knowledge.	3.6
16		Science helps develop our natural resources such as coal, gas, oil, and solar energy.	4.0
20		Scientific knowledge is useful in keeping our national economy competitive in today's world.	3.9
22	**r**	The development of our natural resources, such as coal, gas, oil, solar energy, requires much more than scientific knowledge.	2.3
25		There are many good things we can do today because of scientific knowledge.	4.5
31		The development of our natural resources, such as coal, gas, oil, solar energy, is dependent upon having adequate scientific knowledge.	3.7
41	**R**	Scientific knowledge is useful for only a few people.	4.2
42		Science is our best source of useful knowledge.	2.9
49		Developing new scientific knowledge is very important for keeping our country economically competitive in today's world.	4.1
51		Scientific knowledge is useful.	4.5
		Science is a positive force for the protection of the Environment and Resource Development	**3.5**
3	**R**	Scientific knowledge has often contributed to the destruction of our environment and natural resources.	2.7
38	**R**	Our natural environment would actually be helped by the absence of scientific knowledge.	3.7
43		Science can help us preserve our natural environment and natural resources.	4.0
59		Without science we will not be able to preserve our natural environment and natural resources.	3.6
		Science should influence public policy, be publicly supported but not publicly controlled.	**3.0**
5		Scientific research is rarely dangerous to the public.	2.7
6		Scientific research is generally very important.	4.3
10		Scientific research should be adequately funded by government.	3.7
18	**R**	Scientific research is often potentially dangerous to the public.	3.1
19		There is little need for the legal regulation of scientific research.	1.9
26	**R**	Scientists should not be allowed to research anything they wish.	3.0
28	**R**	Scientific research should be carefully regulated by law.	2.3
45	**R**	Scientific research is economically and politically determined.	2.5
50	**R**	Scientific knowledge influences government decision making too much.	3.1
57	**R**	The government should not be in the business of using tax dollars to fund scientific research.	3.6

Item #	Polarity	Category Description	Means
		Science is a positive force for Public Health	**3.8**
8		Scientific knowledge is the single most important factor in the improvement of medicine and public health.	3.7
9	**R**	Common sense contributes more to good health than does scientific knowledge.	3.0
48		Scientific research makes important contributions to medicine and the improvement of public health.	4.4
58	**R**	Scientific knowledge contributes little to good health.	4.1
		Science is neutral with regard to religion and morality	**2.6**
7	**R**	A person can be both religious and scientific.	1.7
11		Science is a more important source of knowledge than religion.	2.4
32	**R**	Religious knowledge contributes more to the well being of a person's life than does science.	3.0
35		Scientific research is morally neutral.	2.6
39		Religion and science are almost always at odds with each other.	3.1
40		Religion tends to impede scientific progress.	2.8
47		Scientific knowledge tends to erode spiritual values.	2.7
		Emotions and Aesthetics are part of Science	**3.3**
1		Human emotion plays no part in the creation of scientific knowledge.	3.6
12	**R**	Scientific explanations tend to spoil the beauty of nature.	3.7
21	**R**	It is equally important for a person to have scientific knowledge and an appreciation for the arts.	2.1
36		Science can contribute to our appreciation and experience of beauty.	3.9

		Science is open to people regardless of race and gender	**3.1**
4		Women are welcome in science just as much as men are.	3.4
23	**R**	The scientific community is mostly dominated by white men and is often unfriendly to minority people.	2.8
30		African Americans and other minority people are just as welcome in the scientific community as are white people.	3.3
53	**R**	The scientific community is mostly dominated by men and is often unfriendly to women.	2.8
		Science for All	**4.1**
13	**R**	Students should not be forced to take science courses at the university.	3.9
15	**R**	Science should not be made an important subject for the elementary school grades.	4.5
24		Understanding science is a good thing for everyone.	4.4
37	**R**	Only a very few people really understand science.	3.5
52		All students should study science during the secondary school grade levels.	4.4
54	**R**	Most people really do not need to know very much science.	3.9
55		Even at the university level all students should study at least some science.	4.1
56		Science should be taught at all school grade levels.	4.3

Figure 1. Ranked Category Mean



RELIG	Category 6: Science, Religion and Morality
EPIST	Category 1: Epistemology
POLY	Category 4: Public Policy and Science
RACE	Category 8: Science, Race and Gender
EMOT	Category 7: Science, Emotions and Aesthetics
ENVIR	Category 3: Science and the Environment
ECON	Category 2: Science and the Economy
HEAL	Category 5: Science and Public Health
FOR-ALL	Category 9: Science for All

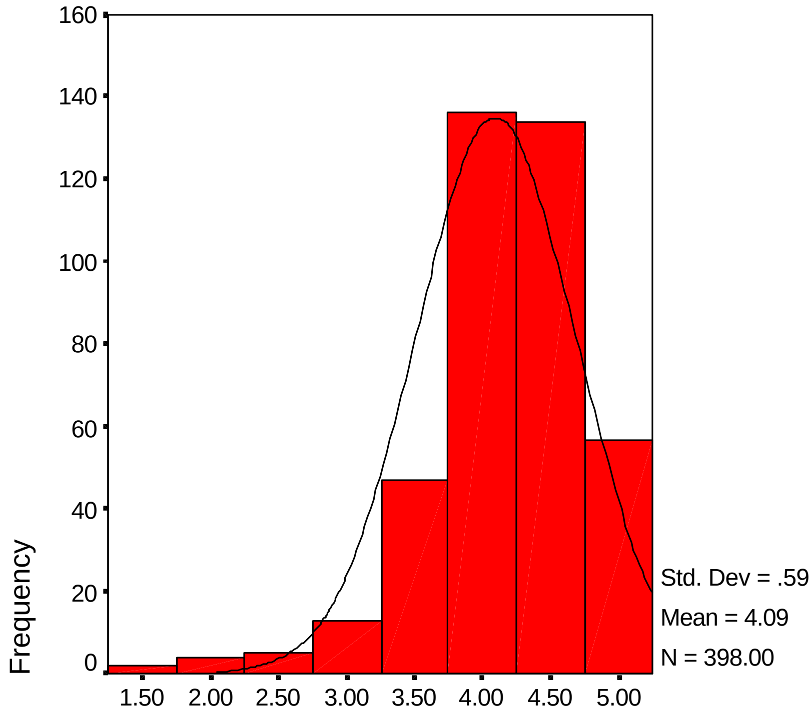


Figure 2. Science for All Category Means

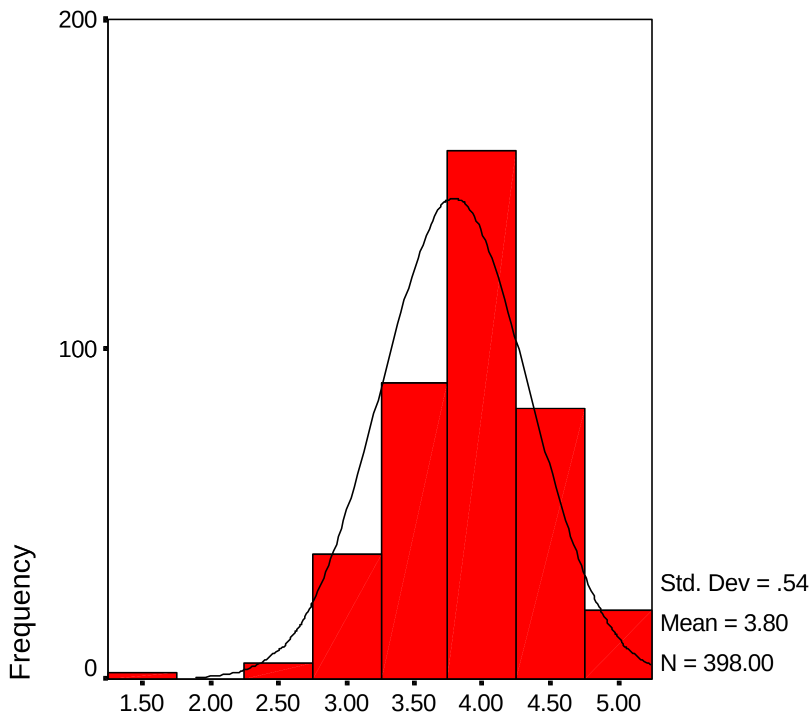


Figure 3. Science and Public Health Category Means

Scientific progress is vital to the Economy (Category 2): Science and the economy – that modern industrial, commercial, and information-based economies depend on scientific developments for increasing production, wealth and general public welfare – ranked third among the preservice teachers with a category mean of 3.75 (rounded to 3.8 and thus tied with Category 5). As can be seen in Figure 4, the students appear somewhat divided about this category. There are ten items in this category and the item means ranged from a low of 2.3 for Item 22 to a high of 4.5 for Item 25, with two of the ten items below the "Consistent with the Model" level. The students appear to reject the idea that scientific knowledge is sufficient for the development natural resources (Item 22) and are barely neutral on whether science is our best source of useful knowledge (Item 42).

Science Is A Positive Force for the Protection of the Environment and Resource Development (Category 3): Is science necessary for the discovery, development, and conservation and protection of natural resources and the environment in general? The preservice teachers barely affirmed this assertion with a category mean of 3.49. There are four items in this category and the item means ranged from a low of 2.7 on Item 3 to a high of 4.0 for Item 43, with one of the four items below the "Consistent with the Model" level. The students were neutral on whether science has contributed to the destruction of our environment and natural resources (Item 3). The distribution of means for this category is shown in Figure 5.

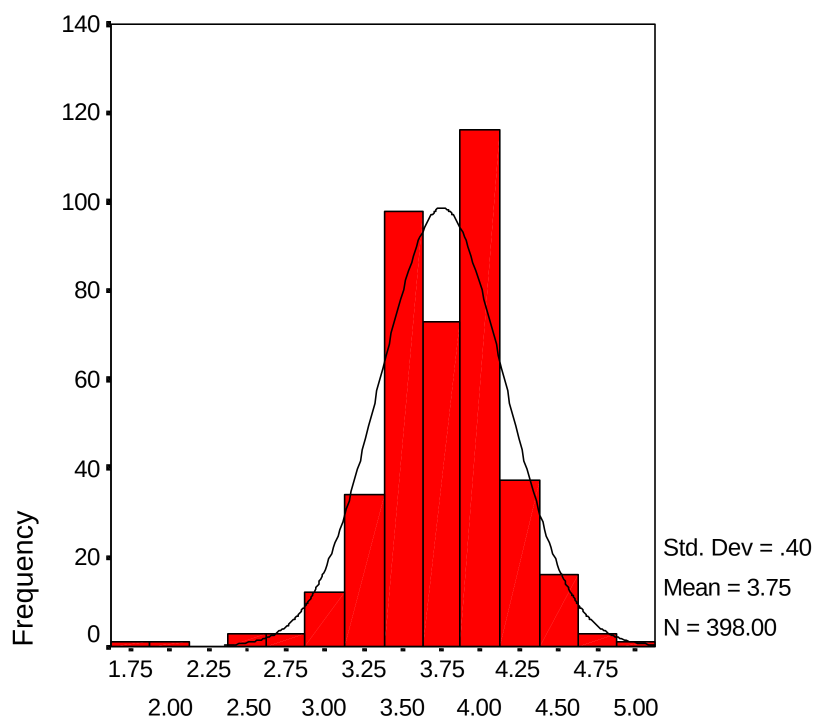


Figure 4. Science and the Economy Category Means

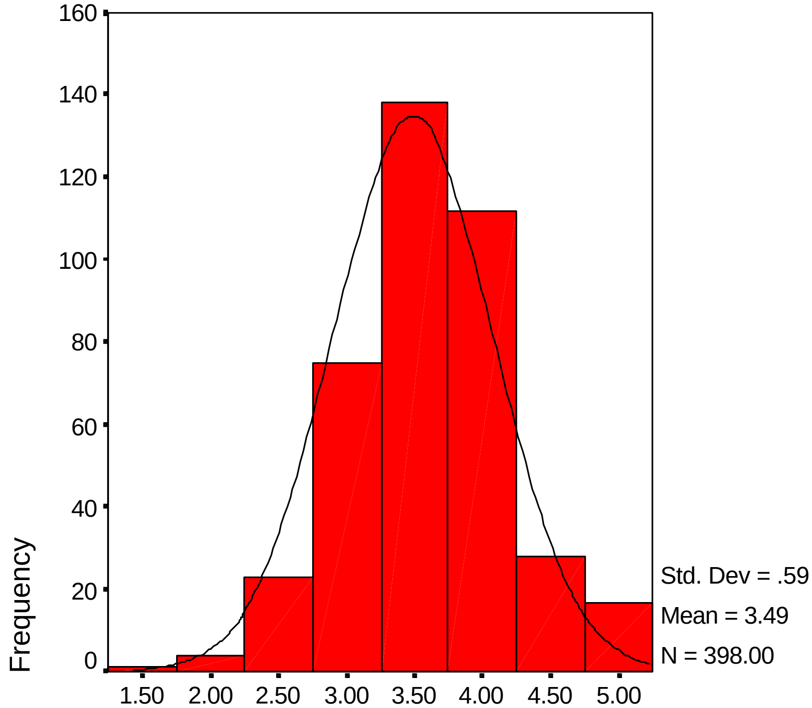


Figure 5. Science and the Environment Category Means

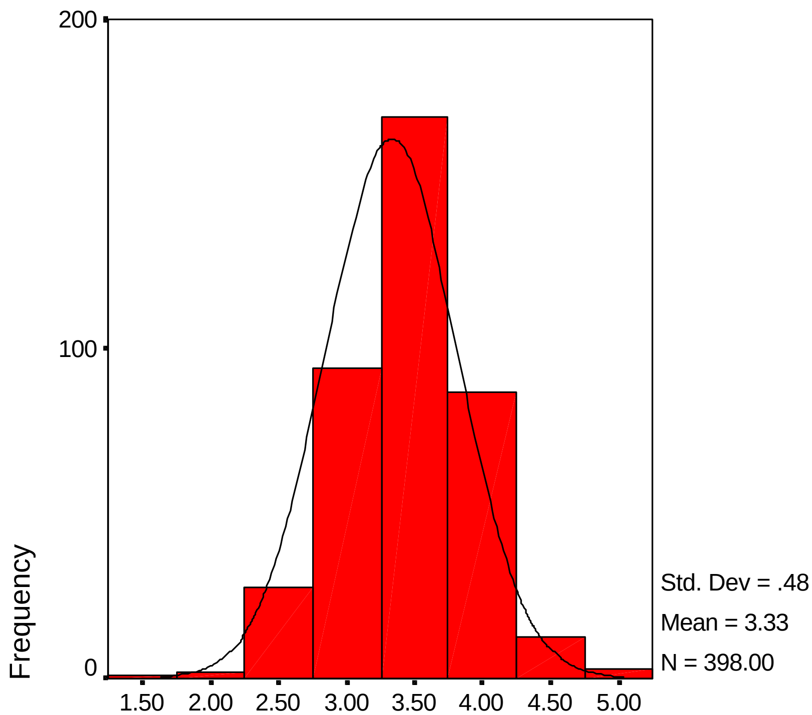


Figure 6. Science, Emotions and Aesthetics Category Means

Emotions and Aesthetics Are Part of Science (Category 7): The preservice teachers were into the upper neutral zone on this category with a category mean of 3.33. They barely affirmed the objectivity of science and any positive influence that science can have on aesthetics. There are four items in this category and the item means ranged from a low of 2.1 for Item 21 to a high of 3.9 for Item 36, with one of the four items below the "Consistent with the Model" level. The low item indicated that the students thought that it is equally important to have scientific knowledge and an appreciation for the arts (Item 21). The distribution of means for this category is shown in Figure 6.

Science Is Open To People Regardless of Race and Gender (Category 8): The students were also neutral on the openness of the science community to women and minorities. The category mean was 3.09. There are four items in this category and the item means ranged from a low of 2.8 on Items 23 and 53 to a high of 3.4 on Item 4. The distribution of means for this category is shown in Figure 7.

Science Should Influence Public Policy, Be Publicly Supported But Not Publicly Controlled (Category 4): Does science act in the public interest? Should science be supported by public funds? Is the science community more than capable of policing its own scientific activity? The preservice teachers were clearly neutral on these questions. The category mean was 3.03. There are ten items in this category and the item means ranged from a low of 1.90 on Item 19 to a high of 4.3 for Item 6. The students affirmed that scientific research is important and should be publicly funded (Items 6, 10, & 57), but they also affirmed the need for public regulation of science (Item 19). The distribution of means for this category is shown in Figure 8.

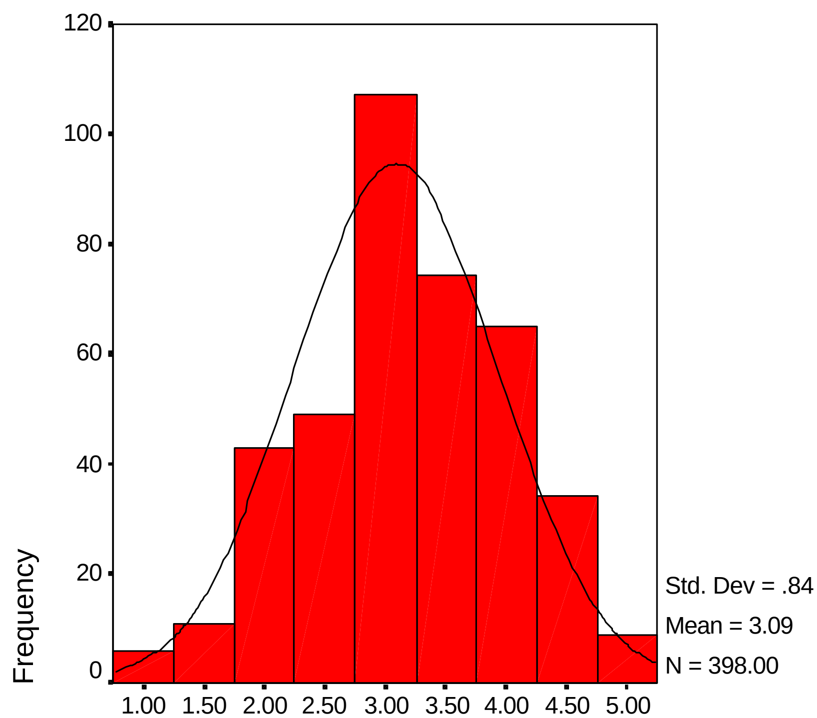


Figure 7. Science, Race and Gender Category Means

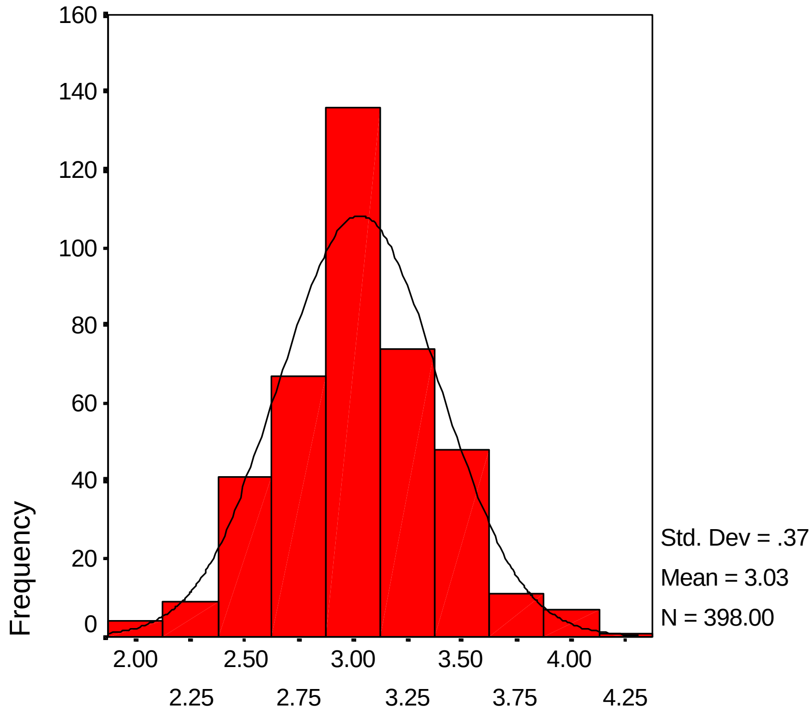


Figure 8. Public Policy and Science Responses

Strong View of Scientific Knowledge – Epistemology (Category 1): Similarly, the preservice teachers were neutral on the superiority of scientific knowledge. The category mean was 2.80. There are nine items in this category and the item means ranged from a low of 2.3 for Item 44 (2.08 for Item 27) to a high of 3.30(3.26) for Item 46. There were no apparent meaningful differences between the two survey administrations. The distribution of means for this category is shown in Figure 9.

Science Is Neutral with Regard to Religion and Morality (Category 6): With a category mean of only 2.60, the preservice teachers were barely neutral on this category. There are seven items in this category and the item means ranged from a low of 1.7 for Item 7 to a high of only 3.1 for Item 39). The preservice teachers felt that one could be both religious and scientific (Item 7), and did not think science to be more important than religion (Item 11). The preservice teachers were also unsure about the neutrality of science with regard to morality (Item 35). The distribution of means for this category is shown in Figure 10.

In summary, the profiles for the survey show that the preservice elementary teachers discriminated with respect to different aspects of culture and science. They are clearly in favor of science education for all students, and hence cannot be considered "anti-science" in any credible way. 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 also 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 and morality. They are also somewhat skeptical about the openness of the science community to women and minorities.

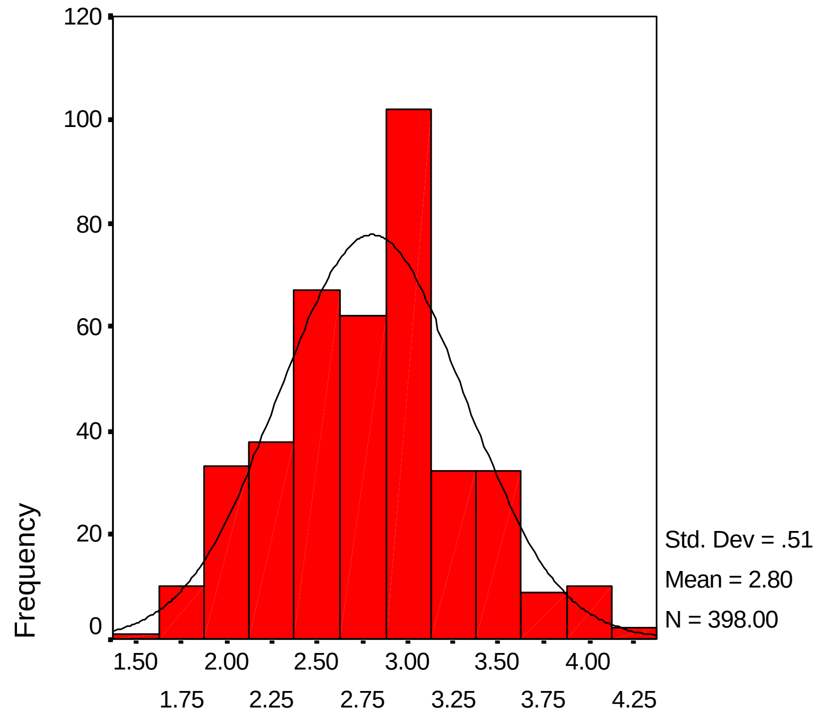


Figure 9. Epistemology Category Means

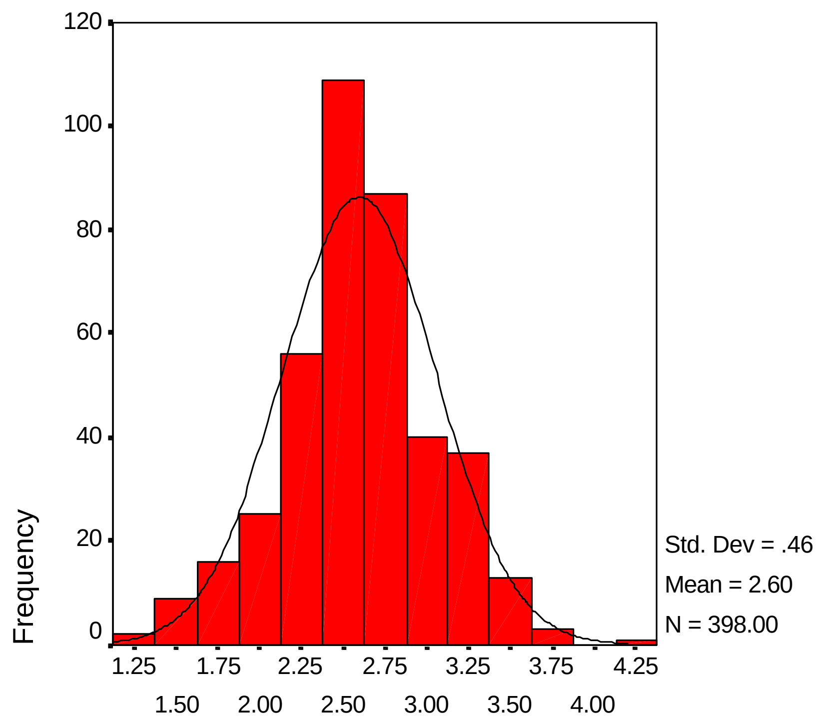


Figure 10. Science, Religion and Morality Category Means

DISCUSSION OF EXPERIMENTAL RESULTS

Gender Discussion: Gender Differences on Category Means

In our administration of the survey, the preservice teachers were asked to report gender and to respond to a question about science interest. With this information it is possible to break out the category means by both gender and science interest, as well as to explore any interactions between gender and science interest with respect to the various category means. Of the 398 surveys, women completed 330 surveys, men completed 62 surveys, and 6 surveys were returned unmarked (see Table 5).

Table 5. Gender Frequencies amongst Respondents

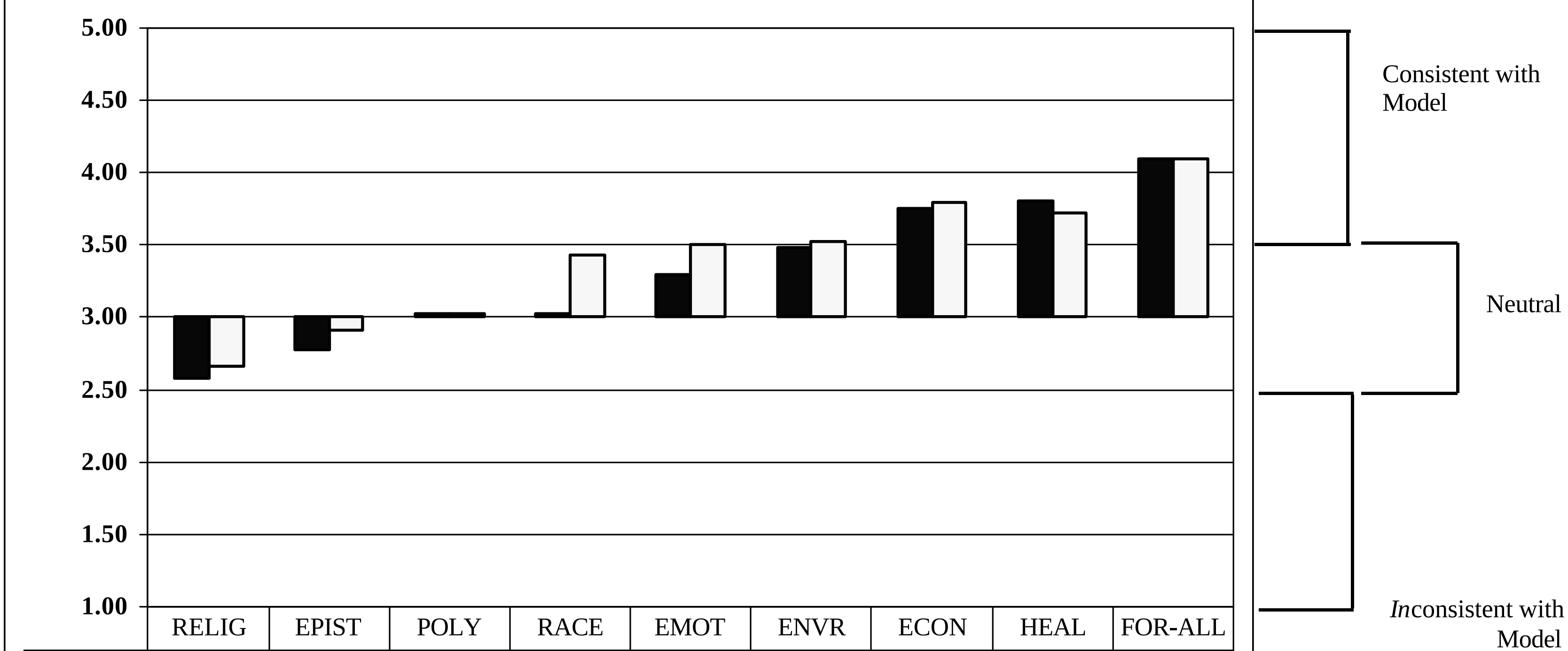
		Frequency	Percent
Valid Cases	Females	330	82.9
	Males	62	15.6
	Total	392	98.5
Missing Cases	System	6	1.5
Total		398	100.0

The category means for men and women subjects are given in Table 6 and plotted in Figure 12. The rank orders are the same for both groups with the exception of a reversal between "Science and Public Health" (HEAL) and "Science and the Economy" (ECON) at the second and third ranks. As will be seen later, this reversal of rank ordered means is not significant since there are no significant differences between the means of the relevant categories for the two groups (see Table 10).

Table 6. Category Means for Females and Males

			Mean (N=330)	Std. Dev.			**(N=62)**	Std. Dev.
FOR-ALL	1.5	5.0	**4.10**	0.577	1.4	5.0	**4.10**	0.587
HEAL	1.3	5.0	**3.81**	0.527	2.5	5.0	**3.72**	0.542
ECON	2.1	4.9	**3.75**	0.389	1.8	4.8	**3.79**	0.402
ENVIR	1.5	5.0	**3.48**	0.576	2.0	4.8	**3.53**	0.591
EMOT	1.5	4.8	**3.29**	0.490	2.3	4.5	**3.51**	0.486
RACE	1.0	5.0	**3.03**	0.366	2.0	5.0	**3.43**	0.367
POLY	1.9	4.3	**3.03**	0.845	2.1	3.8	**3.03**	0.841
EPIST	1.4	4.2	**2.78**	0.516	1.9	4.0	**2.91**	0.511
RELIG	1.3	3.7	**2.58**	0.436	1.4	4.1	**2.66**	0.460
TOTAL	2.7	4.1	**3.30**	0.244	2.5	4.2	**3.38**	0.253

Figure 12. Ranked Female Category Means with Male Category Means



	RELIG	EPIST	POLY	RACE	EMOT	ENVR	ECON	HEAL	FOR-ALL
■ Females	2.58	2.78	3.03	3.03	3.29	3.48	3.75	3.81	4.10
□ Males	2.66	2.91	3.03	3.43	3.51	3.53	3.79	3.72	4.10

RELIG	Category 6: Science, Religion and Morality
EPIST	Category 1: Epistemology
POLY	Category 4: Public Policy and Science
RACE	Category 8: Science, Race and Gender
EMOT	Category 7: Science, Emotions and Aesthetics
ENVIR	Category 3: Science and the Environment
ECON	Category 2: Science and the Economy
HEAL	Category 5: Science and Public Health
FOR-ALL	Category 9: Science for All

The 95% confidence intervals and the ANOVA analyses for differences between category means are given below in Tables 9 and 10. The category profiles, as seen in Figure 13, are similar for both groups. However, there was a small but statistically significant difference (at $p < 0.05$, but not at our more stringent level of 0.01) between the two groups on TOTAL survey score. On the TOTAL, men students were more consistent with the model than were female students (see Table 7).

The statistical analysis showed no significant difference in seven of nine categories, including the "Science for All" category. The statistical differences ($p < 0.01$) between category means came in the "Science, Race and Gender" and "Science, Emotions and Aesthetics" categories. With a category mean of 3.0, the women students were neutral with respect to how open the science community is to women and minorities. The men students, with mean of 3.4, were just under the “consistent with the model” mark. In other words, the men students appear to believe that science is more open to women and minorities than the women believe that it is. With a category mean of 3.3 for the "Science, Emotions and Aesthetics" category, the women students were within the “neutral with respect to the model” range but leaning towards the “consistent with the model” mark. On the other hand, with a category mean of 3.5, the men students appear more inclined to see science as objective and of more value than the arts, yet a discipline that can still contribute to aesthetic appreciation (see Table 7).

Table 7. Categories with Significant Differences between Men and Women

	Female	Male	*Sig*
EMOT	3.3	3.5	***.00***
RACE	3.0	3.4	***.00***
TOTAL	3.3	3.4	***.03***

Science Interest Differences and Category Means

For an indication of science interest, the students were 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 were marked “dislike” for the number one and “like very much” for the number five. As can be seen in Table 8, Table 11, and Figure 13, the mean for student interest in science based on experiences with school science is 3.3, only slightly above the neutral mark.

Table 8. Statistics for the Question: “Based on all your experiences with school science, is

	N	Min	Max	Mean	Std. Dev.	Skew	Std. Error	Kurtosis	Std. Error
Valid Cases	393	1	5	3.32	1.21	-.372	.123	-.750	.246
Missing Cases	5								

Table 9. The 95% Confidence Intervals for Category Means by Gender

		N	Mean	Std. Dev.	Std. Error	95% Confidence Interval for Mean		Min.	Max.	F	Sig
						Lower Bound	Upper Bound				
EPIST	1	330	2.7801	0.5157	0.0284	2.7243	2.8359	1.44	4.22	3.602	0.058
	2	62	2.914	0.4759	0.0604	2.7931	3.0348	1.89	4		
	Total	392	2.8013	0.5113	0.0258	2.7505	2.852	1.44	4.22		
ECON	1	330	3.7462	0.3889	0.0214	3.7041	3.7883	2.1	4.9	0.503	0.479
	2	62	3.7857	0.465	0.0591	3.6676	3.9038	1.8	4.8		
	Total	392	3.7525	0.4015	0.0203	3.7126	3.7923	1.8	4.9		
ENVIRON	1	330	3.478	0.5757	0.0317	3.4157	3.5404	1.5	5	0.483	0.487
	2	62	3.5349	0.6698	0.0851	3.3648	3.7051	2	4.75		
	Total	392	3.487	0.591	0.0299	3.4283	3.5457	1.5	5		
POLICY	1	330	3.0271	0.3656	0.0201	2.9875	3.0667	1.9	4.3	0.017	0.897
	2	62	3.0337	0.3751	0.0476	2.9384	3.1289	2.1	3.8		
	Total	392	3.0281	0.3667	0.0185	2.9917	3.0646	1.9	4.3		
HEALTH	1	330	3.8136	0.5275	0.0290	3.7565	3.8708	1.25	5	1.503	0.221
	2	62	3.7218	0.6109	0.0776	3.5666	3.8769	2.5	5		
	Total	392	3.7991	0.5417	0.0274	3.7453	3.8529	1.25	5		
RELIGION	1	330	2.5804	0.4359	0.0240	2.5332	2.6277	1.29	3.67	1.591	0.208
	2	62	2.6607	0.5704	0.0725	2.5158	2.8055	1.43	4.14		
	Total	392	2.5931	0.4599	0.0232	2.5475	2.6388	1.29	4.14		
EMOTION	1	330	3.2939	0.4895	0.0270	3.2409	3.3469	1.5	4.75	10.375	***0.001***
	2	62	3.5081	0.427	0.0542	3.3996	3.6165	2.25	4.5		
	Total	392	3.3278	0.486	0.0246	3.2795	3.3761	1.5	4.75		
RACE	1	330	3.0326	0.8446	0.0465	2.9411	3.124	1	5	12.074	***0.001***
	2	62	3.4315	0.7413	0.0942	3.2432	3.6197	2	5		
	Total	392	3.0957	0.841	0.0425	3.0122	3.1792	1	5		
FOR_ALL	1	330	4.0983	0.5769	0.0318	4.0358	4.1607	1.5	5	0	0.991
	2	62	4.0974	0.6433	0.0817	3.934	4.2607	1.38	5		
	Total	392	4.0981	0.587	0.0297	4.0398	4.1564	1.38	5		
TOTAL	1	330	3.3016	0.2443	0.0135	3.2752	3.3281	2.65	4.12	4.612	***0.032***
	2	62	3.3764	0.2871	0.0365	3.3035	3.4493	2.48	4.23		
	Total	392	3.3135	0.2526	0.0128	3.2884	3.3385	2.48	4.23		

Table 10. ANOVA Table for Category Means by Gender

		Sum of Squares	df	Mean Square	F	Sig.
EPIST	Between Groups	0.936	1	0.936	3.602	0.058
	Within Groups	101.297	390	0.260		
	Total	102.233	391			
ECON	Between Groups	0.081	1	0.081	0.503	0.479
	Within Groups	62.961	390	0.161		
	Total	63.042	391			
ENVIRON	Between Groups	0.169	1	0.169	0.483	0.487
	Within Groups	136.397	390	0.350		
	Total	136.566	391			
POLICY	Between Groups	0.002	1	0.002	0.017	0.897
	Within Groups	52.569	390	0.135		
	Total	52.571	391			
HEALTH	Between Groups	0.440	1	0.440	1.503	0.221
	Within Groups	114.302	390	0.293		
	Total	114.742	391			
RELIGION	Between Groups	0.336	1	0.336	1.591	0.208
	Within Groups	82.373	390	0.211		
	Total	82.709	391			
EMOTION	Between Groups	2.393	1	2.393	10.375	***0.001***
	Within Groups	89.956	390	0.231		
	Total	92.349	391			
RACE	Between Groups	8.304	1	8.304	12.074	***0.001***
	Within Groups	268.233	390	0.688		
	Total	276.538	391			
FOR_ALL	Between Groups	0.000	1	0.000	0	0.991
	Within Groups	134.719	390	0.345		
	Total	134.719	391			
TOTAL	Between Groups	0.292	1	0.292	4.612	***0.032***
	Within Groups	24.662	390	0.063		
	Total	24.953	391			

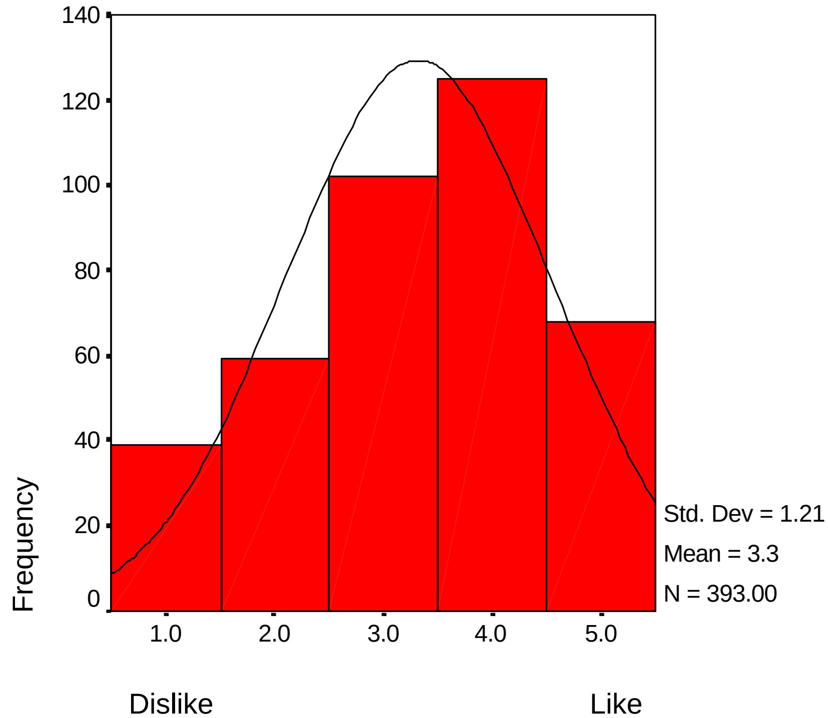


Figure 13. Frequency Distribution for the Question: "Based on all your experiences with school science, is science a subject you like?"

Table 11. Frequency Distribution for the Question: "Based on all your experiences with school science, is science a subject you like?"

	Response	Frequency	Percent	Re-grouped Cases	
Valid Cases	1	39	9.8	98	**Low Science Interest**
	2	59	14.8		
	3	102	25.6	102	**Neutral**
	4	125	31.4	193	**High Science Interest**
	5	68	17.1		
	Total	393	98.7		
Missing Cases	System	5	1.3		
Total		398	100.0		

As shown in Table 11, the responses to the question on interest were recoded into three groups: low science interest, neutral, and high science interest. The descriptive statistics for all three groups are given in Table 15. The ANOVA results for testing category means by interest in science are shown in Table 13 and Table 14. We focused our attention on the low and high science interest groups. The rank order of category means is the same for both groups as shown in Table 12. The category profiles for the low and high science interest groups are shown in Figure 14.

Table 12. Category Means for High and Low Interest Groups Ranked by High Group

	High Interest Group	**Low Interest Group**
RELIG	2.62	2.57
EPIST	2.83	2.86
POLY	3.05	3.05
RACE	3.17	2.91
EMOT	3.38	3.24
ENVR	3.53	3.42
ECON	3.80	3.71
HEAL	3.81	3.79
FOR-ALL	4.18	3.88
TOTAL	3.35	3.26

The statistical analysis showed that the total survey score for the two groups differed significantly. As shown in Table 13 and Table 16, the total survey means for the high (mean = 3.35) and low (mean = 3.26) interest groups are statistically significant. Both means fall within the "neutral with respect to the model" range. In addition to the survey totals, the mean scores in two categories also showed significant differences. In the "Science, Race and Gender" category, the high interest group had a mean of 3.17 while the low science interest group had a mean of 2.91 (see Table 16). Again, both means fall within the "neutral with respect to the model" range. Last, the means in the "Science for All" category for the two groups differed significantly. The mean for the high science interest group was 4.18 to a mean of 3.88 for the low science interest group (see Table 16). However, in both cases the category mean is "consistent with the model."

Table 13. ANOVA Table for Category Means by Interest in Science

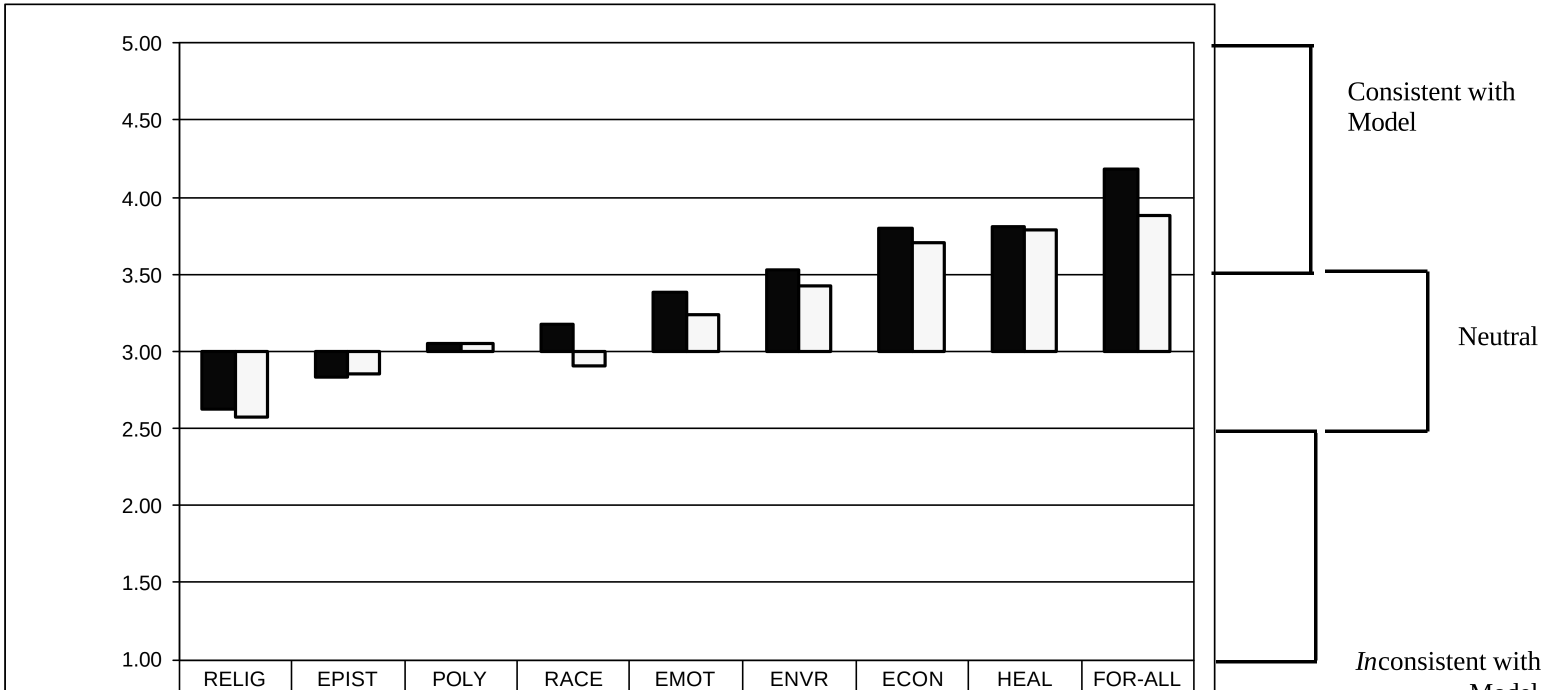
		Sum of Squares	df	Mean Square	F	Sig.
EPIST	Between Groups	1.584	2	.792	3.068	.05
	Within Groups	100.688	390	.258		
	Total	102.272	392			
ECON	Between Groups	.788	2	.394	2.462	.09
	Within Groups	62.453	390	.160		
	Total	63.242	392			
ENVIRON	Between Groups	.914	2	.457	1.313	.27
	Within Groups	135.721	390	.348		
	Total	136.635	392			
POLICY	Between Groups	.588	2	.294	2.194	.11
	Within Groups	52.262	390	.134		
	Total	52.850	392			
HEALTH	Between Groups	1.405E-02	2	7.026E-03	.024	.98
	Within Groups	114.768	390	.294		
	Total	114.782	392			
RELIGION	Between Groups	.321	2	.160	.755	.47
	Within Groups	82.866	390	.212		
	Total	83.187	392			
EMOTION	Between Groups	1.426	2	.713	3.059	.05
	Within Groups	90.929	390	.233		
	Total	92.355	392			
*RACE**	Between Groups	4.678	2	2.339	3.355	***.04***
	Within Groups	271.869	390	.697		
	Total	276.547	392			
*FOR_ALL**	Between Groups	6.158	2	3.079	9.211	***.00***
	Within Groups	130.374	390	.334		
	Total	136.532	392			
*TOTAL**	Between Groups	.665	2	.333	5.342	***.01***
	Within Groups	24.292	390	6.229E-02		
	Total	24.957	392			

* Significance values at <0.05 are in bold print.

Table 14. Scheffe Test for Category Mean Differences by Interest Level

Dependent Variable	(I) 1=High, 2=Neutral, 3=Low	(J) 1=High, 2=Neutral, 3-Low	Mean Diff. (I-J)	Std. Error	Sig.	95% Conf. Interval	
						Lower Bound	Upper Bound
EPIST	1	2	.1283	6.220E-02	.121	-2.4563E-02	.2811
		3	-3.6963E-02	6.302E-02	.842	-.1918	.1179
	2	1	-.1283	6.220E-02	.121	-.2811	2.456E-02
		3	-.1652	7.187E-02	.072	-.3418	1.137E-02
	3	1	3.696E-02	6.302E-02	.842	-.1179	.1918
		2	.1652	7.187E-02	.072	-1.1366E-02	.3418
ECON	1	2	8.874E-02	4.899E-02	.195	-3.1633E-02	.2091
		3	9.046E-02	4.964E-02	.191	-3.1502E-02	.2124
	2	1	-8.8736E-02	4.899E-02	.195	-.2091	3.163E-02
		3	1.727E-03	5.660E-02	1.000	-.1374	.1408
	3	1	-9.0464E-02	4.964E-02	.191	-.2124	3.150E-02
		2	-1.7274E-03	5.660E-02	1.000	-.1408	.1374
ENVIR	1	2	7.501E-02	7.221E-02	.584	-.1024	.2525
		3	.1115	7.317E-02	.314	-6.8292E-02	.2913
	2	1	-7.5007E-02	7.221E-02	.584	-.2525	.1024
		3	3.650E-02	8.344E-02	.909	-.1685	.2415
	3	1	-.1115	7.317E-02	.314	-.2913	6.829E-02
		2	-3.6498E-02	8.344E-02	.909	-.2415	.1685
POLY	1	2	8.658E-02	4.481E-02	.156	-2.3528E-02	.1967
		3	-4.5921E-03	4.541E-02	.995	-.1162	.1070
	2	1	-8.6582E-02	4.481E-02	.156	-.1967	2.353E-02
		3	-9.1174E-02	5.178E-02	.214	-.2184	3.606E-02
	3	1	4.592E-03	4.541E-02	.995	-.1070	.1162
		2	9.117E-02	5.178E-02	.214	-3.6058E-02	.2184
HEAL	1	2	1.158E-02	6.641E-02	.985	-.1516	.1748
		3	1.233E-02	6.729E-02	.983	-.1530	.1777
	2	1	-1.1582E-02	6.641E-02	.985	-.1748	.1516
		3	7.503E-04	7.673E-02	1.000	-.1878	.1893
	3	1	-1.2332E-02	6.729E-02	.983	-.1777	.1530
		2	-7.5030E-04	7.673E-02	1.000	-.1893	.1878
RELIG	1	2	6.340E-02	5.643E-02	.532	-7.5247E-02	.2021
		3	4.866E-02	5.718E-02	.696	-9.1832E-02	.1891
	2	1	-6.3405E-02	5.643E-02	.532	-.2021	7.525E-02
		3	-1.4746E-02	6.520E-02	.975	-.1750	.1455
	3	1	-4.8659E-02	5.718E-02	.696	-.1891	9.183E-02
		2	1.475E-02	6.520E-02	.975	-.1455	.1750
EMOT	1	2	6.922E-02	5.911E-02	.504	-7.6025E-02	.2145
		3	.1466	5.989E-02	.051	-5.8675E-04	.2937
	2	1	-6.9216E-02	5.911E-02	.504	-.2145	7.602E-02
		3	7.736E-02	6.830E-02	.527	-9.0461E-02	.2452
	3	1	-.1466	5.989E-02	.051	-.2937	5.868E-04
		2	-7.7364E-02	6.830E-02	.527	-.2452	9.046E-02
RACE	1	2	3.863E-02	.1022	.931	-.2125	.2898
		3	.2628	.1036	**.041**	8.350E-03	.5173
	2	1	-3.8632E-02	.1022	.931	-.2898	.2125
		3	.2242	.1181	.166	-6.6003E-02	.5144
	3	**1**	-.2628	.1036	**.041**	-.5173	-8.3497E-03
		2	-.2242	.1181	.166	-.5144	6.600E-02
FOR_ALL	1	2	2.557E-02	7.078E-02	.937	-.1483	.1995
		3	.2971	7.172E-02	**.000**	.1209	.4734
	2	1	-2.5566E-02	7.078E-02	.937	-.1995	.1483
		3	.2716	8.178E-02	.004	7.062E-02	.4725
	3	**1**	-.2971	7.172E-02	**.000**	-.4734	-.1209
		2	-.2716	8.178E-02	.004	-.4725	-7.0624E-02
TOTAL	1	2	7.274E-02	3.055E-02	.060	-2.3334E-03	.1478
		3	9.032E-02	3.096E-02	**.015**	1.425E-02	.1664
	2	1	-7.2737E-02	3.055E-02	.060	-.1478	2.333E-03
		3	1.758E-02	3.530E-02	.883	-6.9160E-02	.1043
	3	**1**	-9.0320E-02	3.096E-02	**.015**	-.1664	-1.4254E-02
		2	-1.7583E-02	3.530E-02	.883	-.1043	6.916E-02

Figure 14. Ranked High Interest Category Means with Low Interest Category Means



	RELIG	EPIST	POLY	RACE	EMOT	ENVR	ECON	HEAL	FOR-ALL
■ High Interest	2.62	2.83	3.05	3.17	3.38	3.53	3.80	3.81	4.18
□ Low Interest	2.57	2.86	3.05	2.91	3.24	3.42	3.71	3.79	3.88

RELIG	Category 6: Science, Religion and Morality
EPIST	Category 1: Epistemology
POLY	Category 4: Public Policy and Science
RACE	Category 8: Science, Race and Gender
EMOT	Category 7: Science, Emotions and Aesthetics
ENVIR	Category 3: Science and the Environment
ECON	Category 2: Science and the Economy
HEAL	Category 5: Science and Public Health
FOR-ALL	Category 9: Science for All

Table 15. The 95% Confidence Intervals for Category Means by Interest

Categories	High=1, Neutral=2, Low=3	N	Mean	Std. Dev.	Std. Err.	95% Conf. Interval for Mean		Min	Max
						Lower Bound	Upper Bound		
EPIST	1	193	2.8258	.5356	3.856E-02	2.7498	2.9019	1.67	4.22
	2	102	2.6976	.4494	4.449E-02	2.6093	2.7858	1.67	3.89
	3	98	2.8628	.5097	5.149E-02	2.7606	2.9650	1.44	4.22
	Total	393	2.8018	.5108	2.577E-02	2.7511	2.8524	1.44	4.22
ECON	1	193	3.7992	.4375	3.149E-02	3.7371	3.8613	1.80	4.90
	2	102	3.7105	.3502	3.467E-02	3.6417	3.7792	2.89	4.50
	3	98	3.7087	.3705	3.742E-02	3.6345	3.7830	2.40	4.80
	Total	393	3.7536	.4017	2.026E-02	3.7138	3.7934	1.80	4.90
ENVIR	1	193	3.5350	.5446	3.920E-02	3.4576	3.6123	1.50	5.00
	2	102	3.4600	.6398	6.335E-02	3.3343	3.5856	1.75	5.00
	3	98	3.4235	.6212	6.275E-02	3.2989	3.5480	2.00	5.00
	Total	393	3.4877	.5904	2.978E-02	3.4292	3.5463	1.50	5.00
POLY	1	193	3.0481	.3606	2.596E-02	2.9969	3.0993	2.00	4.30
	2	102	2.9615	.3836	3.798E-02	2.8862	3.0369	1.90	3.90
	3	98	3.0527	.3580	3.616E-02	2.9810	3.1245	2.30	4.10
	Total	393	3.0268	.3672	1.852E-02	2.9904	3.0632	1.90	4.30
HEAL	1	193	3.8057	.5744	4.134E-02	3.7242	3.8872	1.25	5.00
	2	102	3.7941	.5247	5.195E-02	3.6911	3.8972	1.50	4.75
	3	98	3.7934	.4935	4.986E-02	3.6944	3.8923	2.50	5.00
	Total	393	3.7996	.5411	2.730E-02	3.7460	3.8533	1.25	5.00
RELIG	1	193	2.6235	.4861	3.499E-02	2.5545	2.6925	1.29	3.86
	2	102	2.5601	.4078	4.038E-02	2.4800	2.6402	1.43	3.57
	3	98	2.5748	.4619	4.666E-02	2.4822	2.6674	1.29	4.14
	Total	393	2.5949	.4607	2.324E-02	2.5492	2.6406	1.29	4.14
EMOT	1	193	3.3821	.5033	3.623E-02	3.3107	3.4536	2.00	4.75
	2	102	3.3129	.4185	4.143E-02	3.2307	3.3951	2.50	4.75
	3	98	3.2355	.5037	5.088E-02	3.1346	3.3365	1.50	4.75
	Total	393	3.3276	.4854	2.448E-02	3.2795	3.3757	1.50	4.75
RACE	1	193	3.1710	.8080	5.816E-02	3.0563	3.2857	1.00	5.00
	2	102	3.1324	.8814	8.727E-02	2.9592	3.3055	1.00	5.00
	3	98	2.9082	.8376	8.461E-02	2.7402	3.0761	1.00	5.00
	Total	393	3.0954	.8399	4.237E-02	3.0121	3.1787	1.00	5.00
FOR_ALL	1	193	4.1754	.6019	4.332E-02	4.0900	4.2609	1.38	5.00
	2	102	4.1499	.4773	4.726E-02	4.0561	4.2436	2.63	5.00
	3	98	3.8783	.6244	6.307E-02	3.7531	4.0035	2.00	5.00
	Total	393	4.0947	.5902	2.977E-02	4.0362	4.1532	1.38	5.00
TOTAL	1	193	3.3547	.2599	1.871E-02	3.3178	3.3916	2.48	4.12
	2	102	3.2820	.2360	2.337E-02	3.2356	3.3283	2.75	3.88
	3	98	3.2644	.2424	2.448E-02	3.2158	3.3130	2.75	4.23
	Total	393	3.3133	.2523	1.273E-02	3.2883	3.3383	2.48	4.23

Table 16. Categories with Significant Differences between High and Low Interest Groups

	High	Low	*Sig*
RACE	3.17	2.91	***.04***
For_All	4.18	3.88	***.00***
TOTAL	3.35	3.26	***.01***

Science Interest Differences by Gender *and* Category Means

The Chi Square statistics for science interest by gender are presented in Tables 17 and 18. The expected distribution of gender over the interest categories is rejected at the p = 0.01 level. The percentage of men falling in the high interest category is a significantly larger percentage of their members than is true for the women. This is strikingly evident in Figure 15 below. Over 50% of the women students fall in the neutral or low science interest categories in contrast to about 31% of the men.

Figure 15. Science Interest Categories by Gender

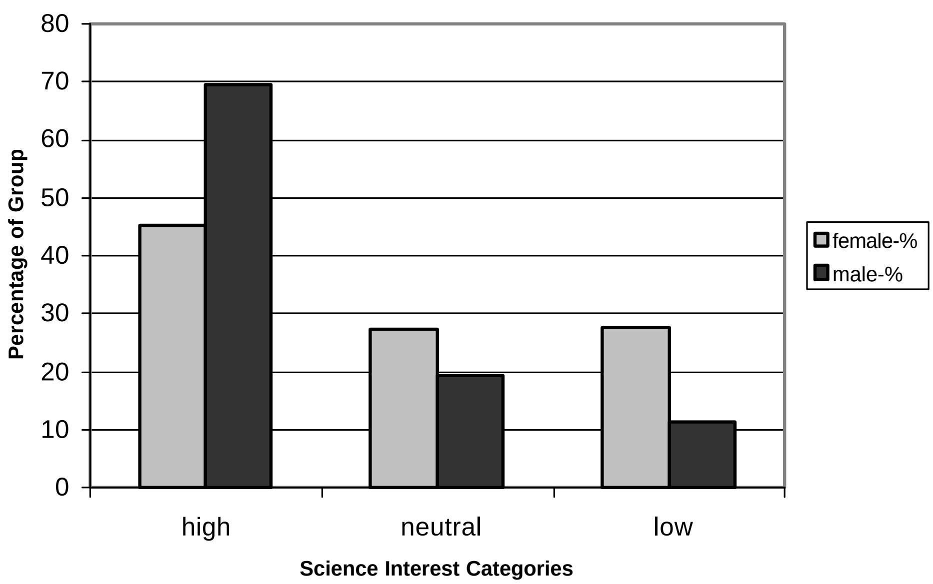


Table 17. Frequency of Science Interest Category by Gender

		Female	Male	Total
High Interest	Count	**149**	**43**	192
	Expected Count	161.6	30.4	192.0
	% Within row	77.6%	22.4%	100.0%
	% Within column	**45.2%**	**69.4%**	49.0%
	% Of Total	38.0%	11.0%	49.0%
Neutral	Count	**90**	**12**	102
	Expected Count	85.9	16.1	102.0
	% Within row	88.2%	11.8%	100.0%
	% Within column	**27.3%**	**19.4%**	26.0%
	% Of Total	23.0%	3.1%	26.0%
Low Interest	Count	**91**	**7**	98
	Expected Count	82.5	15.5	98.0
	% Within row	92.9%	7.1%	100.0%
	% Within column	**27.6%**	**11.3%**	25.0%
	% Of Total	23.2%	1.8%	25.0%
Total	Count	**330**	**62**	392
	Expected Count	330.0	62.0	392.0
	% Within row	**84.2%**	**15.8%**	100.0%
	% Within column	100.0%	100.0%	100.0%
	% Of Total	84.2%	15.8%	100.0%

Table 18. Chi Square Statistics on Gender and Science Interest

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	13.037[a]	2	.001
Likelihood Ratio	13.739	2	.001
Linear-by-Linear Association	12.509	1	.000
N of Valid Cases	392		

[a] Zero cells have expected count less than 5. The minimum expected count is 15.50.

The balance of this report focuses on the interaction between the category means, and gender and science interest. Our research examined the following four null hypotheses:

1. There are no significant differences on the category and total survey means between women preservice teachers of high and low science interest.

2. There are no significant differences on the category and total survey means between men preservice teachers of high and low science interest.

3. There are no significant differences on the category and total survey means between men and women preservice teachers of high science interest.

4. There are no significant differences on the category and total survey means between men and women preservice teachers of low science interest.

The analyses pertinent to these four null hypotheses are discussed below. In each case, the individual survey items for a category are examined where there are significant differences between the category means of the two groups in question. As a practical guide, we are interested in survey items where the difference between item means for two groups is 0.50 or greater.

Table 19. Separate Men and Women Ranked Category Means

Women Preservice Teachers			Men Preservice Teachers		
	High Interest	Low Interest		High Interest	Low Interest
RELIG	2.60	2.56	RELIG	2.71	2.76
EPIST	2.80	2.85	EPIST	2.92	3.02
POLY	3.05	3.05	POLY	3.05	3.10
*RACE**	3.12	2.84	RACE	3.35	3.82
EMOT	3.33	3.23	EMOT	3.56	3.36
ENVIR	3.72	3.43	ENVIR	3.59	3.39
ECON	3.79	3.71	HEAL	3.71	3.71
HEAL	3.83	3.80	ECON	3.83	3.69
*FOR-ALL**	4.20	3.86	FOR-ALL	4.11	4.09
TOTAL	3.34	3.25	TOTAL	3.40	3.40

*Category mean differences are significant at $p < 0.05$.

Table 20. ANOVA on Category Means by Gender and Science Interest

CAT	Gender	Interest	Mean	*F*	Sig
EPIST	Female	High	2.80	2.687	–
		Low	2.85		
	Male	High	2.92	0.329	–
		Low	3.02		
ECON	Female	High	3.79	1.372	–
		Low	3.71		
	Male	High	3.83	0.913	–
		Low	3.69		
ENVIR	Female	High	3.52	0.728	–
		Low	3.43		
	Male	High	3.59	0.521	–
		Low	3.39		
POLY	Female	High	3.05	1.712	–
		Low	3.05		
	Male	High	3.05	0.664	–
		Low	3.10		
HEAL	Female	High	3.83	0.168	–
		Low	3.80		
	Male	High	3.71	0.047	–
		Low	3.71		
RELIG	Female	High	2.60	0.184	–
		Low	2.56		
	Male	High	2.71	1.087	–
		Low	2.76		
EMOT	Female	High	3.33	1.335	–
		Low	3.23		
	Male	High	3.56	1.008	–
		Low	3.36		
RACE	Female	High	3.12	3.443	***.04***
		Low	2.84		
	Male	High	3.35	1.300	–
		Low	3.82		
FOR-ALL	Female	High	4.20	11.33	***.00***
		Low	3.86		
	Male	High	4.11	0.052	–
		Low	4.09		
TOTAL	Female	High	3.34	4.278	***.02***
		Low	3.25		
	Male	High	3.40	0.740	–
		Low	3.40		

NULL Hypothesis 1: There are no significant differences on category and total survey means between women preservice teachers of high and low science interest.

The category profiles for women of high science interest and women of low science interest are shown in Figure 16. In Table 19, we show the ranked category means for men and women with gender broken out into high and low science interest groups. The table rank orders for women of high science interest and women of low science interest are the same. There is also no significant difference between the total survey means for women of high science interest and women of low science interest; hence, that portion of **Null Hypothesis 1** is sustained. There are, however, significant differences for the "Science, Race and Gender" and "Science For-All" category means (see Table 20).

For both groups, the "Science, Race and Gender" category mean falls in the "neutral with respect to the model" range. At 3.12, the high science interest women are on the positive side of neutrality, while at 2.84, the low science interest women are on the negative side. The item responses for both groups are shown in Table 21. Although **Null Hypothesis 1** is statistically rejected for this category, for all four items in this category, the difference between item means is less than our practical standard of 0.50.

The category means for "Science for All" for both women with high science interest and women with low science interest fall in the "consistent with respect to the model" range. With a category mean of 4.20, however, the high science interest women are considerably more positive about "Science for All" than are low science interest women with a category mean of 3.86. **Null Hypothesis 1** is statistically rejected for this category.

There are eight items in the "Science for All" category. The individual item responses for this category for both groups are shown in Table 22. Two of the eight items have item mean differences of 0.50 or greater. Item 13 asserts that students should not be forced to take science courses at the university level. Consistent with the model, women with high science interest strongly rejected this assertion with an item mean of 4.03. At a mean of 3.49, women with low science interest were within the neutral range with respect to the model.

Item 54 asserts that most people do not need to know very much science. Consistent with the model, women with high science interest strongly rejected this assertion with an item mean of 4.03. At a mean of 3.53, women with low science interest also rejected the model response but at a much lower level.

In summary, **NULL Hypothesis 1** – that there are no significant differences on category and total survey means between women preservice teachers of high and low science interest – is rejected for two categories and the total survey mean. Women preservice elementary teachers with high science interest have views more "consistent with the model" than do preservice elementary teachers with low science interest. However, the total survey means for both groups are within the "neutral with respect to the model" range. The biggest difference between the two groups appears to be in their attitudes about the necessity of college level science for all students and the level of need that all people have for science. On both counts, the women preservice elementary teachers with high science interest are considerable more "consistent with the model" than are the other preservice women teachers.

Table 21. Women Preservice Elementary Science Teachers' Responses to "Science, Race & Gender" Category Items (Percentage at Each Response Level)

				*In*consistent with Model		Neutral	Consistent with Model			
			N	**1**	**2**	**3**	**4**	**5**	**Mean**	
4	Women are welcome in science just as much as men are.	High	149	6.0	24.8	12.8	26.8	29.5	3.49	
		Low	91	4.4	40.7	16.5	14.3	24.2	3.13	= 0.36
23	The scientific community is mostly dominated by white men and is often unfriendly to minority people. (reverse polarity)	High	149	7.4	30.9	35.6	24.2	2.0	2.83	
		Low	91	12.1	39.6	33.0	13.2	2.2	2.54	
30	African Americans and other minority people are just as welcome in the scientific community as are white people.	High	149	5.4	21.5	28.9	26.8	17.4	3.30	
		Low	91	9.9	20.9	36.3	11.0	22.0	3.14	
53	The scientific community is mostly dominated by men and is often unfriendly to women. (reverse polarity)	High	149	7.4	26.8	40.9	20.8	4.0	2.87	
		Low	91	15.4	30.8	40.7	11.0	2.2	2.54	

Table 22. Women Preservice Elementary Science Teachers' Responses to "Science for All" Category Items (Percentage at Each Response Level)

				*In*consistent with Model		Neutral	Consistent with Model			
			N	**1**	**2**	**3**	**4**	**5**	**Mean**	
13	Students should not be forced to take science courses at the university. (reverse polarity)	High	149	3.4	9.4	8.7	38.3	40.3	4.03	
		Low	91	8.8	14.3	14.3	44.0	18.7	3.49	=**0.54**
15	Science should not be made an important subject for the elementary school grades. (reverse polarity)	High	148	6.1	2.0	.7	19.6	71.6	4.49	
		Low	90	2.2	4.4	1.1	38.9	53.3	4.37	
24	Understanding science is a good thing for everyone.	High	149	2.7	1.3	3.4	37.6	55.0	4.41	
		Low	91	1.1	6.6	7.7	45.1	39.6	4.15	
37	Only a very few people really understand science. (reverse polarity)	High	149	2.0	18.1	20.1	49.0	10.7	3.48	
		Low	91	6.6	24.2	12.1	44.0	13.2	3.33	
52	All students should study science during the secondary school grade levels.	High	149	2.0	2.7	1.3	33.6	60.4	4.48	
		Low	91	2.2	3.3	3.3	56.7	34.4	4.18	
54	Most people really do not need to know very much science. (reverse polarity)	High	149	1.3	5.4	12.1	51.0	30.2	4.03	
		Low	91	2.2	18.7	15.4	51.6	12.1	3.53	**0.50**
55	Even at the university level all students should study at least some science.	High	149	1.3	4.7	5.4	46.3	42.3	4.23	
		Low	91	4.4	9.9	12.1	47.3	26.4	3.81	
56	Science should be taught at all school grade levels.	High	149	1.3	2.0	1.3	38.3	57.0	4.48	
		Low	91	1.1	7.7	7.7	51.6	31.9	4.05	

NULL Hypothesis 2: There are no significant differences on the category and total survey means between men preservice teachers of high and low science interest.

The category profiles for men of high science interest and men of low science interest are shown in Figure 17. As seen in Table 19, the ranks for men of high science interest and low science interest vary at several ranks. However, there are no significant differences in category means or the total survey means. Hence, **Null Hypothesis 2** is sustained.

In summary, **Null Hypothesis 2** – that there are no significant differences on the category and total survey means between men preservice teachers of high and low science interest – is sustained. Whether the men preservice teachers show high or low science interest, their category and total survey scores are about the same.

NULL Hypothesis 3: There are no significant differences on the category and total survey means between men and women preservice teachers of high science interest.

The category profiles for men and women of high science interest are shown in Figure 18. The ranked category means for high and low science interest broken out by gender is shown in Table 23. Men and women of high science interest show the same rank order of means. There is no significant difference between the total survey means, hence that portion of **Null Hypothesis 3** is sustained (see Table 24).

There is, however, a significant difference between men and women of high science interest on the category means for EMOT, "Science, Emotions and Aesthetics." With a category mean of 3.33, the women with high science interest are within the "neutral with respect to the model" range. In contrast, with a category mean of 3.56, the men with high science interest are just within the "consistent with the model" range. Hence, with respect to this category, **Null Hypothesis 3** is rejected (see Table 24).

Table 23. Men and Women Ranked Category Means Separated by Interest

High Interest				Low Interest		
	Women	Men			Women	Men
RELIG	2.60	2.71		RELIG	2.56	2.76
EPIST	2.80	2.92		*RACE**	2.84	3.82
POLY	3.05	3.05		EPIST	2.85	3.02
RACE	3.12	3.35		POLY	3.05	3.10
*EMOT***	3.33	3.56		EMOT	3.23	3.36
ENVIR	3.72	3.59		ENVIR	3.43	3.39
ECON	3.79	3.83		ECON	3.71	3.69
HEAL	3.83	3.71		HEAL	3.80	3.71
FOR-ALL	4.20	4.11		FOR-ALL	3.86	4.09
TOTAL	3.34	3.40		TOTAL	3.25	3.40

*Category mean differences are significant at $p < 0.05$.

Table 24. ANOVA on Category Means by Science Interest and Gender

CAT	Interest	Gender	Mean	*F*	Sig
EPIST	High	Female	2.80	1.740	–
		Male	2.92		
	Low	Female	2.85	0.677	–
		Male	3.02		
ECON	High	Female	3.79	0.494	–
		Male	3.84		
	Low	Female	3.72	0.029	–
		Male	3.69		
ENVIR	High	Female	3.52	0.650	–
		Male	3.59		
	Low	Female	3.43	0.018	–
		Male	3.39		
POLY	High	Female	3.05	0.002	–
		Male	3.05		
	Low	Female	3.05	0.130	–
		Male	3.10		
HEAL	High	Female	3.83	1.525	–
		Male	3.71		
	Low	Female	3.80	0.192	–
		Male	3.71		
RELIG	High	Female	2.60	1.724	–
		Male	2.71		
	Low	Female	2.56	1.150	–
		Male	2.76		
EMOT	High	Female	3.33	6.899	***0.009***
		Male	3.56		
	Low	Female	3.23	0.437	–
		Male	3.36		
RACE	High	Female	3.12	1.735	–
		Male	3.35		
	Low	Female	2.84	9.773	***0.002***
		Male	3.82		
FOR-ALL	High	Female	4.20	0.756	–
		Male	4.11		
	Low	Female	3.86	0.860	–
		Male	4.01		
TOTAL	High	Female	3.34	1.463	–
		Male	3.40		
	Low	Female	3.25	2.481	–
		Male	3.40		

There are four items in the "Science, Emotions and Aesthetics" category. The individual item responses for this category for both groups are shown in Table 25. Of the four, only one item has an item mean difference of 0.50 or greater. Item 12 asserts that scientific explanations tend to spoil the beauty of nature. Consistent with the model, both men and women with high science interest rejected this assertion with means of 4.02 and 3.76, respectively. However, the men's rejection is much stronger.

In summary, **NULL Hypothesis 3 –** that there is no significant difference on the category and total survey means between men and women preservice teachers of high science interest – is sustained for the total survey means. Both men and women preservice elementary teachers with high science interest have total survey means of 3.40, which is on the high end of the "neutral with respect to the model" range. **NULL Hypothesis 3** is rejected, however, for the "Science, Emotions and Aesthetics" category.

NULL Hypothesis 4: There are no significant differences on the category and total survey means between men and women preservice teachers of low science interest.

The category profiles for men and women of low science interest are shown in Figure 19. The ranked category means for men and women of low science interest are shown in Table 23. There is no significant difference between the total survey means; hence that portion of **Null Hypothesis 4** is sustained (see Table 24).

In Table 23, men and women of low science interest show the same rank order of means except at the RACE category, "Science, Race and Gender." The means for this category are also statistically different for the two groups. Women with low science interest have a category mean of 2.84, which is on the negative side of the "neutral with respect to the model" range. In contrast, men with low science interest have a category mean of 3.82, which is within the "consistent with respect to the model" range. **Null Hypothesis 4** with respect to the category means for "Science, Race and Gender" between men and women of low science interest is rejected. The item responses for both groups are shown in Table 26. Three of four items exceed our practical standard of 0.50.

In summary, **NULL Hypothesis 4 –** that there are no significant differences on the category and total survey means between men and women preservice teachers of low science interest – is sustained for the total survey means. However, the low science interest men preservice teachers have attitudes with respect to "Science, Race and Gender" that are much more "consistent with the model" than the women counterparts.

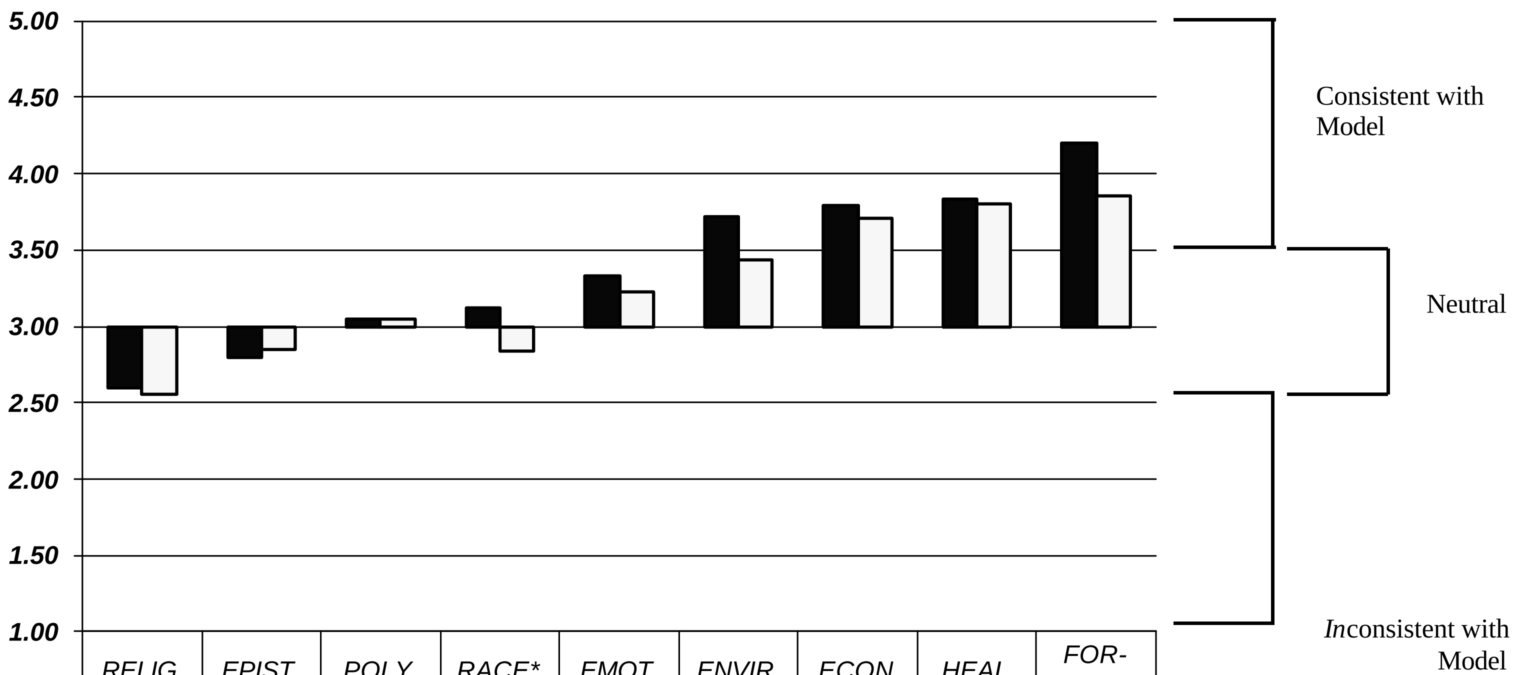
Table 25. High Science Interest Men and Women Preservice Elementary Teachers' Responses to "Science, Emotions and Aesthetics" Category Items (Percentage at Each Response Level)

			N	*In*consistent with Model		Neutral	Consistent with Model			
				1	**2**	**3**	**4**	**5**	**Mean**	
1	Human emotion plays no part in the creation of scientific knowledge.	♀	147	3.4	18.4	17.0	38.1	23.1	3.59	
		♂	43		11.6	18.6	34.9	34.9	3.93	= 0.34
12	Scientific explanations tend to spoil the beauty of nature. (reverse polarity)	♀	149	1.3	8.7	21.5	49.7	18.8	3.76	
		♂	43		4.7	14.0	55.8	25.6	4.02	**= 1.22**
21	It is equally important for a person to have scientific knowledge and an appreciation for the arts. (reverse polarity)	♀	149	34.2	43.0	7.4	13.4	2.0	2.06	
		♂	43	23.3	44.2	14.0	18.6	23.3	2.28	= 0.22
36	Science can contribute to our appreciation and experience of beauty.	♀	149	1.3	6.7	9.4	63.1	19.5	3.93	
		♂	43		2.3	16.3	60.5	20.9	4.00	= 0.07

Table 26. Low Science Interest Women and Men Preservice Elementary Science Teachers' Responses to "Science, Race & Gender" Category Items (Percentage at Each Response Level)

			N	*In*consistent with Model		Neutral	Consistent with Model			
				1	**2**	**3**	**4**	**5**	**Mean**	
4	Women are welcome in science just as much as men are.	♀	91	4.4%	40.7%	16.5%	14.3%	24.2%	3.13	
		♂	7		14.3%			85.7%	4.57	**= 1.44**
23	The scientific community is mostly dominated by white men and is often unfriendly to minority people. (reverse polarity)	♀	91	12.1%	39.6%	33.0%	13.2%	2.2%	2.54	
		♂	7		28.6%	42.9%	14.3%	14.3%	3.12	
30	African Americans and other minority people are just as welcome in the scientific community as are white people.	♀	91	9.9%	20.9%	36.3%	11.0%	22.0%	3.14	
		♂	7		14.3%	14.3%	14.3%	57.1%	4.14	**= 1.00**
53	The scientific community is mostly dominated by men and is often unfriendly to women. (reverse polarity)	♀	91	15.4%	30.8%	40.7%	11.0%	2.2%	2.54	
		♂	7		14.3%	42.9%	28.6%	14.3%	3.43	**= 0.89**

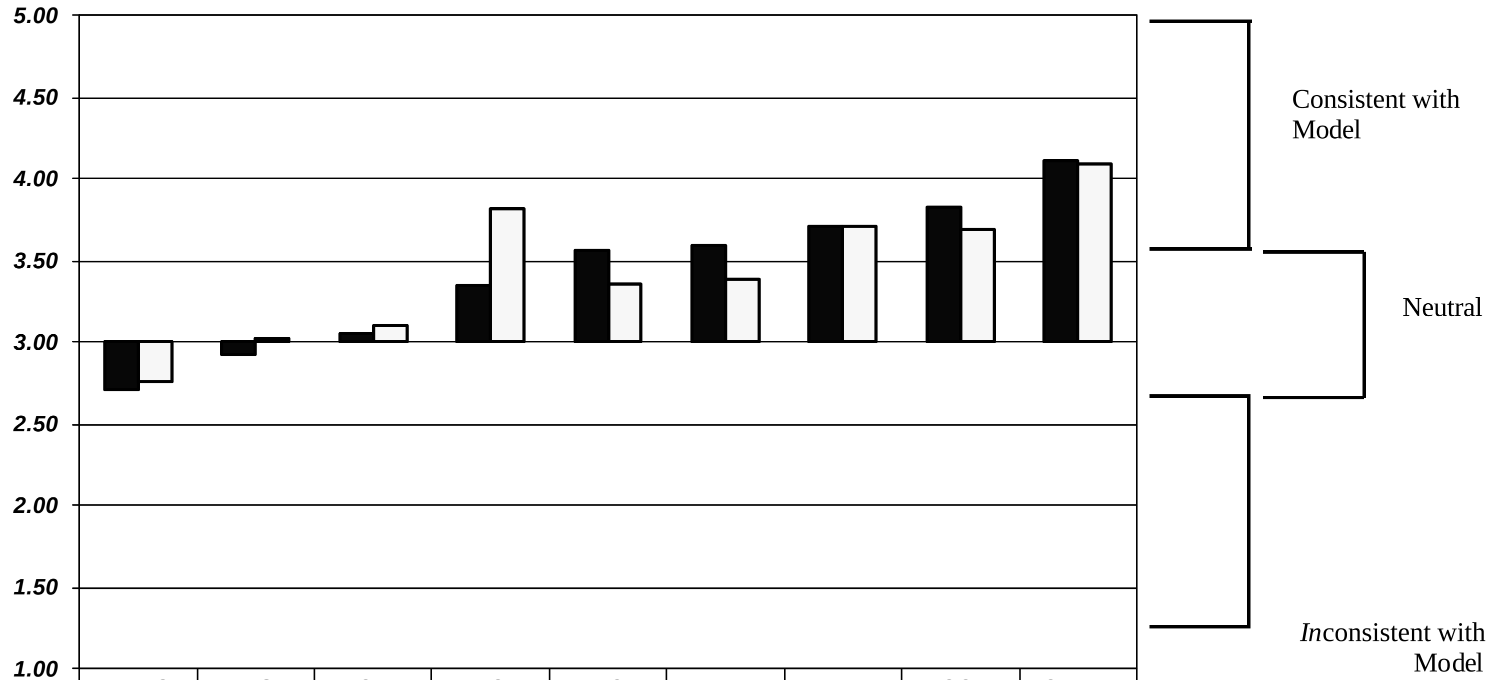
Figure 16. Category Means for Women by High and Low Science Interest Groups



	RELIG	EPIST	POLY	RACE*	EMOT	ENVIR	ECON	HEAL	FOR-ALL*
■ High Interest	2.60	2.80	3.05	3.12	3.33	3.72	3.79	3.83	4.20
□ Low Interest	2.56	2.85	3.05	2.84	3.23	3.43	3.71	3.80	3.86

RELIG	Category 6: Science, Religion and Morality
EPIST	Category 1: Epistemology
POLY	Category 4: Public Policy and Science
RACE	Category 8: Science, Race and Gender
EMOT	Category 7: Science, Emotions and Aesthetics
ENVIR	Category 3: Science and the Environment
ECON	Category 2: Science and the Economy
HEAL	Category 5: Science and Public Health
FOR-ALL	Category 9: Science for All

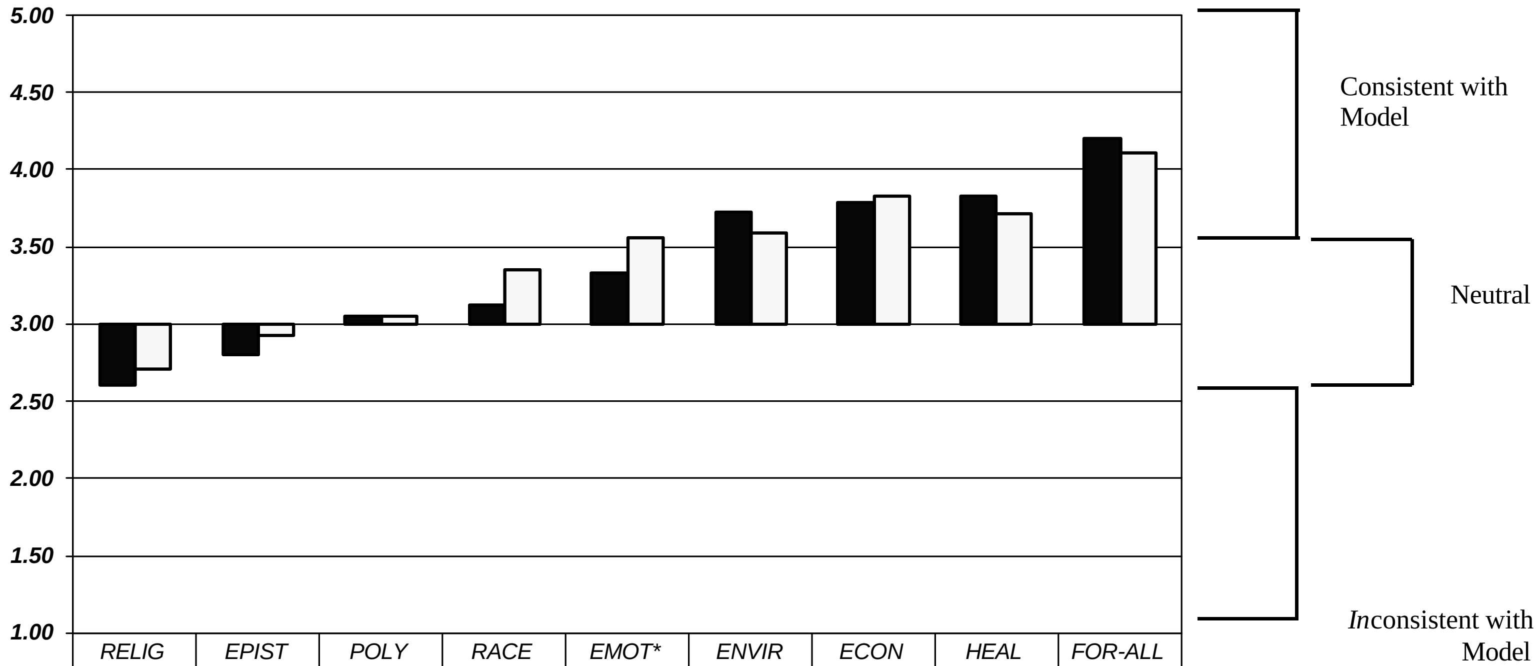
Figure 17. Category Means for Men by High and Low Science Interest Groups



	RELIG	EPIST	POLY	RACE	EMOT	ENVIR	HEAL	ECON	FOR-ALL
High Interest	*2.71*	*2.92*	*3.05*	*3.35*	*3.56*	*3.59*	*3.71*	*3.83*	*4.11*
Low Interest	*2.76*	*3.02*	*3.10*	*3.82*	*3.36*	*3.39*	*3.71*	*3.69*	*4.09*

RELIG	Category 6: Science, Religion and Morality
EPIST	Category 1: Epistemology
POLY	Category 4: Public Policy and Science
RACE	Category 8: Science, Race and Gender
EMOT	Category 7: Science, Emotions and Aesthetics
ENVIR	Category 3: Science and the Environment
ECON	Category 2: Science and the Economy
HEAL	Category 5: Science and Public Health
FOR-ALL	Category 9: Science for All

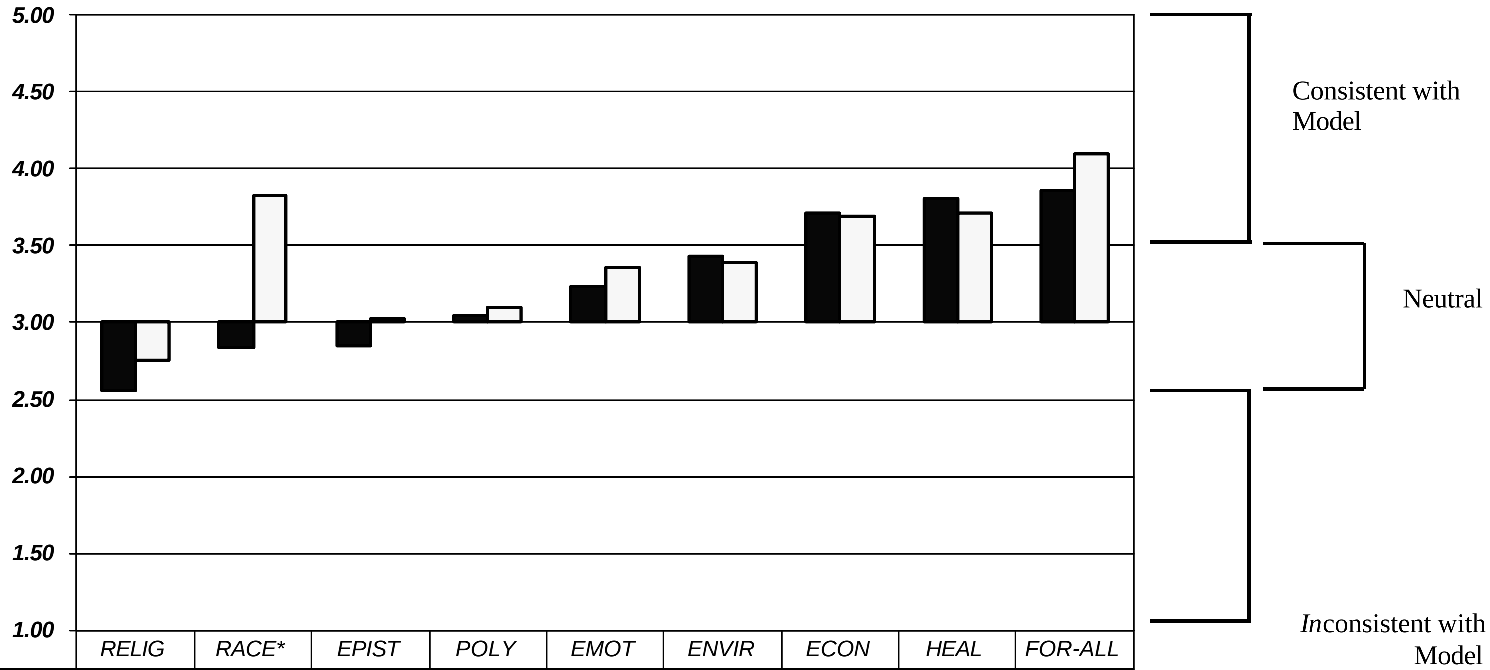
Figure 18. Category Means for Men and Women of High Science Interest



	RELIG	EPIST	POLY	RACE	EMOT*	ENVIR	ECON	HEAL	FOR-ALL
■ Women	2.60	2.80	3.05	3.12	3.33	3.72	3.79	3.83	4.20
□ Men	2.71	2.92	3.05	3.35	3.56	3.59	3.83	3.71	4.11

RELIG Category 6: Science, Religion and Morality
EPIST Category 1: Epistemology
POLY Category 4: Public Policy and Science
RACE Category 8: Science, Race and Gender
EMOT Category 7: Science, Emotions and Aesthetics
ENVIR Category 3: Science and the Environment
ECON Category 2: Science and the Economy
HEAL Category 5: Science and Public Health
FOR-ALL Category 9: Science for All

Figure 19. Category Means for Men and Women of Low Science Interest



	RELIG	RACE*	EPIST	POLY	EMOT	ENVIR	ECON	HEAL	FOR-ALL
■ Women	2.56	2.84	2.85	3.05	3.23	3.43	3.71	3.80	3.86
□ Men	2.76	3.82	3.02	3.10	3.36	3.39	3.69	3.71	4.09

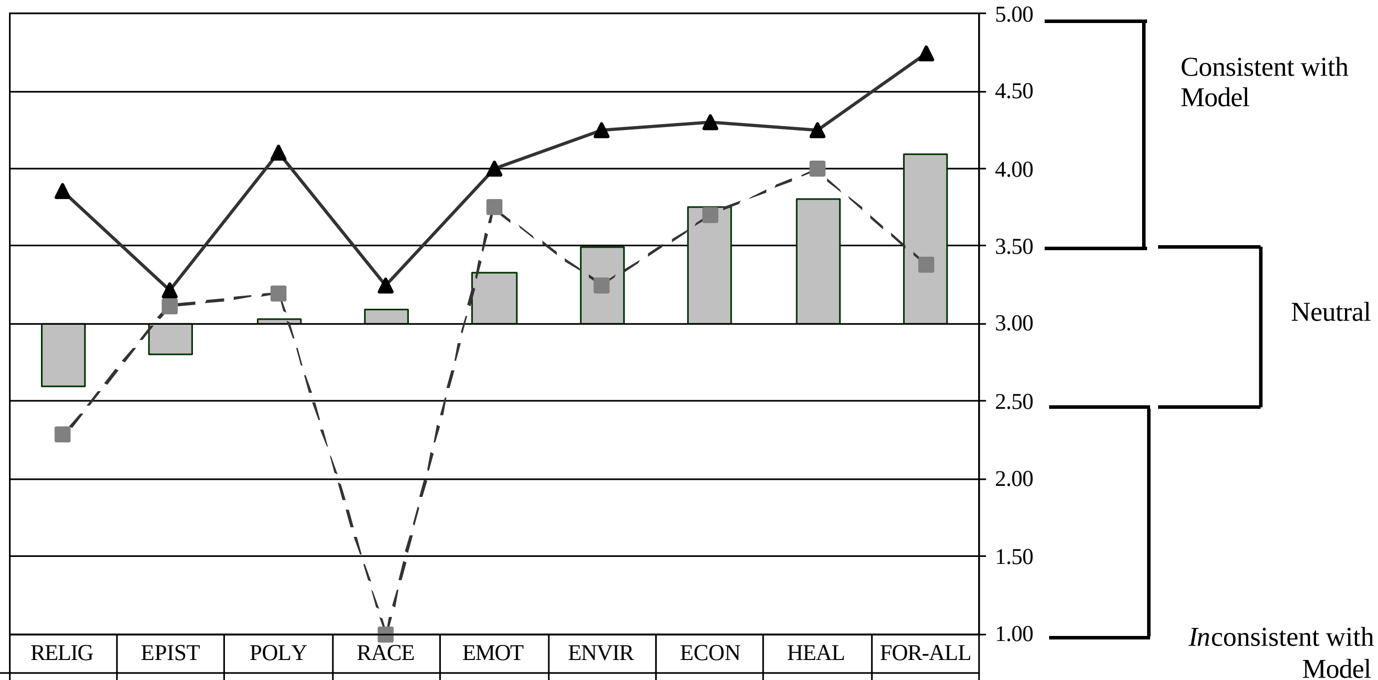
RELIG	Category 6: Science, Religion and Morality
EPIST	Category 1: Epistemology
POLY	Category 4: Public Policy and Science
RACE	Category 8: Science, Race and Gender
EMOT	Category 7: Science, Emotions and Aesthetics
ENVIR	Category 3: Science and the Environment
ECON	Category 2: Science and the Economy
HEAL	Category 5: Science and Public Health
FOR-ALL	Category 9: Science for All

WHERE TO NEXT

This report has discussed the instrument development and reviewed data collected to date. Data collection is on going at this time (28 December, 2000).

Tentative Paper Topics	Journal	Participants	Completion
Development of TSSI Address anti-science concern; use comparison with 4 scientists; discuss use of TSSI in teacher education	JSTE	Cobern & Loving	Winter 2001
Study with scientists		Cobern & Loving	Sum 2001
Gender, science interest & TSSI	CJSTE	Loving & Cobern	Sum 2001
El Tchrs vs Sec Tchrs; examine cross effect of gender	SSM	Cobern & Loving	?
All of the above plus scientist data	AJER	Loving & Cobern	?

Figure 20. Preservice Elementary Teachers Category Means with Low and High Category Averages for Four Research Scientists



	RELIG	EPIST	POLY	RACE	EMOT	ENVIR	ECON	HEAL	FOR-ALL
Elementary Teachers	2.60	2.80	3.03	3.09	3.33	3.49	3.75	3.80	4.09
Researcher Lows	2.29	3.11	3.20	1.00	3.75	3.25	3.70	4.00	3.38
Researcher Highs	3.86	3.22	4.10	3.25	4.00	4.25	4.30	4.25	4.75

RELIG	Category 6: Science, Religion and Morality
EPIST	Category 1: Epistemology
POLY	Category 4: Public Policy and Science
RACE	Category 8: Science, Race and Gender
EMOT	Category 7: Science, Emotions and Aesthetics
ENVIR	Category 3: Science and the Environment
ECON	Category 2: Science and the Economy
HEAL	Category 5: Science and Public Health
FOR-ALL	Category 9: Science for All

CONCLUSION

This research began with the idea that there is a within and without paradigm view of science education for general public understanding or literacy. If indeed science on the whole is non-problematic for a group the general public (i.e., the public is in no way alienated or disconnected), then typical science instructional experiences are quite appropriate and sufficient for helping the public (or specifically elementary teachers) develop a deeper understanding of science. Where people have questions and reservations about the enterprise known as science, however, that is a situation requiring a very different pedagogical approach; and it is our conviction that very many elementary teachers, and many in the public at large, do resist the "paradigm" we call science. Hence we have taken up the task of quantitatively investigating people's perceptions of science within the context of several important cultural and social issues. To this end we designed the Thinking about Science Survey (TSSI) based on nine categories (See Table 1) that address important cultural and social issues with respect to science. TSSI is not about science attitude issues nor is it about the nature of science, though each of these concepts is related to the TSSI conceptual base. TSSI intends to illuminate the balance and valuations people hold about science in the context of several other culturally and socially - but not scientific per se - important issues.

Our findings suggest that TSSI can yield reliable and significant data for the purposes intended. The instrument should be useable in studies that compare the ideas held by different groups. For example, it would be of some interest to know how elementary school teachers, secondary school science teachers, and scientists compare. From our data we were pleased to find strong support for the category, "Science for All." Although the preservice elementary teachers had reservations about some features of the common image of science, they clearly were not anti-science. On the other hand, the preservice elementary teachers show a profile that differs over several categories from the common image of science. It is not our view that the "common image" is necessarily the correct view of science thus we are not displeased with the profile found amongst the preservice elementary teachers. Rather, the profile differences suggest to us a need to better understand how the public interprets science and to better understand the public's interaction with the common image of science, and why the science community tends to present itself as it does.

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APPENDIX A

The *Thinking about Science* Survey instrument.

The Thinking about Science Survey

Please respond to the following 60 items according to how you feel about science and other disciplines. Record your answers on the category recording form. This survey is completely anonymous.

		Strongly Disagree		**Uncertain**		**Strongly Agree**
1	Human emotion plays no part in the creation of scientific knowledge.	1	2	3	4	5
2	No source of knowledge provides absolute truth – not even science.	1	2	3	4	5
3	Scientific knowledge has often contributed to the destruction of our environment and natural resources.	1	2	3	4	5
4	Women are welcome in science just as much as men are.	1	2	3	4	5
5	Scientific research is rarely dangerous to the public.	1	2	3	4	5
6	Scientific research is generally very important.	1	2	3	4	5
7	A person can be both religious and scientific.	1	2	3	4	5
8	Scientific knowledge is the single most important factor in the improvement of medicine and public health.	1	2	3	4	5
9	Common sense contributes more to good health than does scientific knowledge.	1	2	3	4	5
10	Scientific research should be adequately funded by government.	1	2	3	4	5
11	Science is a more important source of knowledge than religion.	1	2	3	4	5
12	Scientific explanations tend to spoil the beauty of nature.	1	2	3	4	5
13	Students should not be forced to take science courses at the university.	1	2	3	4	5
14	The strength of our national economy does not depend on scientific knowledge.	1	2	3	4	5
15	Science should not be made an important subject for the elementary school grades.	1	2	3	4	5
16	Science helps develop our natural resources such as coal, gas, oil, and solar energy.	1	2	3	4	5
17	Scientific knowledge is the most objective form of knowledge.	1	2	3	4	5

18	Scientific research is often potentially dangerous to the public.	1	2	3	4	5
		Strongly Disagree		**Uncertain**		**Strongly Agree**
19	There is little need for the legal regulation of scientific research.	1	2	3	4	5
19	There is little need for the legal regulation of scientific research.	1	2	3	4	5
20	Scientific knowledge is useful in keeping our national economy competitive in today's world.	1	2	3	4	5
21	It is equally important for a person to have scientific knowledge and an appreciation for the arts.	1	2	3	4	5
22	The development of our natural resources, such as coal, gas, oil, solar energy, requires much more than scientific knowledge.	1	2	3	4	5
23	The scientific community is mostly dominated by men and is often unfriendly to women.	1	2	3	4	5
24	Understanding science is a good thing for everyone.	1	2	3	4	5
25	There are many good things we can do today because of scientific knowledge.	1	2	3	4	5
26	Scientists should not be allowed to research anything they wish.	1	2	3	4	5
27	No form of knowledge can be completely certain – not even scientific knowledge.	1	2	3	4	5
28	Scientific research should be carefully regulated by law.	1	2	3	4	5
29	We can be certain that scientific knowledge is reliable.	1	2	3	4	5
30	African Americans and other minority people are just as welcome in the scientific community as are white people.	1	2	3	4	5
31	The development of our natural resources, such as coal, gas, oil, solar energy, is dependent upon having adequate scientific knowledge.	1	2	3	4	5
32	Religious knowledge contributes more to the well being of a person's life than does science.	1	2	3	4	5
33	The methods of science are the most reliable source of true, factual knowledge.	1	2	3	4	5
34	Science is the best source of reliable knowledge.	1	2	3	4	5
35	Scientific research is morally neutral.	1	2	3	4	5
36	Science can contribute to our appreciation and experience of beauty.	1	2	3	4	5

37	Only a very few people really understand science.	1	2	3	4	5
		Strongly Disagree		**Uncertain**		**Strongly Agree**
38	Our natural environment would actually be helped by the absence of scientific knowledge.	1	2	3	4	5
38	Our natural environment would actually be helped by the absence of scientific knowledge.	1	2	3	4	5
39	Religion and science are almost always at odds with each other.	1	2	3	4	5
40	Religion tends to impede scientific progress.	1	2	3	4	5
41	Scientific knowledge is useful for only a few people.	1	2	3	4	5
42	Science is our best source of useful knowledge.	1	2	3	4	5
43	Science can help us preserve our natural environment and natural resources.	1	2	3	4	5
44	No form of knowledge – including science – can ever be completely objective.	1	2	3	4	5
45	Scientific research is economically and politically determined.	1	2	3	4	5
46	The methods of science are objective.	1	2	3	4	5
47	Scientific knowledge tends to erode spiritual values.	1	2	3	4	5
48	Scientific research makes important contributions to medicine and the improvement of public health.	1	2	3	4	5
49	Developing new scientific knowledge is very important for keeping our country economically competitive in today's world.	1	2	3	4	5
50	Scientific knowledge influences government decision making too much.	1	2	3	4	5
51	Scientific knowledge is useful.	1	2	3	4	5
52	All students should study science during the secondary school grade levels.	1	2	3	4	5
53	The scientific community is mostly dominated by white men and is often unfriendly to minority people.	1	2	3	4	5
54	Most people really do not need to know very much science.	1	2	3	4	5
55	Even at the university level all students should study at least some science.	1	2	3	4	5

56	Science should be taught at all school grade levels.	1	2	3	4	5
57	The government should not be in the business of using tax dollars to fund scientific research.	1	2	3	4	5
		Strongly Disagree		**Uncertain**		**Strongly Agree**
58	Scientific knowledge contributes little to good health.	1	2	3	4	5
59	Without science we will not be able to preserve our natural environment and natural resources.	1	2	3	4	5
60	Scientific knowledge is the truest form of knowledge.	1	2	3	4	5

APPENDIX B

Self-Scoring Guide

Strong view of scientific knowledge (Epistemology)

		SCORE
2	r	
17		
27	r	
29		
33		
34		
44	r	
46		
60		
TOTAL		

Scientific progress is vital to the Economy

		SCORE
14	r	
16		
20		
22	r	
25		
31		
41	r	
42		
49		
51		
TOTAL		

Science is a positive force for the protection of the Environment and Resource Development

		SCORE
3	r	
38	r	
43		
59		
TOTAL		

Science should influence public policy, be publicly supported but not publicly controlled.

		SCORE
5		
6		
10		
18	r	
19		
26	r	
28	r	
45	r	
50	r	
57	r	
TOTAL		

Science is a positive force for Public Health

		SCORE
8		
9	r	
48		
58	r	
TOTAL		

Science is neutral with regard to religion and morality

		SCORE
7	r	
11		
32	r	
35		
39		
40		
47		
TOTAL		

Emotions and Aesthetics are part of Science

		SCORE
1	r	
12	r	
21	r	
36		
TOTAL		

Science is open to people regardless of race and gender

		SCORE
4		
23	r	
30		
53	r	
TOTAL		

Science for All

		SCORE
13	r	
15	r	
24		
37	r	
52		
54	r	
55		
56		
TOTAL		

Standard scores for each category are calculated according to the following formulae. Round scores to whole number.

1. (_________) * (50/45) = _________
   Total

2. (_________) _________
   Total

3. (_________) * (50/20) = _________
   Total

4. (_________) _________
   Total

5. (_________) * (50/20) = _________
   Total

6. (_________) * (50/35) = _________
   Total

7. (_________) * (50/20) = _________
   Total

8. (_________) * (50/20) = _________
   Total

9. (_________) * (50/40) = _________
   Total

10 to 25	Disagree/Disaffirm Model Science Position
26 to 35	Neutral
36 to 50	Agree/Affirm Model Science Position

APPENDIX C

Student Comments on Items

Q1	**Human emotion plays no part in the creation of scientific knowledge.**
1	I think that this statement is saying that human emotion does not have any connection or relation to the creation of scientific knowledge.
2	Scientific knowledge is based on facts not emotions. These facts can be proven through experiments whereas is emotion cannot be proven through experiments.
3	The creation of scientific knowledge has nothing to do with human emotions because it's about discoveries and theories.
4	To science is science, fact, black and white. There are no gray areas. There are no compromises.
Q2	**No source of knowledge provides absolute truth – not even science.**
1	Even in the sciences, there are variables which can always be controlled.
2	If you were to take scientific facts you could never produced the exact same results. You would produce similar but not exactly the same results.
3	Nothing that you learn (subject) can tell you the exact truth about it, not even science.
4	Science is sometimes a theory and not always a proven fact.
Q3	**Scientific knowledge has often contribute d to the destruction of our environment and natural resources.**
1	For example, Aerosols in hair spray were created by scientific thinkers, but in turn (at first) harmed the ozone layer
2	Some scientific discoveries have to proven to pollute our society but have also been beneficial.
3	What one knows about science has contributed or helped the destruction of our environment and natural resources.
4	With knowledge comes a responsibility to use that knowledge in a productive way. Unfortunately, individual values are different and so are the results and consequences of the attainment of scientific knowledge.
Q4	**Women are welcome in science just as much as men are.**
1	Science is for everyone, men, women and children. We all live on the same earth and we all should be educated about science.
2	Women are allowed to participate in science just not as much as men. Meaning man are more accepted in science.
3	Women are just is smart is men are and are not "naturally" dumber.
4	Women bring to science (and every other endeavor) valuable insights and qualities which are necessary for total success and fulfillment of the quest for knowledge.
Q5	**Scientific research is rarely dangerous to the public.**
1	Scientific research is not dangerous to the public.
2	Sometimes it has side effects but very rarely.
3	To it is not dangerous or hurtful to discover the things about science.
4	With adequate responsibility, as discussed in statement 3,scientific research can have an overall positive impact on the public.

Q6	**Scientific research is generally very important.**
1	Finding out information by use of the scientific method is important
2	I think this means that scientific research is important most of the time. I guess the word generally is throwing me a bit as I think that scientific research is always important
3	It in order for research to be organized and specific, it needs to be done in a scientific way. In order for us to learn more about ourselves, our bodies and are environments, scientific research needs to be a part of our society.
4	That research in a general sense is very important. It is important to learn about research to also improve and prove science theories.
5	This is saying, that scientific research is a key factor in developing and progressing our society. Most people feel that it is an important part of our world.
Q7	**A person can be both religious and scientific.**
1	Everyone has scientific qualities whether they are religious or not. We are born to somewhat think scientifically.
2	People can believe in a higher being and also in the findings of science.
3	There is no doubting the progress science has given us. It's results are all around us. But a person's spirituality is a very personal matter on a very personal level and faith can be just is important, individually, as science.
4	This statement is saying that a person can still believe in science and its theories and still believe in their religious theories.
5	This statement is saying that being religious does not exclude you from being scientific, as being scientific does not exclude you from being religious. These two factors can enhance each other.
Q8	**Scientific knowledge is the single most important factor in the improvement of medicine and public health.**
1	Knowing what goes on in the world around you helps in the creation and invention of new medicines.
2	Scientific knowledge is the best way to forward the progress of medicine and public health. As long as this knowledge is well rounded, this statement is okay. This statement could be interpreted many ways.
3	That without scientific knowledge, we as a society could not and would not progress. It is the element to improving our way of life and all the problems we face.
4	This discounts the human factor and that's an opinion, but I think that's what that statement says.
5	This statement is reporting that the only way to improve medicine and public health is with just scientific knowledge, which is not always the case. Usually many other factors are taken into consideration to improve both medicine and public health.
Q9	**Common sense contributes more to good health than does scientific knowledge.**
1	Being healthy depends more on how you take care of your self than knowing why you are becoming ill.
2	Commonsense and scientific knowledge should go hand-in-hand have better health.
3	Scientific knowledge can support commonsense when it comes to good health. Commonsense does play a large part in good health.
4	This statement discounts the science factor.
5	This statement says that commonsense is only important for someone trying to mainly live and survive, whereas more is needed for scientific knowledge.

Q10	**Scientific research should be adequately funded by government.**
1	It is important to fund scientific research to be adequately funded by government and other companies that research to prove their theory correct.
2	Public should continue to pay taxes for the research of different scientific problems.
3	That the government should provide sufficient funds for scientific studies, that allow us to study and develop new cures and ways to improve life.
4	The government should support science, as this is the area of study that answers many, if not all, of life's mysteries.
5	Too much private money and to little on the other hand can result in the funding of only specific things. Scientific research should be for all people.
Q11	**Science is a more important source of knowledge than religion.**
1	In ancient times, scientific events were explained through mythology or at least at that time, their religious beliefs. Today, science is based on real facts and information which can be reproduced by others rather than through religious experiences.
2	Science can be proven. It is something people can engage in together.
3	Science is rooted in facts, while religion is based or on opinion and beliefs. while both are a result of explored hypotheses, scientific presumptions can be tested to attempt to find the answer. Religion is much more subjective.
4	This says that science is greater than religion. That science is more important to or for society.
Q12	**Scientific explanations tend to spoil the beauty of nature.**
1	Explanations of science take away from what people see.
2	Knowing too much about the way something works or how it is produced can cause the outward appearance or the overall effect to be less than it was before the explanation.
3	The splendor of nature is not as awe- inspiring once you know how and why things have come to be as they are.
4	They are experiments already done and proven.
Q13	**Students should not be forced to take science courses at the university.**
1	Certain science courses, maybe like advanced ones, but I feel science is important to and needed.
2	People should have the choice to take science course at the university level.
3	Some see science as a waste of time and would suggest the only those fields which require scientific knowledge should be given science courses. Others, where science is not seen as important, would not have to take courses. However, I think science applies to all things.
4	Some may think that science is not important to in the curriculum, but it builds problem solving and makes students question and formulate hypotheses. In essence, science requires students to take control of their own learning.
Q14	**The strength of our national economy does not depend on scientific knowledge.**
1	I think it does depend on scientific knowledge.
2	It does not depend solely on science, but some science is a part of our national economy.
3	Many think science does not apply to the national economy and that math is more important. Science however deals with critical thinking, which does affect economy.
4	Our national economy is not dependent on scientific knowledge.

Q15	**Science should not be made an important subject for the elementary school grades.**
1	Is should not be the most important subject, but equally among the others. It is just as important.
2	It should be used in elementary school.
3	Science should be just is important as other courses because it promotes critical thinking.
4	This says that science should be “put on the back burner” so to speak.
Q16	**Science helps develop our natural resources such as coal, gas, oil, and solar energy.**
1	I think that this statement is saying that science helps our society to use natural resources to enhance our world.
2	Science is always working to better our natural resources. It takes a lot our natural resources. Different parts of science help create the things we need.
3	Science lets people understand how and where and why we have these natural resources. It lets improvements and new discoveries made.
4	The processes for harnessing and using these resources were developed by scientists and are still being refined.
5	To science gives us our natural resources through different processes of refining, finding it and transporting it. It also allows the use of it through very many processes.
Q17	**Scientific knowledge is the most objective form of knowledge.**
1	A lot science is objective. Chemistry is a science involving formulas that most often have only one right answer. The knowledge you learn from science allows you to form concrete answers to some problems.
2	It science is very important to the understanding many things. It is objective because things can be challenged, explored, tested and researched.
3	Science is objective because there are so many things to research, discover and learn all the time.
4	Scientific knowledge is in the eye of the beholder. There can be many opinions about one subject and it depends on individual to how they see it.
5	This statement says that science tends to be a fact-based subject rather than an opinion-based topic.
Q18	**Scientific research is often potentially dangerous to the public.**
1	I am unsure about this statement; however, I would assume that it is saying that some of the scientific research done in labs can often hurt the community (nuclear work comes to mind).
2	It may be dangerous because people may not fully understand science and its research. People may get scared of outcomes and jump to conclusions.
3	Some types of scientific research, such as nuclear research or cloning could be potentially dangerous to the public.
4	That research can do negative things to public opinion and can allow people to worry about things that are out of their hands.
5	The way some things are researched in a o science can cause harm to others. Many risks are taken sometimes we are unaware of them.

Q19	**There is little need for the legal regulation of scientific research.**
1	Although I do not agree, this statement claims that the government should not get involved with the issues of scientific research because it is not needed.
2	I don't agree with this statement. I believe that legal regulation is needed. Things need to be monitored. However, this statement says that there should not to many regulations or laws hindering research.
3	Legal regulation can stifle the creative scientific process for research and prevent discoveries. On the other hand, some legal regulation is needed to control issues such as cloning.
4	Saying that the government should not monitor or keep tabs on what colleges, universities, or people with great money are doing.
5	Scientific research is a large part of science and should be allowed to reach new ideas.
Q20	**Scientific knowledge is useful in keeping our national economy competitive in today's world.**
1	Definitely. We need to keep up or exceed other countries to maintain our economy.
2	Science is very helpful in keeping us competitive with others. Scientific knowledge plays a key role in our economy and technology and furthers our nation.
3	Scientific knowledge is how our society keeps its edge in the national economy competitive. This is how the U.S. stays ahead with new and continually updated technology to sell to the rest of the world and to ourselves.
4	This means that we have to keep researching and exploring science because there are so many ideas that make science up and it is important to keep up on current ideas issues that may help the future.
5	This statement is claiming that scientific knowledge is part of what helps the USA in the race with other countries from an economic perspective.
Q21	**It is equally important for a person to have scientific knowledge and an appreciation for the arts.**
1	It is important for a person to appreciate all aspects of life whether it be technical or artistic or anything else because it makes a person well rounded and they are related – nothing is in isolation.
2	It is not only important for person to have an understanding and knowledge for science but to accompany it was other subject areas too.
3	It s important for people to be well rounded – to know about numerous kinds of things.
4	It to it is important that students know about these topics, but it needs to be on an equal basis rather than one overpowering another
Q22	**The development of our natural resources, such as coal, gas, oil, solar energy, requires much more than scientific knowledge.**
1	People need to know more about these things, and gain a better understanding.
2	To understand natural resources, one must have more than scientific knowledge, they are more complex and require greater understanding. This statement is trying to say that memorizing is not enough, you must apply and use.
3	We also must know something about physical geography.
4	You have to also know about other things like conservation, ecosystems and nature. There are many things to consider besides how to get them.
Q23	**The scientific community is mostly dominated by men and is often unfriendly to women.**
1	In history, the majority of people in this field are men. Women have had difficulty entering it and gaining respect.
2	Men tend to have more scientific interest and so there are more man in the field and women have a hard time fitting in.
3	This may seem true, but women do have and play a role in the scientific community.
4	This statement is trying to say that man are the majority of science community and not very inviting to women.

Q24	**Understanding science is a good thing for everyone.**
1	Everyone needs and should know about science.
2	Science is all around us and the more we understand the better off we are.
3	Science is something (a subject area) which can only benefit a person by having knowledge of it.
4	Science reaches every part of our lives and is important to know about it.
Q25	**There are many good things we can do today because of scientific knowledge.**
1	Because of science we can find cures for disease, communicate and do researcher more effectively.
2	Science has made it possible to make advances in the world today and has made many achievements which benefit it.
3	Scientific knowledge has advanced humans many ways – medically, technically, etc.
4	True because of technology and today's values.
Q26	**Scientists should not be allowed to research anything they wish.**
1	Scientists should have an area in which they specialize in and focus only on that area.
2	Scientists should not be allowed to discover anything new, they should have certain guidelines to follow.
3	Scientists should only be allowed to research things to make our a world better place.
4	Scientists should research only things that other people tell them need to be researched, or scientists should not research anything risky.
Q27	**No form of knowledge can be completely certain – not even scientific knowledge.**
1	Even if something is researched completely, and proven certain there could still possibly be a way to prove it uncertain.
2	Many times we think of scientific knowledge as the right answer, this knowledge also has room for error.
3	Nothing is a sure absolute positive thing. All things in science very.
4	There is no completely right answer.
Q28	**Scientific research should be carefully regulated by law.**
1	If the law regulates what scientist research, it will prevent potentially dangerous or in moral things from be discovered.
2	Scientific research must be regulated by law
3	Scientific research of all kinds should be closely monitored because of moral and humanity problems
4	Scientific research should be regulated by law, it should be shared knowledge that everyone has to access to. There are so many things we need to research still and find more out about them, the public should know. What right does the government hand to keep information vital to their citizens out of reach?
5	Scientists should be allowed to what they want. They should have restrictions
Q29	**We can be certain that scientific knowledge is reliable.**
1	Scientific knowledge is reliable because of the work and knowledge that goes into the information. Scientific knowledge is more reliable than most other knowledge.
2	Scientists research things well, therefore their findings must be correct.
3	This statement clashes with statement No. 27 – if no form of scientific knowledge is certain, than we can't be certain that it is always reliable.
4	We don't know anything for sure. So scientific knowledge is probably our best bet.
Q30	**African Americans and other minority people are just as welcome in the scientific community as are white people.**

1	African Americans and other minority people are less knowledgeable in the field of science.
2	Everyone should be given a chance and equal opportunity.
3	It takes brains to do scientific research, not color.
4	Scientific community should not be color bias as any community should.
Q31	**The development of our natural resources, such as coal, gas, oil, solar energy, is dependent upon having adequate scientific knowledge.**
1	Because of scientific knowledge we are able to develop the natural resources of this planet such as coal, gas, oil, solar energy.
2	If we don't have scientific knowledge, we don't have skills to develop our natural resources.
3	In order for us to label them as natural resources, we must have that knowledge to study the way it forms.
4	In order to discover how our natural resources developed, we need to understand the scientific process behind it.
5	This statement means that without adequate knowledge of science we cannot properly use our natural resources nor can we preserve them.

Q32	**Religious knowledge contributes more to the well being of a person’s life than does science.**
1	Religion is more beneficial to a person’s quality of life than is science.
2	The well-being of a person is affected more by their religious knowledge than by science.
3	This statement is saying the spiritual power is more important to individuals than how the work scientifically.
4	While religion plays an important role in peoples lives, science and technology contribute or to practical everyday life.
5	Your religion should be more important than scientific knowledge.
Q33	**The methods of science are the most reliable source of true, factual knowledge.**
1	Of all methods that search for true and factual knowledge, science is the most reliable source and method.
2	Science is based on research and actual hands-on material and is considered true, since math and English are more information and formula based.
3	Scientific knowledge is based on facts and truths.
4	Scientific methods help us to understand the truth.
5	The methods of science are a great process in order to gather and use information but anything can eventually be disapproved.
Q34	**Science is the best source of reliable knowledge.**
1	Of all other sources, science is the most reliable in terms of truth.
2	Science is our best source in order to gain test knowledge.
3	Science is truth!
4	There is no other source that is as reliable as science; meaning there is no source as definite as science.
5	We can depend and rely on the knowledge that is gained from science.
Q35	**Scientific research is morally neutral.**
1	Acts of research dealing with science do not promote one side over another side.
2	No one can take an opposite approach, since the material is usable and is often observed in its natural setting.
3	Scientific research is not persuaded one way or another by moral beliefs or issues.
4	There is no bias scientific research.
5	Scientific research is not morally neutral. We constantly develop things that are morally wrong, for example, cloning.
Q36	**Science can contribute to our appreciation and experience of beauty.**
1	Beauty belongs to the beholder.
2	Science helps us to understand why things happen. Sense we understand why we can appreciate things better.
3	That if you understand how the beauty that you see around you happens you are more likely to appreciate and experience it better
Q37	**Only a very few people really understand science.**
1	It is hard to understand things that happened in science. Many people do not fully understand concepts of science.
2	Science is confusing. Science scares people.
3	That only a few very gifted people really understand about science.

Q38	**Our natural environment would actually be helped by the absence of scientific knowledge.**
1	Scientific knowledge isn't always good thing. For example, the natural environment is suffering from it.
2	That the increasing scientific knowledge has hurt the natural environment, because we don't use it appropriately.
3	The environment would be better without scientific knowledge.
Q39	**Religion and science are almost always at odds with each other.**
1	Fundamentally, religion and science believe two different things.
2	Religion and science are at odds when science over steps its boundaries and trying to explain the unexplained.
3	What religion says and what happens in science are different.
Q40	**Religion tends to impede scientific progress.**
1	Beliefs tend to keep people from trying to understand science.
2	People are unwilling to forget about religion, beliefs and concentrate on science.
3	Religion does not help progress scientific knowledge.
Q41	**Scientific knowledge is useful for only a few people.**
1	I disagree with the statement. I feel that science is useful to every single person, especially with a growing technology.
2	I disagree with the statement. I think everyone benefits from having scientific knowledge. Science is all around us and we all experience in everyday.
3	If you are not going into a field that will involve information pertaining to science, then learning about science may only be beneficial to those going into a science knowledge based career.
4	Information about science isn't something that everyone can use.
5	That not everyone needs to know about science.
Q42	**Science is our best source of useful knowledge.**
1	I'm not sure if this is entirely correct. I think other things such as reading are just as important to provide useful knowledge.
2	It is a topic that can often be proven, therefore people believe it to be true.
3	It is one of best, but I wouldn't say the best. I feel that all subjects are interrelated. Each one is great in its own way! All of these subjects together make the best.
4	Science is the best subject to get knowledge from.
5	When we have questions about something that is applicable to our life, the best way to answer that question is through science.
Q43	**Science can help us preserve our natural environment and natural resources.**
1	I think this is true the more information at understanding you have all of the earth and natural resources, the more we see how important it is to preserve these things.
2	Science can help our environment.
3	The statement I feel sounds very true. If we become more aware of our environment and all of the negative aspects our society brings to it, I think that we would all make some very drastic changes.
4	The use of new technology and discoveries can lead us to new methods to preserving our earth.
5	We can take better care of our environment and resources through science.

Q44	**No form of knowledge – including science – can ever be completely objective.**
1	I agree. I think science is the most objective, but it still is not completely so.
2	Nothing you know can ever be objective
3	Science is a combination of facts and ideas that are constantly trying to be proven. Because there are different viewpoints on topics, it is difficult to say that knowledge of in the form is solely objective based.
4	There is no absolute proof to any form of knowledge that is not in some way have some basis on opinion.
5	This is a strong phrase and unfortunately I don't know how to reply to it.
Q45	**Scientific research is economically and politically determined.**
1	I disagree. I don't think economics or politics can determine all of scientific research.
2	It is more economically determined rather than politically determined. I hope!
3	People in society and the changing world around us make science a predetermined subject.
4	Science research is only supported by economics and politics.
5	What we study through science is chosen through money and politics.
Q46	**The methods of science are objective.**
1	Science experiments and tests should be done in an objective way. As much as possible we try to keep science objective. Often however humans bring subjectivity to science.
2	The methods of science are always changing and never really set.
3	The methods of science can be tested and retested proven beyond the shadow of doubt. Science methods do not include feelings or emotions.
4	The ways in which science is discovered or proven are unbiased and based on observable facts.
Q47	**Scientific knowledge tends to erode spiritual values.**
1	How things are brought into this world. Biology. Creation vs. Evolution.
2	One can't believe in scientific theories and have religious convictions.
3	Scientific knowledge tends to disapprove beliefs held by religious or spiritual people. Scientific knowledge can undermine spiritual teachings.
4	This statement is trying to make science and spirituality enemies. Science should be amoral.
Q48	**Scientific research makes important contributions to medicine and the improvement of public health.**
1	Chemistry figures out vaccines to help symptoms cease or to stop diseases from spreading. Biology helps us live healthy lifestyles.
2	Science is helping the quality of life through real world application.
3	Scientific research is important to improving the quality of life.
4	There have been many worthwhile advancements in our society because scientific research. Our lives have improved as a result of scientific research.

Q49	**Developing new scientific knowledge is very important for keeping our country economically competitive in today's world.**
1	If we do not continue our development of science, we will fall behind other countries and societies. If we want to keep the power we now hold, we must continue our research.
2	Science can lead to very important discoveries. These discoveries be technology and medicine that people want to purchase.
3	Scientific knowledge is imperative in order to be competitive in the world markets.
4	Using science to create better fuel and ways in which we live our life can help us cut back on aid from other countries or help produce new routes of selling.
Q50	**Scientific knowledge influences government decision making too much.**
1	Government decisions are largely based on scientific research and knowledge.
2	Government officials tend to rely on scientific knowledge when making decisions.
3	Science is very important to government decisions.
4	Scientific knowledge includes the way the government as a society lives and should be a leading decision factor to make our lives better.
Q51	**Scientific knowledge is useful.**
1	Scientific knowledge means understanding why things happen the way they do so it is saying that knowing this is useful in understanding your environment.
2	This means that any knowledge gained will be useful to you throughout your life. It will help create a better understanding of the world around us.
3	That it can be used in everyday life. That it has a purpose.
Q52	**All students should study science during the secondary school grade levels.**
1	Forcing students into studying or taking science classes makes it mandatory. That student should be required to take at least one science class.
2	In secondary grades, that level of science is a very important skill – knowledge that the student should have.
3	This should be required for so many years. It is an important subject, just as important as any other.
Q53	**The scientific community is mostly dominated by white men and is often unfriendly to minority people.**
1	For some reason, this profession must be dominated by white males, thus creating an atmosphere threatening to all others.
2	Most everything that has been done field of science has been done by a majority of white man so it is shown in those eyes. It does not mean that it is right. Really don't think this is a true statement though.
3	No opportunities given to minorities.
Q54	**Most people really do not need to know very much science.**
1	Most people don't apply science to their lives were jobs.
2	This is somewhat of a ridiculous statement. Science is everything around us and to not learn science would be very detrimental to people to be successful in life.
3	Trying to state that there isn't a purpose behind science.
Q55	**Even at the university level all students should study at least some science.**
1	Darn right!
2	Science is important at all levels – even college.
3	That college has minimum requirements for students -- general education.

Q56	**Science should be taught at all school grade levels.**
1	Science instruction should begin as early as kindergarten and continued through grade 12.
2	This means that all children regardless of age should have the opportunity to learn and be taught science.
Q57	**The government should not be in the business of using tax dollars to fund scientific research.**
1	Scientific research is not something that should be funded by the government. It should be funded by the private sector such as businesses and organizations.
2	Using tax monies for scientific research should not be a right or responsibility of the government.
Q58	**Scientific knowledge contributes little to good health.**
1	Scientific knowledge is not all that important keeping our bodies healthy.
2	Scientific knowledge will not held a person’s health.
Q59	**Without science we will not be able to preserve our natural environment and natural resources.**
1	Our natural environment and natural resources would be destroyed if there were no people who knew how to take care of them.
2	Science is necessary in the fight to save our earth’s natural environment and resources.
Q60	**Scientific knowledge is the truest form of knowledge.**
1	Knowledge based on science or scientific research is rarely wrong.
2	Science is the basis of knowledge.

Appendix D – Item Descriptive Statistics

Item	N	Min	Max	Mean	Std. Dev.	Skew	Std. Err.	Std. Err.	Kurt.	Std. Err.	Std. Err.
1	394	1	5	3.64	1.08	-0.52	0.12	0.12	-0.55	0.25	0.25
2	397	1	5	2.76	1.30	0.32	0.12	0.12	-1.07	0.24	0.24
3	397	1	5	2.65	1.19	0.34	0.12	0.12	-0.87	0.24	0.24
4	398	1	5	3.42	1.31	-0.19	0.12	0.12	-1.33	0.24	0.24
5	398	1	5	2.70	1.07	0.27	0.12	0.12	-0.80	0.24	0.24
6	398	1	5	4.30	0.80	-1.51	0.12	0.12	3.07	0.24	0.24
7	398	1	5	1.71	0.84	1.55	0.12	0.12	3.09	0.24	0.24
8	398	1	5	3.68	1.01	-0.67	0.12	0.12	-0.15	0.24	0.24
9	398	1	5	3.02	0.97	-0.16	0.12	0.12	-0.78	0.24	0.24
10	397	1	5	3.72	0.87	-0.58	0.12	0.12	0.30	0.24	0.24
11	398	1	5	2.37	1.17	0.49	0.12	0.12	-0.67	0.24	0.24
12	398	1	5	3.68	0.89	-0.61	0.12	0.12	0.13	0.24	0.24
13	397	1	5	3.86	1.08	-0.94	0.12	0.12	0.25	0.24	0.24
14	398	1	5	3.58	0.90	-0.33	0.12	0.12	-0.10	0.24	0.24
15	394	1	5	4.45	0.99	-2.23	0.12	0.12	4.63	0.25	0.25
16	398	1	5	3.99	1.03	-1.18	0.12	0.12	1.13	0.24	0.24
17	397	1	5	3.14	0.86	-0.10	0.12	0.12	0.31	0.24	0.24
18	398	1	5	3.06	0.94	-0.05	0.12	0.12	-0.53	0.24	0.24
19	391	1	5	1.94	0.90	0.94	0.12	0.12	1.00	0.25	0.25
20	391	1	5	3.88	0.91	-1.23	0.12	0.12	2.04	0.25	0.25
21	398	1	5	2.13	1.03	0.91	0.12	0.12	0.20	0.24	0.24
22	397	1	5	2.28	0.83	0.65	0.12	0.12	0.65	0.24	0.24
23	398	1	5	2.79	0.97	0.19	0.12	0.12	-0.46	0.24	0.24
24	398	1	5	4.35	0.83	-1.75	0.12	0.12	4.05	0.24	0.24
25	398	1	5	4.50	0.74	-2.42	0.12	0.12	8.63	0.24	0.24
26	397	1	5	3.01	1.18	-0.08	0.12	0.12	-0.89	0.24	0.24
27	398	1	5	2.24	1.10	0.85	0.12	0.12	0.09	0.24	0.24
28	398	1	5	2.32	0.89	0.37	0.12	0.12	-0.34	0.24	0.24
29	397	1	5	2.80	0.94	0.16	0.12	0.12	-0.68	0.24	0.24
30	398	1	5	3.32	1.17	-0.11	0.12	0.12	-0.85	0.24	0.24
31	397	1	5	3.73	0.88	-0.84	0.12	0.12	0.80	0.24	0.24
32	397	1	5	2.95	1.12	-0.05	0.12	0.12	-0.73	0.24	0.24
33	398	1	5	3.10	0.90	-0.05	0.12	0.12	-0.45	0.24	0.24
34	398	1	5	2.92	0.92	-0.01	0.12	0.12	-0.58	0.24	0.24
35	398	1	5	2.63	0.99	0.28	0.12	0.12	-0.35	0.24	0.24
36	398	1	5	3.87	0.78	-1.00	0.12	0.12	1.72	0.24	0.24
37	398	1	5	3.45	1.06	-0.56	0.12	0.12	-0.54	0.24	0.24
38	398	1	5	3.70	0.97	-0.70	0.12	0.12	0.28	0.24	0.24
39	387	1	5	3.05	0.98	-0.02	0.12	0.12	-0.74	0.25	0.25
40	391	1	5	2.81	0.88	0.10	0.12	0.12	-0.15	0.25	0.25
41	393	1	5	4.15	0.74	-1.22	0.12	0.12	2.95	0.25	0.25

Item	N	Min	Max	Mean	Std. Dev.	Skew	Std. Err.	Std. Err.	Kurt.	Std. Err.	Std. Err.
42	397	1	5	2.93	0.93	-0.02	0.12	0.12	-0.64	0.24	0.24
43	396	1	5	4.04	0.72	-1.28	0.12	0.12	3.54	0.24	0.24
44	397	1	5	2.25	0.87	0.52	0.12	0.12	0.13	0.24	0.24
45	396	1	5	2.46	0.81	0.37	0.12	0.12	0.18	0.24	0.24
46	397	1	5	3.28	0.79	-0.23	0.12	0.12	-0.02	0.24	0.24
47	397	1	5	2.66	0.87	0.27	0.12	0.12	-0.21	0.24	0.24
48	397	1	5	4.36	0.70	-1.38	0.12	0.12	3.51	0.24	0.24
49	395	1	5	4.05	0.79	-1.27	0.12	0.12	3.04	0.24	0.24
50	397	1	5	3.12	0.73	-0.07	0.12	0.12	1.14	0.24	0.24
51	396	1	5	4.47	0.66	-1.59	0.12	0.12	4.52	0.24	0.24
52	396	1	5	4.39	0.82	-1.95	0.12	0.12	5.02	0.24	0.24
53	397	1	5	2.82	0.97	0.06	0.12	0.12	-0.25	0.24	0.24
54	397	1	5	3.88	0.93	-0.93	0.12	0.12	0.64	0.24	0.24
55	396	1	5	4.12	0.91	-1.27	0.12	0.12	1.71	0.24	0.24
56	397	1	5	4.27	0.88	-1.62	0.12	0.12	3.14	0.24	0.24
57	397	1	5	3.61	0.93	-0.54	0.12	0.12	0.21	0.24	0.24
58	397	1	5	4.14	0.84	-1.33	0.12	0.12	2.46	0.24	0.24
59	395	1	5	3.56	0.93	-0.51	0.12	0.12	-0.25	0.24	0.24
60	397	1	5	2.73	0.87	-0.06	0.12	0.12	-0.14	0.24	0.24