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Different Conceptions of the Nature of Science Among Preservice Elementary Teachers of Two Countries

Do-Yong Park, Illinois State University
Yong Bok Lee, Seoul National University of Education

Abstract

This study examined the differences of the nature of science (NOS) conceptions portrayed by preservice teachers in Korea (N = 42) and the United States (N = 50). We conducted a survey of preservice elementary science teachers' NOS conceptions followed by interviews in both countries to further investigate their viewpoints. The NOS domains of this investigation were Relativism versus Positivism, Inductivism versus Deductivism, Contextualism versus Decontextualism, Process versus Content, and Instrumentalism versus Realism. Findings indicated that preservice elementary science teachers' images of science were dominated by Relativism and Process in both countries. The conceptions of preservice teachers were different, however, in Inductivism versus Deductivism, Contextualism versus Decontextualism, and Instrumentalism versus Realism. Implications of these findings are discussed at the end of this article.

Introduction

For the last three decades, the science education community has viewed teaching the nature of science (NOS) as essential (Abd-El-Khalick & Lederman, 2000; American Association for the Advancement of Science [AAAS], 1993; Lederman, 1992). The importance of student understanding of the NOS is currently reflected in the goals and recommendations of K-12 science education documents developed in the United States (AAAS, 1993; National Research Council [NRC], 1996) and *The 7th National Science Education Curriculum* of Korea (Korea Ministry of Education & Human Resources Development, 2002). Teachers' images of science become important, especially when describing and presenting science in classes of Western and non-Western countries as it influences not only the way that teachers present science in the classroom but also the way that students view science. The topic of NOS has been heavily researched with the conclusion being that science teachers have inadequate understandings of the NOS in that they mostly believe that scientific knowledge is not tentative and that they possess a Positivist view of science (Abd-El-Khalick & BouJaoude, 1997; Abd-El-Khalick & Lederman, 2000; Lederman, 1992; Pomeroy, 1993). Lederman (1992) reviewed research of teachers' conceptions of science published since the 1950s and noted that most of the primary and secondary teachers did not hold the desired understandings of the NOS. In fact, many studies characterized the majority of science teachers as functioning with a Positivist view (Duschl & Wright, 1989; King, 1991; Loving, 1991; Powell, 1994). The question that arises is, "Is there a difference in teachers' conceptions of the NOS in different cultural contexts?" Liu and Lederman's (2003) work demonstrated that

Taiwanese preservice teachers conceived science as close to technology and as a materialistic benefit that is more pragmatic than rational and theoretical. As noted in the works of Abd-El-Khalick and BouJaoude (2003) and Aikenhead and Otsuji (2000), this conception tends to appear in non-Western cultural contexts. Teachers' position in regards to the NOS may be related to their conceptions of science teaching and learning. Literature shows that there were two positions regarding the relationship between teachers' conceptions of the NOS and their science teaching behavior in the classroom: (1) the studies that depended upon the relationship (Brickhouse, 1990; Gallagher, 1991; Lorsbach, Tobin, Briscoe, & Lamaster, 1992; Mitcherner & Anderson, 1989; Tobin & Espinet, 1989) and (2) the works that found no relationship (Duschl & Wright, 1989; Lederman & Zeidler, 1987). Although our study did not examine this relationship, we took the former position in our discussion—that is, that teachers' teaching behaviors were influenced by their conceptions of the NOS.

Would a view of the NOS be the same or different among the preservice teachers in different countries? If different, what does it imply for teacher preparation programs?

The five dimensions of science images that are generally recognized when discussing the NOS viewpoints (Nott & Wellington, 1993) are (1) Relativism versus Positivism, (2) Inductivism versus Deductivism, (3) Contextualism versus Decontextualism, (4) Process versus Content, and (5) Instrumentalism versus Realism. Using this framework, the study explored preservice elementary teachers' images of science between Korea and the United States, and it explained the differences in each domain of the NOS to gain a better understanding about how preservice teachers' images are specifically different.

Design and Data Collection

The methodology used for this study was twofold: (1) a questionnaire and (2) a semistructured follow-up interview. The questionnaire was mailed to three instructors in three universities, and they administered it in their classrooms during the middle of the fall semester. Out of 100 questionnaires, 92 responses were returned and analyzed for this study. After the questionnaire, three participants in each group were randomly chosen for a follow-up interview in which they responded to items in each dimension. Interview questions were semistructured in that new questions were brought up during the interview to clarify key words and to gain insights into the interviewees' responses on issues brought up on the questionnaire. Two or three items representing each dimension were selected for the interview: Items 3, 14, and 16 for Relativism versus Positivism; Items 5 and 19 for Inductivism versus Deductivism; Items 6 and 22 for Contextualism versus Decontextualism; Items 7 and 17 for Process versus Content; and Items 10 and 21 for Instrumentalism versus Realism (see Appendix A). Therefore, the follow-up interviews were used to help verify the students' responses in the event that the Likert scale questionnaire did not provide sufficient in-depth information.

The U.S. sample was selected from the elementary science method courses at two universities—one in the East (US-A; N = 26) and one in the Midwest (US-B; N = 24). The Korean sample was taken from the elementary science method courses at a university located in the capital city of Seoul, the Republic of Korea (N = 42). Two universities of the U.S. were chosen to see if there was a variance in their teacher preparation programs regarding the students' view of science. All of the participants in both countries in this study were never instructed explicitly on the NOS before nor during the course of this investigation. The participants from the two institutions of the U.S. took 12 credits of science, and all of the Korean participants had science as their endorsement (21 credit hours of science) at the time of the investigation.

The Instrument

The survey instrument used in this investigation was a questionnaire called *Your Nature of Science Profile* (see Appendix A). Nott and Wellington (1993) developed the instrument as a class activity to encourage teachers to critically consider the image they have of science. The questionnaire has 24 statements and addresses five dimensions of science images: (1) Relativism versus Positivism, (2) Inductivism versus Deductivism, (3) Contextualism versus Decontextualism, (4) Process versus Content, and (5) Instrumentalism versus Realism. The one for Korean participants was translated into Korean and administered after two science educators reviewed it with the agreement of 98% (2% disagreement on the choice of wording). The procedure followed was that one person reviewed the translated version of the instrument and checked it whether they agreed or not, and the other science educator did the same work on a separate paper. The two reviews were compared in terms of the level of agreement. The Pearson's reliability with these participants was 0.79. Table 1 shows the distribution of statement items among the five dimensions.

Table 1. Distribution of Items Related to the Five Dimensions

Dimensions	Statement Items
Relativism versus Positivism	-1, -3, -21, 12, 14, 16, 18, 20
Inductivism versus Deductivism	-5, -11, 19, 23
Contextualism versus Decontextualism	-2, -3, -6, -8, 13, 16, 18, 22
Process versus Content	-7, -9, -17, -24, 15
Instrumentalism versus Realism	-10, 21, 4, 12, 14

A description of each dimension of science image as defined by Nott and Wellington (1993) is as follows. The first dimension is Relativism versus Positivism. As a *Relativist*, a student would deny that things are true or false solely based on an independent reality. As a *Positivist*, the student believes strongly that scientific knowledge is more valid than other forms of knowledge. The laws and theories generated by experiments are the descriptions of patterns we see in a real, external, and objective world. In *Inductivism*, the second dimension, the student believes that the scientist's job is the interrogation of nature. By observing many particular instances, it is possible to infer from the particular to the general and then determine the underlying laws and theories. In *Deductivism*, the student believes that scientists proceed by testing ideas produced by the logical consequences of current theories or of their bold imaginative ideas. Science proceeds by testing the observable consequences of hypotheses (i.e., observations are directed or led by hypotheses—they are theory laden). In addition, a student may exhibit Contextualism versus Decontexualism as his or her image of science. For *Contextualism*, the student holds the view that scientific knowledge and processes are interdependent with the culture in which the scientists live and where it takes place. For *Decontextualism*, the student holds the view that scientific knowledge is independent of its cultural location and sociological structure. Another dimension of science is Process versus Content. In *Process*, the student sees science as a characteristic knowledge that has identifiable methods/processes. The learning of these is the essential part of science education. On the other hand, in the *Content* dimension, the student thinks that science is characterized by the facts and ideas it has and that the essential part of science education is the acquisition and mastery of this body of knowledge. The last dimension of science is Instrumentalism versus Realism. If a student holds an *Instrumentalist* view, then he or she would believe that scientific theories and ideas are fine with how he or she works—that is, they allow correct predictions to be made. They are instruments the student can use, but they say nothing about an independent reality or their own truth. If a student holds a *Realistic* view, he or she would believe that scientific theories are statements about a world that exists in space and time independently of the scientists' perceptions. Correct theories describe things which are really there, independent of the scientists (e.g., atoms).

Data Scoring and Analysis

Preservice teachers were asked to give each statement a number ranging from strongly agree (+5) to strongly disagree (-5). A score of 0 was processed as a balanced view. Scores were added up to give a grand total for each dimension. Some statements were scored as a negative when the statement was asked negatively. A "-" next to the number indicated that the scores needed their sign to be reversed (e.g., if a response to the statement is -3, then the score will be +3). Scores ranged from positive to negative points in each dimension. For example, a decision of whether a student has a Relativist or Positivist viewpoint is made on the grand total scale that comes from the average of all the participants' scores in each country as follows: Relativism (-40 to -1) and Positivism (1 to 40), Inductivism (-20 to -1) and Deductivism (1 to 20), Contextualism (-40 to -1) and Decontextualism (1 to 40), Process (-25 to -1) and Content (1 to 25), and Instrumentalism (-25 to -1) and Realism (1 to 25). The minimum/maximum scores depend on the number of questions in each dimension. Students' responses were analyzed for the purpose of placing evident conceptions into the five dimensions. The Chi Square for each domain was used twice. The first one was used for investigating a significant difference between the two U.S. universities of US-A and US-B. The second Chi Square was used for finding any significant differences between the universities in the U.S. and Korea.

Results

Conceptions of NOS

Table 2 shows the profile of preservice elementary teachers' images of science both at the U.S. and Korean universities. The U.S. preservice elementary teachers' views of science in each dimension showed no significant difference between the US-A and US-B universities. As seen in Table 2, Relativism, Decontextualism, and Process of science are predominantly held views by the preservice elementary teachers in the U.S. They also demonstrated both Inductivism and Deductivism, and Instrumentalism and Realism. On the other hand, Korean preservice teachers' views are Relativism, Deductivism, Process of science, and Realism. The big difference that was found was that Korean preservice teachers held a strong view of Deductivism and Realism, which the U.S. preservice students did not demonstrate. Instead, the U.S. prospective teachers held a view of Decontextualism, which Korean preservice teachers did not have.

Table 2. Percentage of Preservice Teachers' Responses in Each Dimension of Science Images Between the Two Countries

Dimension	Symbol	United States			Korea % (N = 42)
		US-A % (*n* = 26)	US-B % (*n* = 24)	Total % (N = 50)	
Relativism	REL	80.8 (21)	91.7 (22)	86.0 (43)	76.2 (32)
Positivism	POS	15.4 (4)	4.2 (1)	10.0 (5)	21.4 (9)
Inductivism	IND	38.5 (10)	54.2 (13)	46.0 (23)	4.8 (2)
Deductivism	DED	53.8 (14)	29.2 (7)	42.0 (21)	90.5 (38)
Contextualism	CON	19.2 (5)	33.3 (8)	26.0 (13)	50.0 (21)
Decontextualism	DEC	65.4 (17)	62.5 (15)	64.0 (32)	35.7 (15)
Process	PRO	92.3 (24)	87.5 (21)	90.0 (45)	88.1 (37)
Content	COT	7.7 (2)	12.5 (3)	10.0 (5)	7.1 (3)
Instrumentalism	INS	50.0 (13)	54.2 (13)	52.0 (26)	14.3 (6)
Realism	REA	38.5 (10)	37.5 (9)	38.0 (19)	78.6 (33)

The following section presents students' responses in each dimension among the three universities.

Relativism Versus Positivism

These two conceptions were examined through Items 1, 3, 12, 14, 16, 18, 20, and 21 (see Appendix A). Analysis of responses revealed that the majority of preservice elementary teachers in the two countries viewed the truth of scientific theories as being dependent on the norms of the social group and that the truth of scientific theories is relative rather than absolute. The most common conceptions of the interviewees were, ". . . I think scientific facts are formed through scientists' agreement, but there are some cases not all agreed. In that case, it does not become a scientific fact yet" (Item 3); "I would not be able to see the external world without my perception . . . so I would say what I see is sort of a real external world" (Item 14); and for Item 16, ". . . um, I believe the scientific theories have developed and changed through the improvement of skills and lab equipments. . . . [W]ithout a microscope, I would not be able to see cell in detail." Forty-three U.S. preservice teachers (86.0%) held a Relativist view of science, while five participants (10.0%) possessed a Positivist viewpoint. Thirty-two Korean preservice teachers (76.2%) viewed scientific truth as being Relative, and only nine participants (21.4%) held a Positivist viewpoint. (The missing percentage points represent a neutral response.) For statistical analysis, there is no statistical significance between US-A and US-B at the 0.05 level ($\chi^2 = 1.75$, $df = 2$, $p = 0.42$) and no statistical difference between the U.S. and Korea either ($\chi^2 = 2.41$, $df = 2$, $p = 0.30$).

Inductivism Versus Deductivism

These two conceptions were examined through Items 5, 11, 19, and 23 (see Appendix A). The results showed that the preservice elementary teachers in the U.S.

possessed a bipolar view on Inductivism versus Deductivism. Of 50 responses, 23 U.S. preservice teachers (46.0%) strongly agreed to an Inductivist's view of science, and 21 participants (42.0%) espoused a Deductivist's view of science. The U.S. interviewees' responses included the following: "Well, I think some scientists just follow the theory and do it [experiment] and see what happens later. I mean . . . the money they got from a grant agency should be spent [on] what they proposed, so they just do it" (Item 5); "I think I, at least, have an idea what would happen but we're not sure what it would be exactly" (Item 5); and "I think I would need imagination when I find a pattern from the experimental results" (Item 19). On the other hand, Korean students' views on science were dominated by Deductivism (90.5%). They think that scientists start an experiment with a theory and idea about the results of the experiment. They believe that scientists carry out experiments to test the hypothesis and imaginative ideas led by theory. Responses from Korean interviewees included the following:

> I disagree that scientists start lab experiment with no ideas about the results. Most scientists have imaginative ideas and hypothesis about the results based on a theory before lab experiments. But I had a problem when I did an experiment to make it neutral by mixing acid and base with same moles, respectively. When completed, a neutral solution was made. The solution of phenol that turns red in a neutral solution indicates it is neutral. But it did not turn red when I dropped it in. I know the fact that it is supposed to turn red. But it did not. So I tried it three times and finally made it turn red. From this experience, I realized that my knowledge guided my experiment. (Item 5)

> Sure, I believe they [scientific theories] are, in part, the results of imagination. I read many cases like this in various scientists' story books. But I don't believe all the theories are the results of imagination and intuition. Yet, I think it happens a lot with imagination. (Item 19)

For statistical analysis, there was no statistical significance between US-A and US-B at the 0.05 level ($\chi^2 = 3.32$, $df = 2$, $p = 0.19$), but there was a significant difference between the U.S. and Korea ($\chi^2 = 24$, $df = 2$, $p = 0.00$).

Contextualism Versus Decontextualism

The U.S. preservice elementary teachers held a dominant view of Decontextualism, while Korean preservice elementary teachers' views seemed split into two strong views: 50.0% for Contextualism and 35.7% for Decontextualism. Korean preservice teachers are in between regarding how the truth of scientific knowledge and processes are influenced by cultural and sociological structure. Interview responses included the following: "I marked '0' for this view. Although I agree to the fact that scientific research is influenced by [the] economic value of it . . . but I believe it all depends on people and their situation. If you develop a new medicine, you might have to consider its economic value but it is not always the case" (Item 6) and "I believe that scientific knowledge is [morally] neutral and, consequently, scientific research must be carried out under any circumstances. However, the application of it must consider moral issues. For instance, stem cell research is itself neutral, but I believe that many moral issues must be involved with the use of it. To me, the application really depends on how the society accepts [it]" (Item 22). On the other hand, 13 U.S. prospective teachers (26.0%) viewed science with Contextualism, while 32 participants (64.0%)

viewed science with Decontextualism. The U.S. preservice teachers held the view that scientific truth is independent of its culture and sociological structure. They think that, fundamentally, each area has its own agenda for research, which should not be determined by each other. Responses of interviewees were as follows: "I do agree to some extent, but I basically believe each area has its own research agenda. . . . [A]lthough scientific research may be influenced by an economic and political agenda in a country, it should not happen 'cause it has its own research agenda to move forward. . . . I think stem cell research should go on" (Items 6 and 22). For statistical analysis, there was no statistical significance between US-A and US-B at the level of 0.05 ($\chi^2 = 2.54$, $df = 2$, $p = 0.28$). This result indicated that the U.S. preservice teachers at two universities held the same views of science, which were dominated by Decontextualism. However, a significant difference was found between the U.S. and Korea ($\chi^2 = 7.48$, $df = 2$, $p = 0.02$). In other words, the U.S. preservice elementary teachers viewed that scientific truth can be established independently of its culture and social influence, while Korean students viewed the opposite.

Process Versus Content

Almost all of the U.S. and Korean preservice teachers in this sample considered science as Process (90.0% of the U.S. and 88.1% of the Korean participants) rather than Content (10.0% U.S. and 7.1% Korean). One of the most highlighted responses of those interviewed in both countries was, "I think scientific knowledge changes at some point in time, but the process of science is not changing. So I only need to know 'how to do' rather than what to do. . . . [A]ll I have to learn is how to find out information on [the] internet." In addition, some responses reflected the context of the Process by responding, "I gave a high score for Process because, in elementary science education, we got to focus on the process of science." The interviewer asked, "Why elementary?" The preservice teacher answered, "In fact, if you only teach the process of science with little content knowledge at the secondary level, your students would not be successful because of college entrance exam[s]. So to teach the process of science at the secondary [level], we ought to be able to change what/how to assess. Since we do not have pressure from college entrance exam[s] in elementary, we can teach and focus on the process of science" (Item 7) and "I think it [scientific method] is transferable, but I don't have experiences, though. Yet, it is highly possible when I imagine" (Item 17). There was no statistical difference between US-A and US-B at the 0.05 level ($\chi^2 = 0.32$, $df = 2$, $p = 0.57$) and no significant difference between the U.S. and Korea ($\chi^2 = 2.60$, $df = 2$, $p = 0.27$) either. The result shows that both the U.S. and Korean preservice elementary teachers held the same view on the Process versus Content dimension of science.

Instrumentalism Versus Realism

While over half of the U.S. preservice elementary science teachers (52.0%) held the Instrumentalist view of science, 38.0% of the participants held the Realistic view. Basically, the U.S. preservice teachers believed that scientific theories are tools that can be used to explain the natural world. One of the common responses was, "I think scientific theories are good when they work in explaining about the natural phenomena. If they do not work, then they will die out, I think" (Item 10). Some U.S. preservice teachers believed that there was something that we could not explain. One of the interviewees said, "I believe there is something that we cannot explain out there." The interviewer asked if there were any examples. The preservice teacher replied, ". . . You know, I saw a lot of mysteries through TV, media, and books. We still don't have any clue for the causes. I mean, we still don't know what caused that to occur" (Item 21). However, the Korean preservice teachers (78.6%) dominantly viewed science as the truth that exists in a natural world, independent of scientists' perceptions. Interview responses included the following: "I don't think it is only valid when scientific theories work good. I think that scientific theories are the result of what scientists agreed. At the same time, yet, I believe that scientific knowledge that we believe it is true might not be true" (Item 10) and "I think this is related to the theory of constructivism. Although I am not fully knowledgeable about it, I do not agree 100% to the theory. We did not yet go to the end of this universe. So we couldn't. But I think there is a world out there [without our perception]" (Item 21). There was no statistical significance found between US-A and US-B at the level of 0.05 ($\chi^2 = 0.17$, $df = 2$, $p = 0.92$), yet a statistically significant difference was found between the U.S. and Korea ($\chi^2 = 16.2$, $df = 2$, $p = 0.00$). In other words, the U.S. preservice teachers held both Instrumentalist and Realist viewpoints, but the Korean preservice teachers' responses demonstrated their view that correct scientific theories described the natural world to exist. To the majority of Korean preservice elementary teachers, the existence of scientific knowledge has nothing to do with scientists. This view is a little distant from the contemporary perspective of science. As Ziman (2000) stated, "Scientific knowledge is generated and received, regenerated, or revised, communicated and interpreted by the human minds" (p. 6).

Discussion and Implications

Comparison of preservice elementary science teachers' images of science between the U.S. and Korea revealed that both groups held the same view of Relativism and Process (see Table 2). The majority of preservice elementary science teachers, both in the U.S. and Korea, held the view that scientific knowledge is tentative and can be established through different scientific methods and processes which are in line with the contemporary view. With this in mind, if we are supportive of a position in literature that teachers' teaching behavior is influenced by their conceptions of the NOS (Brickhouse, 1990; Gallagher, 1991; Lorsbach et al., 1992; Mitcherner & Anderson, 1989; Tobin & Espinet, 1989), then it stands to reason that the elementary students both in the U.S. and Korea would be taught by teachers who hold the contemporary view of science that scientific theories are the result of the scientific community's endeavors. It is also likely that the elementary students might not learn science as a body of absolute truth, but they may strongly believe in science as a creative work of scientists utilizing inquiry methods. The contemporary view is that scientific study and scientific theories and ideas are created, falsified, and validated by scientists (Feyerabend, 1978; Kuhn, 1996). On the other hand, very few preservice teachers (see Table 2) possessed a Positivist view that the scientist's job is to establish the absolute and objective truth about the natural world through empirical facts and observed phenomena (Bauer, 1992). This view is the logical empiricist view, which is the traditional model of science. School science practice in the past has been dominated by the logical empiricist view of science (Duschl, 1990; Hodson, 1988).

In their report, *Science for All Americans*, AAAS (1993) pointed out that science "as a social activity inevitably reflected social values and viewpoints" (p. 8). Scientists are influenced by contextual values, including societal concerns and its culture (Ziman, 1980). Surprisingly, however, many U.S. preservice elementary science teachers (64.0%) held a view of Decontextualism, which is not amenable to the AAAS's position nor the National Science Teachers Association's (NSTA) (2000) position. In other words, preservice elementary science teachers in the U.S. viewed science as being independent of its cultural location and sociological structure. Contrary to this, Korean preservice teachers have a bipolar view on Contextualism (50.0%) and Decontextualism (35.7%). Regarding the Realistic view of science, 38.0% of the U.S. preservice teachers held a Realistic view, while 52.0% of them showed an Instrumentalist view in which scientific theories are instrumental in explaining and predicting the natural world. Half of the U.S. preservice teachers in this study believed that scientific theories and ideas say little in representing a reality of nature. Interestingly, the majority of Korean preservice teachers (78.6%) espoused the view of Realism that is a more traditional view of science. Many Korean preservice teachers believe that scientific knowledge and theories are statements about a natural world that exists independently of the scientists' perceptions. One of the reasons for this result is the fact that the Korean schools' science curriculum still presents science as a body of knowledge discovered by the scientific method, which is deemed value-free, objective, and powerful. This image will very likely be passed onto students unless an intervention program is implemented to improve both preservice and inservice teachers' understanding of the NOS. For this study, we did not intervene with the NOS lectures, so we assume that a view of science gained through their past education was carried into the present because students' images of science typically reflected the views presented by the curriculum during their education.

The teachers' conception about the NOS is important when considering their influence on the students' conception of it. The science teacher candidates are generally required to take science methods courses in order to get a teaching certificate. The teachers would then teach science in schools with this teaching certificate, and the students would learn science in the ways that it is delivered by these teachers. If the teachers teach science in the traditional view of the NOS, then it is likely that the students' viewpoints might follow. Teachers' teaching of science is strongly related to how they view science. As Palmquist and Finley (1997) asserted, how science teachers carry out the instruction presents a particular view of the NOS to their students. Teachers' conceptions about science teaching ultimately result in having a great impact on student learning (Greenwald, Hedges, & Laine, 1996; Haney, Czerniak, & Lumpe, 1996). Teachers believe that their behavior will result in the students learning what they desire and value (Crawley & Koballa, 1992; Haney et al., 1996). In addition, the depth of preparation of the teachers' content knowledge influences both what and how the teacher chooses to teach (Carlsen, 1991). In keeping with Schulman's (1987) notion of Pedagogical Content Knowledge, experienced teachers' ways are different from scientists' ways of perceiving knowledge in the natural sciences because they interpret such knowledge from a teaching perspective. Barufaldi, Bethel, and Lamb (1977) reported that science methods courses which taught inquiry methods developed, altered, and enhanced preservice elementary teachers' philosophical view of science. They claimed that a science methods course of this nature was one vehicle by which effective and positive attitude changes in preservice teachers were developed toward the tentative nature of scientific knowledge.

A learner's epistemological framework is an important factor for impacting changes in knowledge representation (Schauble, Klopfer, & Raghavan, 1991; Strike & Posner, 1990). It is suggested that preservice elementary science teachers understand the NOS and establish an epistemological framework in line with the contemporary view of science. This study showed the different images and understandings of science that preservice elementary science teachers held during their work in a science methods course in two different countries. The finding is invaluable when considering the fact that teachers' views of science affect the way they teach science.

Further Study

This investigation found different NOS conceptions among the preservice elementary science teachers in the U.S. and Korea. Most preservice teachers in the two U.S. universities held a view of Instrumentalism whereas most Korean participants held a view of Realism. However, this difference might be local since there is a great variance among the teacher preparation programs in the U.S. Thus, it limits this study to local explanations. If a larger population was involved, it would provide ample data to test the generalizability of this difference.

One thing that is certain is that both countries are employing different curricula for their elementary science teacher programs. The *National Science Education Standards* (NRC, 1996) defines curriculum as "the way content is delivered . . . the structure, organization, balance, and presentation of the content in the classroom" (p. 2). Obviously, the two programs are different in content organization, structure, and balance. Upon reflecting on the interplay between these discrepancies and the students' NOS conceptions, it is necessary to identify which factors influence students' views about science and their interpretations of the NOS knowledge.

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Appendix A

Your Nature of Science Profile

Please read each of the statements carefully. Give each one a number ranging from "Strongly Agree" (+5) to "Strongly Disagree," (-5) and place it next to the statement. A score of 0 will indicate a balanced view.

1. The results that pupils get from their experiments are as valid as anybody else's. ( )
2. Science is essentially a masculine construct. ( )
3. Science facts are what scientists agree that they are. ( )
4. The object of scientific activity is to reveal reality. ( )
5. Scientists have no idea of the outcome of an experiment before they do it. ( )
6. Scientific research is economically and politically determined. ( )
7. Science education should be more about the learning of scientific processes than the learning of scientific facts. ( )
8. The processes of science are divorced from moral and ethical considerations. ( )
9. The most valuable part of a scientific education is what remains after the facts have been forgotten. ( )
10. Scientific theories are valid if they work. ( )
11. Science proceeds by drawing generalizable conclusions (which later become theories) from available data. ( )
12. There is such a thing as a true scientific theory. ( )
13. Human emotion plays no part in the creation of scientific knowledge. ( )
14. Scientific theories describe a real external world which is independent of human perception. ( )
15. A good solid grounding in basic scientific facts and inherited scientific knowledge is essential before young scientists can go on to make discoveries of their own. ( )
16. Scientific theories have changed over time simply because experimental techniques have improved. ( )
17. Scientific method is transferable from one scientific investigation to another. ( )
18. In practice, choices between competing theories are made purely on the basis of experimental results. ( )
19. Scientific theories are as much a result of imagination and intuition as inference from experimental results. ( )
20. Scientific knowledge is different from other kinds of knowledge in that it has higher status. ( )
21. There are certain physical events in the universe which science can never explain. ( )
22. Scientific knowledge is morally neutral—only the application of the knowledge is ethically determined. ( )
23. All scientific experiments and observations are determined by existing theories. ( )
24. Science is essentially characterized by the methods and processes it uses. ( )

Correspondence regarding this article should be directed to

Dr. Do-Yong Park
Illinois State University
Science Education
College of Education
120 Felmley Science Hall
Normal, IL 61790-5330
(309) 438-5050
Fax: (309) 438-8659
dpark@ilstu.edu

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