Sculpted by Culture: Students' Embodied Images of Scientists

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We conducted a cross cultural comparative analysis involving children from India, South Korea, Turkey and the United States. The study investigated children's perceptions regarding scientists, the similarities and differences between their stereotypic perceptions of scientists and the cultural factors that contribute to them. The participant pool included students from grades 3 and 7 (120 per grade, per country) who were administered the Draw-A-Scientist-Test (Chambers, 1983). Randomly chosen students were also interviewed using a semi-structured interview protocol. A one-way ANOVA was performed to test for differences among the four countries. Results revealed some commonalities in the stereotypic perceptions regarding scientists and discussed the "value" placed on science in these countries.

Introduction

Mention the words "outsourcing" or "H1B visa quota" or "call centers" and the image associated with these usually includes individuals from countries such as India, China, South Korea and to a lesser extent from the Middle East. New industrial countries like India, South Korea and Turkey are not only economically but also culturally very diverse and are racing to catch up with the "West". While more is known about older students from these countries and their influx into the United States to work or enroll in graduate schools in STEM (Science, Technology, Engineering, and Mathematics) related areas, little is known about the children. In this study we investigate students' perceptions regarding science and scientists via the stereotypes they exhibit in their drawings. Stereotypes are blanket beliefs and expectations about members of certain groups that present an oversimplified opinion or prejudiced attitude. They go beyond necessary and useful categorizations and generalizations in that they are typically negative, are based on little information and are highly resistant to change.

Review of Literature

Background Research about the Draw-A-Scientist-Test (DAST)

Research into children's perceptions of science and scientists commenced well over 50 years ago. The seminal work by Mead & Metraux (1957) systematically described how students viewed scientists. 35,000 American high school students participating in their study wrote an essay describing their image of a scientist. Results revealed the typical high school student perceived a scientist as being an elderly or middle-aged male in a white coat and glasses who worked in a laboratory where he performed dangerous experiments. "He is the slightly sinister man in the white coat, performing chemical wonders as incomprehensible as magic" (Ward, 1977, p. 7). The popular stereotype of the white-coated male scientist with extraordinary powers has persisted over the ages reinforced by both the print media and television. Much of the subsequent research relied on students' written responses regarding stereotypical images of scientists. Literature shows that both children and teachers frequently visualize scientists as bespectacled, white-smocked, middle-aged White males with wild hair, holding smoking, bubbling test tubes and working inside a laboratory (Basalla, 1976; Barman, 1997; Ford & Varney, 1989; McDuffie, 2001; Moseley & Norris, 1999). These common stereotypic characteristics of scientists are strongly held by children between the ages of seven to twelve (Bowtell, 1996; Mays, 2001).

In 1983 Chambers developed the Draw-a-Scientist-Test patterned after the Draw-A-Man-Test (Goodenough, 1926; Harris, 1963). The students' drawings were assessed for seven predetermined indicators of the "standard image" of the scientist from which Chambers was able to demonstrate that children held stereotypical views of scientists that varied by age and grade level. Chambers (1983) and Schibeci & Sorensen (1983) showed that by second grade, the average number of indicators included in drawings had more than doubled, with indicator numbers reaching a peak in the fifth grade when the image of the stereotype had fully formed. To provide a reliable and efficient format for analyzing students' drawings, Finson, et al. (1995) developed the Draw-A-Scientist Checklist (DAST-C). The checklist consisting of items was advantageous, lending itself to comparative data analysis by virtue of being able to quantify scores for students' drawings, facilitating statistical analysis. Items such as gender, race, signs of danger and secrecy, mythical images of scientists (Dr Jekyll / Mr. Hyde, Frankenstein), and images of scientists working in a laboratory have extended the range of stereotypical image of the scientist. Using ANOVA procedures, Finson (2002) reported an interrater reliability of 0.96 to 0.98 with regard to the DAST-C instrument.

Several researchers took methodological issue to DAST. Jarvis & Rennie (1995) thought that the use of drawings only was problematic. They opined that a drawing without words could represent an abstract idea the observer may be unable to comprehend. They suggested that children be asked to add sentences or annotate their drawings to improve interpretation of the drawing. According to Losh, Wilke & Pop (2008), a major shortcoming of DAST is in asking children to draw 'only scientists'. They postulate that it is unlikely children view scientists as different from other professionals especially in absence of comparison across occupations. Symington & Spurling (1990) revised the original DAST test and renamed it the DAST-R (Draw A Scientist Test-Revised). They believed that when asked to draw a scientist, students often drew the "public perception of a scientist" rather than their own. In their revised protocol, they asked students to "Do a drawing which tells what you know about scientists and their work." When results using the revised prompt were compared to those obtained using the original DAST task, enough differences arose between the two for the researchers to recommend a critical examination of the DAST prompt. Maoldomhnaigh & Hunt (1989) reported that when they asked their subjects to draw two pictures of scientists the frequency of appearance of mythic stereotypes changed from one set of representations to the other leading them to conclude that students might have more than one definition of the word "scientist". Maoldomhnaigh & Mholain (1990) cautioned greater care needed to be exercised in the standardization of task directions provided to children regarding their drawings as changing the wording in the directions could produce different types of drawings.

Synopsis of International Studies Using DAST

While several research studies have been conducted in the United States regarding children's perceptions of scientists, there is a paucity of such data in the international arena. Chambers (1983) conducted a study of images of scientists in the People's Republic of China, and reported that the images of scientists drawn by students closely matched those from Western culture. Schibeci & Sorensen (1983) conducted a study of elementary children in Australia using the DAST and reported that the media, primarily television, contributed significantly to reinforcement of the stereotypical image. She (1995) analyzed how science text books influence student's images of science and scientists by administering a modified DAST to 289 Taiwanese elementary and middle school students. Results revealed that students drew images similar to those in their textbooks with an increase in sophistication and complexity at higher grade levels. Earlier studies conducted by She showed Chinese Taiwan students held very similar stereotypical images of scientists as those in the West. Fung (2002) administered the DAST to 675 Hong Kong Chinese students comparing primary and secondary school student's images. She reported that students developed more stereotypical images with age and that the scientists drawn were predominantly masculine. A study of 76 primary students in Ireland (Maoldomhnaigh & Hunt, 1989) revealed that not a single male student drew a female scientist and that only 23 out of 45 female students drew female scientists. Song & Kim (1999) reported that out of 1,137 Korean students ages 11, 13 and 15, 74 % described their scientist as male and only 16 % as female. Buldu (2006) described a study in Turkey when DAST was administered to children aged 5-8 years. None of the 24 boys drew female scientists and 5 of 13 girls drew female scientists. Sjøberg (2002) investigated students' experiences and interests relating to science and technology in 21 countries. He reported that the image of science and scientists in developing countries was more positive and that those students were more eager to learn science.

Gardner (1980) suggested that the cultural models students are exposed to significantly impact their mental schema the results of which are exhibited in drawings arising from those schemas; cultural factors are hence responsible for the formation of stereotypes regarding scientists. Primary among these are images students see in textbooks and other print media as well as on television that contribute to their perceptions of what science is and what scientists do. According to Hammrich (1997), individuals with negative perceptions of science or scientists are unlikely to pursue science courses or enter a science related career. Conversely, it has been reported that if students could visualize themselves in a particular career, then the likelihood of them pursuing an educational program to prepare for that career is increased (Beardsley & O'Dowd, 1961; Smith & Erb, 1986).

The research questions for our cross cultural study are: a) What perceptions do children from these countries have with regard to science and scientists, b) What similarities and differences exist between the student's perceptions (grade wise, gender wise and country wise) and c) what cultural factors contributed to these?

Context: How Science is Taught in Participant Countries

In India, science is taught at all grade levels starting with General Science and Environmental Studies at the elementary levels, differentiating into Physics, Chemistry and Biology at the 8th grade level. Science teaching is mostly passive, generally taught out of a textbook, the teacher doing a few demonstrations at the elementary level. At the 9th & 10th grade level, students visit the science laboratory during practical periods to perform experiments. In Turkey, the third grade curriculum does not include any science course. Students take a general science and technology course at fourth grade and continue to take this every year until the end of eight years of compulsory basic education. Specific science subjects (e.g. biology, physics, etc.) are taught starting from first year of high school at 9th grade. Students in the Turkish study used the science laboratories occasionally; they were more often involved in class demonstrations and thought experiments than were engaged in wet laboratories. In South Korea, science is taught 3 times per a week at the 3rd and 7th grade level. For both the 3rd and 7th grade science is taught as an integrated science (not taught as separate disciplines such as biology, earth science, chemistry, and physics. In addition all science courses contain a laboratory component which is at least one class period per week. In the United States, science is taught at all grade levels, but at higher grade levels, students can choose the number of science courses they want to take in order to graduate. Class sizes are often small (25-30) and depending on the school, science can be taught between once to 4 times a week at the elementary and more often at higher grade levels.

Method

Participants included students at the 3rd and 7th grades middle to upper income schools in Bombay, India, Seoul, South Korea, Ankara, Turkey and Lubbock, Texas. 120 randomly selected students at each grade level in each country participated in the study, (n = 480; G3, m =241, f = 239; G7, m = 252, f = 228)

Research Design and Data Collection

We chose a mixed method research design in order to assist us in first determining and then comparing what perceptions our student participants had about science and scientists. Using the qualitative survey enabled us to describe specific characteristics (Jaeger, 1988) over a large number of students in 4 different countries. The survey instrument consisted of four parts, a) to draw a scientist and describe what the scientist was doing in the picture and b) to draw a student doing science and describe what the student was doing, in addition, students were also asked to describe c) what career they wanted to pursue after they completed school, explain why and, d) whether they liked science, explain their answer. Participants were asked to indicate their gender and grade level on the survey. Approximately 30 minutes were allotted for participants to complete their drawings. Five randomly chosen students out of every 100 participants at each grade level were individually interviewed. A semi-structured interview protocol with open ended questions was used.

Data Analysis

The drawings were evaluated using the DAST-C checklist using the standard indicators developed by Finson, Beaver, and Cramond (1995), the more the number of indicators, the stronger the stereotype held. The three researchers jointly scored 20 drawings and established clear criteria for analysis of each item on the DAST-C checklist. Then they scored separately another 20 drawings and sorted out any disagreements that arose. The researchers individually analyzed the rest of the drawings and an inter-rater reliability of 92 % (percentage of agreement) was obtained. In most cases the sex of the scientist was easy to determine; in the few drawings in which the sex was indeterminate, the image was scored as neutral. With regard to the scientist being Caucasian, Turks are considered as Caucasian; however diagrams from India and South Korea were evaluated as Caucasian only in case of the person in the diagram being identified as a particular Caucasian e.g. Albert Einstein or Newton. Once the drawings were scored, the percent distribution of numbers of standard indicators was determined for each grade level. A one-way ANOVA was performed to test for differences among the three countries. Part b of the questionnaire administered asked participants to draw a student doing science in school. For this task the drawings of students doing science were grouped into three main categories: (1) those who pictured themselves as passive learners such as reading about science or taking notes at a desk (2) those who saw themselves as active learners and (3) others (looking for insects, leaves, plants, or rocks outdoors). Independent samples t-tests were conducted to examine differences in gender for each grade. Interviews were transcribed and coded; codes were collapsed as themes emerged.

Results

Part A: Stereotypes

One-way ANOVA with posthoc Tukey was performed to examine differences in student responses among four countries. All statistical procedures were conducted using SPSS. For Grade 3 (G3) students, the results indicated that mean differences in all items except for item 12 (Indications of Secrecy, warnings of "private," etc.) were statistically significant at the .05 level at least between two countries. In particular, the mean of Turkey students on the item 4 (symbols of research) was significantly lower than those from India, Korea, and USA ($p < 0.05$). We believe that this result can be explained by the fact that science is not taught at the third grade level in Turkey. With the other participating countries, we found a very strong identification with the person doing science, the scientist and the symbols of research (instruments) used to do science. The instruments drawn were largely ones found in the chemistry laboratory such as beakers, flasks, test tubes etc and were more well defined in the drawings of Grade 7 (G7) than in G3 students. In addition, the means of Turkey and USA on the item 9 (Caucasians Only) were significantly higher than those from Korea and India. One probable cause for this result is that Caucasians are more likely to identify themselves with a Caucasian than a person from another country. Conversely, we found that a number of G3 students from India, South Korea and Turkey identified the scientist they drew as Einstein, Newton, Edison, Bell and Pasteur. Few students from these countries were able to name a scientist from their home country. The means of G3 United States students on item 11 (Mythic Stereotypes) was significantly higher than those from the other countries. Several students both at the third and 7th grade drew their scientist as a frightening figure some labeling their drawings as “Frankenstein”, “Evilla”, “Cruella” and “Witch”. There were more captions and descriptions that indicated poison were being mixed or made by the scientist. We attribute this to representations of scientists in this manner in the media especially television.

In comparison to G3 students, G7 students’ drawings of scientist included more details about what the scientist did, what he/she wore, and the details of his/her visage. G7 students’ drawings included more stereotypical scientist images than 3rd graders’. For G7 students, results indicated that the mean differences in all items except for the items 5 (Symbols of Knowledge e.g. Books, clip boards, pens in pockets, etc.), 6 (Technology Represented e.g. Telephone, TV, computers, etc.), 10 (Scientist in Middle Aged/ Elderly) and 12 (Indications of Secrecy, warnings of "private," etc.) were statistically significant at the .05 level at least between two countries. In particular, the mean of South Korean students was significantly higher than those from India, Turkey, and USA on the item 13 (working in lab). This is an interesting result because in South Korea, science is taught as an integrated discipline in both the 3rd and 7th grade. The mean of students from the United States on item 15 (open comments related to dress items, neckties, hair style, smile/frown, etc.) was significantly lower than those from Korea, India, and Turkey. A larger number of students drew their scientists in everyday clothes than in a lab coat. Most of the diagrams showed the scientists as smiling. On the item 4 (symbols of research), the mean of Turkey students was significantly lower than those from the other countries which is the same as 3rd graders.

Part B: Draw a Student Doing Science in School

In part b, participants drew a picture of a student doing science in school and explained what the student was doing. G3 students from India and the United States perceived doing science as passive significantly more than those from Korea and Turkey ($p < 0.05$) while Korean students regarded doing science as active more than those from India, Turkey, and USA ($p < 0.05$). This is a surprising result considering that science is often taught with teacher-centered, memorization-based approaches especially at the secondary level in Korea as it is in India. For the 7th grade, Turkey students regarded doing science as passive less than those from other three countries regardless that science learning in Turkey is less lab based. The results however affirm that activity based science instruction has a greater impact on children, leaving an indelible impression on their mind that is different from the experience of hearing a lecture about science while seated at a desk in a classroom.

Part C: Future Career Choice

When asked about the future career choice, a significantly larger number of Korean 3rd graders wanted to become scientists than other three countries 3rd graders ($p < 0.05$). Turkish students reported they wanted to be a Formula 1 race car driver or a soccer player. This was probably influenced by Turkish television broadcasts that were dominated by telecasts of the two sports. Among Indian students, while few reported they wanted to be a scientist, a majority identified science related fields such as engineering, medicine, etc., that they wanted to pursue as a future career choice. Many United States students (especially males) revealed they wanted to be sportsmen, especially football, basketball and baseball players.

Gender Analysis

Independent samples t-tests were conducted to examine differences in gender for each grade (n = 480; G3, m =241, f = 239; G7, m = 252, f = 228). An overall analysis by gender revealed that the mean difference on the items 5 (symbols of knowledge), 8 (male) and 13 (working in a lab) was significant at the .05 level. Females more than males drew their scientist in a laboratory setting with symbols of knowledge such as books, charts, etc. It is also not surprising that males tended to draw their scientist as a male while females drew both male and female scientists. When asked about the future career choice, males said they wanted to be scientists more than the females. For G7 students, the mean difference on the items 2, 6, 8 and 11 was significant at the .05 level. More females drew their scientists with eyeglasses than did the males. However more males drew their scientists as males with symbols of technology and mythical stereotypes. Overall gender analysis confirms a predominantly "manly" image of a scientist irrespective of the country from which the student hails from. Similar results have been reported by Andre, Whigham, Hendrickson & Chambers, (1999); and by Bianchini, Cavazos & Helms, (2000).

Discussion

Stereotypes have been described both as an individual as well as a collective, cultural phenomenon (Markus & Zajonc, 1985; Tajfel, 1981). Culture impacts not only science but also the perceptions of science and scientists its citizens possess. Some commonalities exist across grade, gender and country in the stereotypes participating children exhibit regarding their perceptions of scientists. The difference is in the degree to which the prevailing culture of a country allows negative stereotypes to deter a child's learning of science. Epstein (1997) discussed how children learn and grow through three overlapping spheres of influence: family, school, and community. These three spheres must form partnerships to best meet the needs of the child. Public attitude towards science and technology is crucial and affects children's future career choices both implicitly as well as explicitly. Communities with a strong positive schema toward science reinforce a belief that science produces things that make life healthier, easier, and more comfortable, with the implicit assumption that this will continue, or make a positive assessment of the likelihood of future benefits. Conversely, communities with a strong negative schema will represent personal reservations about science and technology; express concerns about the speed of change in modern life and portray a sense that science may, at times, pose conflicts with traditional values or belief systems (National Science Board, 1998).

Parental / familial involvement in school has been found to improve facets of children's education such as academic achievement (Van Voorhis, 2001; Zellman & Waterman, 1998). Hagerty (1964) reported that parents, counselors, principals, friends, and media, as well as teachers, influence career choices. Research has shown a relationship between role model influence and career aspirations and choice (Nauta, et al., 1998; DeSantis & Quimby, 2004). Smith & Erb (1986) suggest that exposing middle and high school students to role models as part of their science instruction positively impacts their attitudes towards science and scientists. In countries like India and South Korea, students, especially from the middle class who pursue STEM areas of study at graduate schools in the United States often act as de facto role models other students look up to. In the interviews, the children from the developing countries often referred directly or indirectly to the "value" of science. Though they found the study of science difficult and tedious, they also saw science as a means to improve their lives.

> "Science is not my favorite subject to study in school. It is so hard and we have to memorize everything to do well in the exam. When I grow up I want to be an author and write stories, but I think I will be a computer engineer like my brother and uncle and make lots of money" (Interview 1, August 3rd 2007, Manoj, 5th grader, India).

The availability of role models in science and science related fields and the inevitable lure of a "better life" are often hard to resist.

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