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This study compared students' perceptions of doing science and scientists reflected in their drawings using a modified version of the Drawing-A-Scientist-Test across five different countries: China, India, South Korea, Turkey, and US. The participants were 1,800 students from grades three, seven and ten from the five countries. Thirty students randomly selected were interviewed using a semi-structured interview protocol. Results indicated that fewer stereotypes were exhibited at the lower grades than at the higher grades in all of the countries. Students from India, US, and South Korea perceived doing science passive more than those from Turkey and China. A larger number of Indian and Turkish students reported that they wanted to become a scientist or have a science related career compared to those from the other countries. In addition, students' perceptions of scientist were not related to their career choices in any country. However, students who perceived science as active practice were inclined to choose science-related career more than students who regarded science as passive practice in Korea and US. There was no statistically significant difference by perception of doing science actively or passively for career choice in India, Turkey and China.

Keywords: stereotypes of science, perceptions of doing science, international comparison study, STEM careers, Draw-A-Scientist-Test

INTRODUCTION

The words, "outsourcing" or "H1B visa quota" or "call centers" and the image associated with these usually include individuals from countries such as China, India, South Korea and to a lesser extent from the Middle East. New industrial countries such as China, India, South Korea and Turkey are not only economically but also culturally diverse and are racing to catch up with the more advanced "West." According to Charlton and Andras (2006), as globalization continues to increase, there will be an escalation in competition and migration of both students and teachers resulting in transnational flows of capital and jobs. Recent enrollment rates of "foreign" graduate students in STEM (Science, Technology, Engineering, and Mathematics) related areas of several Universities in the

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State of the literature

- Common stereotypic perceptions about scientists are prevalent among students in different countries.
- Statistical analysis revealed no difference among males and females with regards to scientist stereotypes.
- Early research suggested females expressed more negative attitudes towards science than males that contributed to the lack of women in science fields.

Contribution of this paper to the literature

- This paper provides an extensive literature review on the Draw-A-Scientist-Test and students' perceptions of scientists and doing science.
- Data was collected and analyzed from five different countries contributing to the knowledge base where there is a paucity of research set in an international arena.
- Results indicated having a strong stereotypic image about scientists did not impact the student's choice to pursue science or a science related career.

United States (US) provide evidence of this. National Science Board (NSB, 2012) reported that the number of total foreign graduate students continued to increase through fall 2010, with all of the increase occurring in STEM fields. In particular, foreign students on temporary visas earned 57% of all engineering doctorates, 54% of all computer science degrees, and 51% of physics doctoral degrees (NSB, 2012). However, little is known why students from those countries pursue careers in STEM more than those in US.

Research suggests that several factors affect students' choice of pursuing a science career such as student interests in and attitudes toward science, social environment , experiences in science classroom, and gender (Aschbacher, Li, & Roth, 2010; Hazari et al., 2010; Stake & Nicksen, 2005; Tai, Liu, Maltese, & Fan, 2006). In particular, researchers have paid a great deal of attention to students' attitudes toward science given that positive attitudes influence students' selection of science courses, career choices, and science achievement (Farenga & Joyce, 1998; Lietz et al., 2002; Martin et al., 2000; Simpson & Oliver, 1990). According to Osborne et al. (2003), students' attitudes refer to the feelings, beliefs and values students hold about the enterprise of science, scientists, school science, and the impact of science on society. Most scholars agree that students' perceptions of scientists and science learning experiences are key components of their attitudes towards science (Gardner, 1975; Haladyna, Olsen, & Shaughnessy, 1982; Klopfer, 1971; Oliver & Simpson 1988). Although research suggests a positive relation between attitudes as a holistic construct and career choice, little is known how student perceptions of scientists and science learning are related to their career choices in STEM.

In this regard, this study compared students' perceptions of doing science and scientists reflected in their responses to a modified version of Draw-A-Scientist Test (DAST) across five different countries, i.e., China, India, South Korea, Turkey, and US. Moreover, it investigated how those perceptions are related to their stated career interests on an open-ended survey. This international comparison study was conducted with 3rd, 7th, and 10th graders in the five countries. Research questions that guided this research were: a) what perceptions do students from these countries have with regard to scientists and doing science?; b) what similarities and differences exist among the student's perceptions (grade wise, gender wise and country wise)?; and c) how are their perceptions related to their stated future career choice?

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. Thirty five thousand American high school students participating in their study wrote an essay describing their image of a scientist. Results revealed that 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).

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, based on little information and are highly resistant to change. 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; Rubin, Bar, & Cohen, 2003). These common stereotypic characteristics of scientists are strongly held by children between the ages of seven to twelve (Bowtell, 1996; Mays, 2001). However, a study (Thomas, Henry, & Snell, 2006) showed that even college students hold similar perceptions of scientists as did the younger students referred to in previous studies. Further the authors suggested that gender stereotypes were widely persistent even among college science majors.

In 1983, Chambers developed the Draw-a- Scientist-Test (DAST) 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 and 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 was fully formed. Since Chambers' introduction of DAST, researchers have implemented it in various research contexts and thus DAST has been considered as an effective methodological approach to understand student perceptions of scientists (Finson, 2002; Lunn & Noble, 2008; Monhardt, 2003).

However, some researchers have raised questions about the use of DAST as a means to understand student perceptions of scientists. Jarvis and Rennie (1995) argued that the use of drawings alone to understand student perception 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 and Pop (2008), a major shortcoming of DAST is in asking children to draw 'only scientists.' They postulate that it is unlikely that children view scientists as different from other professionals especially in the absence of comparison across occupations. Farland and McComas (2007) also argued that students may have more than one image available and suggested that students be asked to make several drawings of scientists at different times. Symington and Spurling (1990) pointed out that when asked to draw a scientist, students often drew the "public perception of a scientist" rather than their own. In this regard, they revised the original DAST test, which is called the DAST-R (Draw A Scientist Test-Revised). 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. With those issues in mind, this current study utilized a modified version of DAST in which students were asked to draw not only a scientist but also a student doing science to obtain a better understanding of their perceptions of science learning experiences and about scientists. Participating students were also asked to write a short description of each drawing.

To provide a reliable and efficient format for analyzing students' drawings, Finson, Beaver, and Cramond (1995) developed the Draw-A-Scientist Checklist (DAST-C). The checklist consisting of 15 items was advantageous, lending itself to comparative data analysis by virtue of being able to quantify scores for students' drawings, facilitating statistical analysis. The overall rating obtained through the DAST-C is distributed across a continuum that represents the degree of stereotypical quality. 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 that DAST-C established a high inter-rater reliability of 0.96 to 0.98. With respect to the validity of DAST-C, Finson (2003) demonstrated its valid implementation to students from different racial groups (i.e., Caucasian, Native American, and African American), while Monhardt (2003) demonstrated its implementation to those who are not proficient in written responses such as elementary school students. Given the acceptable reliability and validity, this study used the DAST-C for data analysis.

Synopsis of international studies using DAST

While several research studies have been conducted in US 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 and Sorensen (1983) conducted a study of elementary children in Australia using the DAST and reported 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 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, 1988) revealed that not a single male student drew a female scientist and that only 23 out of 45 female students drew female scientists. Song and 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. Research indicates that this gender stereotype is also salient among Korean younger elementary students (Jun, 2004; Kwon, 2005). A study suggests that Korean 5th grade students held negative perceptions of scientists such as being anti-social; working in isolation, and weird appearance compared to 3rd grade students (Jeon, 2004). Ju, Lee, Kim and Lee (2009) reported that one of the prominent stereotypes Korean 3rd grade students possessed about science was the symbol of science including beaker, mass cylinder, alcohol lamp, and glass tube mostly related to chemistry. Medina-Jerez, Middleton, and Orihuyela-Rabaza (2011) explored 1017 Colombian and Bolivian students' perceptions of scientists by using the Draw-a-Scientist Test Checklist. The results suggested that the Colombian students had more stereotypical perceptions about scientists than Bolivian students. Nationality, grade, and school type were critical factors that led to the differences on how students perceived scientists. Türkmen (2008) analyzed the image of a scientist drawn by 287 Turkish fifth grade students and reported that stereotypical images of scientists in the students' drawings are slightly lower than what had been revealed in previous studies.

Buldu (2006) described a study in Turkey when DAST was administered to children ages 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. Various cultural factors are 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.

Students' Attitudes toward Science & Their Career Choices

Research shows that students' attitudes towards science are related to their choice to pursue a science career. According to Hammrich, (1997), individuals with negative perceptions of science or scientists are unlikely to choose science courses or pursue 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).

In a nationwide study in US, Tai and his colleagues (2006) investigated whether 8th grade students who reported they expected to enter a science-related career by age 30 obtained baccalaureate degrees in science-related fields at higher rates than students who did not have this expectation. Results indicated that students who expected to have a science related career by age 30 were 3.4 times more likely to earn baccalaureate degrees in physical science and engineering than those who did not have that expectation. Further, students who expected a science related career were1.9 times more likely to earn baccalaureate degrees degree in life science than their counterparts.

Earlier studies suggested that female students express more negative attitudes toward science than male students (Catsambis, 1995; Willson, 1983). This gender related difference in attitudes was considered to contribute to the lack of women in science fields (Kahle & Lakes, 1983). However, recent research reveals social factors contribute to the gender difference in attitudes towards science such as family support, peer support, school science characteristics, social factors, and science learning experiences (Brotman & More, 2008; Gilmartin & Aschbacher, 2006; Hazari et al. 2010; Stake & Nickens, 2005). In addition to gender, Greenfield (1995) explained that ethnic origin is significantly associated with attitudes towards science and career choices in science. Caucasians were found to have the most positive attitudes towards science and Japanese-Americans were most positively inclined towards scientific careers. Greenfield (1995) found that the influence of ethnic origin was found to be more significant than gender.

Research Context

The participant countries other than US were selected because they are rapidly developing industrialized countries with an escalation in migration of personnel in STEM areas to US. Further, the ease of data collection by the authors who hail from the respective countries and have ties to US was a key factor. The Trends in International Mathematics and

Table 1. Comparison of How Science is taught in Five Participating Countries

Country	National Curriculum	3rd Grade Science	7th Grade Science	10th Grade Science	Science Labs
India	No	General Science	General Science	Physics, Chemistry Biology	Elementary: few demonstrations Verification labs at higher grades
South Korea	Yes	Integrated Science	Integrated Science	Physics Chemistry Biology Earth Science	One lab period per week per science course
Turkey	Yes	No specific	General Science & Technology	Physics Chemistry Biology	Occasional hands on activities, verification labs
China	Yes	Integrated Natural Science	Integrated /separate sciences	Physics Chemistry Biology	Labs twice a week at higher grades, more at lower grades
United States	No	General Life Science	Physical, Earth Sciences	Physics, Chemistry Biology	Demonstrations and activities at lower grades, structured labs in higher grades

Science Study (TIMSS), and Program for International Student Assessment (PISA) data though available was not used to draw comparisons as countries such as India and China did not participate in these studies.

How science is taught in participating countries

Table 1 summarizes details about science teaching at the schools from which data was collected in the five participating 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 mostly cook-book type experiments.

In Turkey, in 3rd grade there is no specific science course, however some broader or cross cutting science concepts such as change, interaction, cause-effect relationship, similarities and variation in nature, and interdependence of organisms are briefly covered in an integrated course titled “Knowledge of Life”. The emphasis of this course is broad skills of life such as critical thinking, problem solving, communication, traffic rules, protecting ourselves from natural and environmental hazards, etc. In 7th grade, students take a general science course titled “Science and Technology” 4hrs per week. This course covers both physical and life sciences units. At 10th grade students take Biology, Chemistry and Physics 2hrs each per week. Laboratory activities are done within the normal course hours, the extent to which teacher uses laboratory facilities greatly varies by schools, teachers, and availability of equipment and materials.

In South Korea, science is taught 3 times per a week at the 3rd and 7th grade level. Science for both the 3rd and 7th grade 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 US, 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.

In China, science is taught as Natural Science at the elementary level from grade 3, but it is not tested on as a requirement to enter middle schools, hence students are able to spend more time in the laboratory performing experiments. At the middle school level, grade 8, science is delineated into specific subjects, i.e. physics, chemistry, biology. At this level, students visit the laboratory once every two weeks, however the science taught is more theoretical. All students up to grade 11 have to learn science as a school subject. The average class size is 45-50, at the elementary and junior high levels, science is taught twice a week (45 minute periods) and thrice a week at the high school level.

Table 2. Distribution of Participants by Country, Gender and Grade Level

Country	Gender	Grade 3	Grade 7	Grade 10	Total
South Korea	Male	60	60	60	360
	Female	60	60	60	
India	Male	60	60	61	360
	Female	60	60	59	
Turkey	Male	60	72	70	360
	Female	60	48	50	
USA	Male	61	60	59	360
	Female	59	60	61	
China	Male	60	51	60	360
	Female	60	69	60	

METHODS

Participants

Participants included 1,800 students at the 3rd, 7th and 10th grades in Bombay, India; Seoul, South Korea; Ankara, Turkey; Beijing, China; and Lubbock, Texas, US. Given the impact of socio-economic factors on student perceptions, participant schools were selected from middle to upper income schools in a city in each country. In India, most schools are generally K-10 or K-12, all in the same school; there are no separate elementary, middle and high schools. Indian students' data were collected from a semi private school in Bombay for K-12 which serves about 4,000 students. In South Korea, data was collected from 3 elementary, 3 middle, and 3 high schools located in Seoul and the average student enrollment of those schools is between 1,500 and 2,000. While US data was collected from 1 elementary (enrollment; 520), 1 middle (enrollment: 634), and 1 high school (enrollment: 2,500) in Lubbock, Texas, Turkish data was collected from 2 primary schools serving grades 1-8 (enrollment: 500-900) and one high school (enrollment: 1,200) located in Ankara. In China, three schools, a primary, middle, and high school each serving 2000-3000 students located in Beijing participated in the study. All participating schools kept the gender distribution around 50%. The medium of instruction in both India and US was English whereas students in the other countries were taught in their native language (i.e., Chinese, Korean, and Turkish).

Within the participating schools, one hundred twenty students per grade level 3rd, 7th & 10th) were randomly selected. The procedure for selecting students was uniform in all schools. Teachers provided researchers only the roll numbers of the students in the class from which researchers randomly picked numbers considering even distribution of gender and teachers pulled the students selected. Table 2 delineates the gender breakup of the participants, grade wise and country wise.

Research Design and Data Collection

A mixed method research design was employed to compare differences and similarities in students' perceptions of science and scientists among different countries. Major data sources included student responses to survey instrument and interviews. The survey instrument consisted of three parts: Part A) to draw a scientist and describe what the scientist was doing in the picture; Part B) to draw a student doing science and describe what the student was doing; and Part C) to describe what career they wanted to pursue after they completed school and explain why. Participants were asked to indicate their gender and grade level on the survey. Approximately 30 minutes were allotted for participants to complete their surveys. Two randomly chosen students at each grade level in each country were individually interviewed using a semi-structured interview protocol. The interviews aimed to elicit the student's elaborated ideas of science, scientists, and his/her potential career interest in science, as well as the reasoning behind these responses.

Data Analysis

Students' Perceptions of Scientists

The drawings of scientists (Part A) were evaluated using the DAST-C developed by Finson, Beaver, and Cramond (1995). The DAST-C consists of 15 items that represent 15 stereotypic characteristics of scientists that students commonly have. During the analysis of a student's drawing, the researchers checked the items on the DAST-C corresponding to the stereotypic images that appeared on the student's drawing. For statistical analysis, one point was assigned to each checked item and each student's total score was calculated by adding up the points. The possible full score for each student's scientist drawing is 15. The higher the score is, the stronger stereotype a student holds.

Table 3. Descriptive Statistics by Country and Grade Level

Country	Grade	Mean	*SD*	*N*
South Korea	Grade3	4.29	1.652	120
	Grade7	4.63	2.082	120
	Grade10	4.62	1.783	120
	Total (M)	4.51	1.849	360
India	Grade3	3.38	1.421	120
	Grade7	4.08	1.526	120
	Grade10	4.70	1.822	120
	Total (M)	4.06	1.683	360
Turkey	Grade3	3.41	1.399	120
	Grade7	5.07	2.020	120
	Grade10	5.04	2.335	120
	Total (M)	4.51	2.101	360
U.S.	Grade3	3.36	1.724	120
	Grade7	4.62	1.759	120
	Grade10	3.94	1.889	120
	Total (M)	3.97	1.860	360
China	Grade3	3.43	1.407	120
	Grade7	3.59	1.747	120
	Grade10	3.93	1.719	120
	Total (M)	3.65	1.640	360
Total	Grade3	3.58	1.564	600
	Grade7	4.40	1.901	600
	Grade10	4.45	1.966	600
	Total (M)	4.14	1.861	1800

Table 4. Distribution of Indicators for Each Country

Item No.	Indicator of stereotype	Country				
		South Korea(%)	India(%)	Turkey(%)	U.S.(%)	China(%)
1	Lab coat	53.6	24.7	25.3	32.5	6.1
2	Glasses	36.1	24.7	32.2	36.7	23.9
3	Facial Hair	10.6	19.7	22.8	15.8	14.4
4	Research Symbol	80.0	88.1	49.7	77.8	59.2
5	Knowledge Symbol	26.7	11.4	21.9	9.4	11.9
6	Technology	12.2	8.6	18.9	5.0	21.4
7	Relevant Caption	6.1	10.6	16.9	12.2	3.9
8	Male Only	71.1	87.8	72.2	56.4	81.9
9	Caucasian Only	8.6	13.9	91.4	61.7	20.3
10	Middle Age/Elderly	21.7	21.9	26.1	18.6	40.6
11	Mythic Stereotype	2.2	1.9	8.9	18.1	5.0
12	Secrecy	0.3	0.3	1.1	0.0	033
13	Working in lab	71.4	55.3	24.4	30.3	32.5
14	Danger	9.4	0.6	1.7	5.6	1.4
15	Smile	40.8	36.1	36.9	17.2	42.5

To enhance the accuracy of scoring by DAST-C, the three researchers jointly scored 20 drawings randomly selected from each country and established clear criteria for analysis of each item on the DAST-C. Then they scored separately another 20 drawings from each country and sorted out any disagreements that arose to calculate an initial inter-rater reliability, which was 92%. The three researchers discussed all disagreements until they reached agreements and then they individually analyzed the rest of the drawings.

Students' Perceptions of Doing Science

For Part B, the drawings of a student(s) 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 pictured themselves as active learners; and (3) others (not clear about activeness or passiveness). Like Part A, the three researchers separately analyzed 20 drawings from each country using the three categories and discussed any disagreement until they reached agreement. They then independently analyzed the rest of the data.

Students' Career Choices

Students' responses to Part C were grouped into three categories: a) scientist (e.g., biologist and chemist); b) science related career (e.g., biotechnologist and computer engineer); and c) non science related career (e.g., singer and soccer player). Their descriptions of reasons for their career choices were open coded, and then contrasted and compared to identify common patterns. Chi-square test was performed to examine whether there were statistically significant differences in career choices by country and by gender in each country. Interviews were transcribed and analyzed using the constant comparative method (Strauss & Corbin, 1990). The results from the interviews were triangulated with those from the survey (modified DAST).

Relationships among Students' Perceptions of Scientists and Doing Science, and Career Choices

To examine whether student perceptions of scientists were related to their career choices, participants in each country were divided into two groups according to their stated career choices; one wanting to pursue science or science-related career; the other wanting to pursue non-science related career. Then, a t-test was conducted to determine whether the means of the stereotype scores of the two groups were statistically different from each other.

In order to assess the relationship between student perceptions of scientists and perceptions of doing science, the mean scores of the stereotype were compared country-wise by three categories based on student perception of doing science; a) drawing themselves doing science in a passive manner, b) drawing themselves engaging in science in an active manner, and c) drawings not falling into either the passive or active categories. To compare the mean scores of stereotype by these three groups, one-way ANOVA was conducted for each country. To examine the relationship between students' perceptions of doing science and their career choices, crosstabulation was performed.

RESULTS

Part A: Perceptions of Scientists

Overall Perceptions

To test the differences in the mean scores of the students' perceptions of scientists measured by DAST-C by country, by grade, and by gender, ANOVA was conducted. The results indicated that the main effect of country (F=15.679, p-value=.000) and grade level (F=45.938, p-value=.000) were statistically significant while the main effect of gender was not significant. In general, South Korean (M=4.51) and Turkish (M=4.51) students held the stronger stereotype about scientists than did India (M=4.06), US (M=3.97) and China (M=3.65) (See Table 3).

Table 4 describes the distribution of the indicators for each country. The stereotypes of scientists most frequently exhibited by students of all grade levels and countries fell into two major categories: a) those related to the physical appearance of the scientist and b) those representative of the environment in which the scientist was drawn. In the former category these predominantly included items 1 and 2 (lab coat and glasses) in Table 4. Also, the majority of scientists were illustrated as being male. In the case of environment, most students drew scientists working in a laboratory performing experiments. For instance, Indian and Chinese students perceived scientists as being males (India: 87.8%, China: 81.9%) and working in a laboratory surrounded by research symbols (India: 88.1%, China: 59.2%). In South Korea, 71.1% of students drew scientists as males, wearing a lab coat (53.6%) and working in a laboratory (71.4%) surrounded by objects of research (80.0%). Noticeably, more South Korean students than those from India, Turkey, China, and the US drew scientists wearing a lab coat and working in a laboratory. This is an interesting result because in South Korea, as in Turkey, science is taught as an integrated discipline in both the 3rd and 7th grade and science courses are not typically lab-based at such grade levels.

Meanwhile, a larger number of students from the US drew their scientists in everyday clothes as opposed to wearing lab coats. In addition, the item 15 (open comments related to dress items, neckties, hair style, smile/frown, etc.) was less depicted by the students from the US than those from Korea, India, Turkey, and China. Moreover, the US students held stronger stereotypes on mythic stereotypes than those from the other countries. For instance, several grade 3 and grade 7 students portrayed their scientists as a frightening figure, some labeling them as "Frankenstein", "Evilla",

Table 5. Distribution of Doing Science by Country and Grade Level

Country	Grade	Doing Science		
		Active (%)	Passive (%)	Others (%)
Korea	Grade 3	84.6	10.3	5.1
	Grade 7	65.0	33.3	1.7
	Grade 10	50.4	47.9	1.7
	Total	66.6	30.6	2.8
India	Grade 3	45.8	45.0	9.2
	Grade 7	55.0	42.5	2.5
	Grade 10	73.2	24.1	2.7
	Total	57.7	37.5	4.8
Turkey	Grade 3	56.7	18.3	25.0
	Grade 7	82.2	3.4	14.4
	Grade 10	76.7	15.0	8.3
	Total	71.8	12.3	15.9
US	Grade 3	58.3	41.7	0.0
	Grade 7	38.3	47.5	14.2
	Grade 10	79.5	20.5	0.0
	Total	58.2	36.9	4.8
China	Grade 3	64.2	18.3	17.5
	Grade 7	84.2	5.0	10.8
	Grade 10	66.7	21.7	11.7
	Total	71.7	15.0	13.3
Total	Grade 3	61.8	26.8	11.4
	Grade 7	64.9	26.4	8.7
	Grade 10	69.1	25.9	5.0
	Total	65.2	26.4	8.4

"Cruella," and "Witch." While these are common representations in the US they were not seen among students from other participating countries.

It is also important to note that over 90% of Turkish student depicted scientists as Caucasian, while the students from other countries illustrated other ethnic groups, such as Hispanic, Asian, and African. One possible cause for this result is that Turkish population is primarily Caucasian and further, that Caucasians are more likely to identify themselves with the scientist profession than a person from another country.

By Grade

In this study, some grade 3 students drew their scientist examining leaves or looking through the telescope. Interviews revealed that those were topics recently studied by the students in their science lessons. We also found that more grade 3 students than grade 7 and grade 10 students from all participant countries identified the scientist as Einstein, Newton, Edison, Bell, and Pasteur. Few participants were able to correctly name a scientist from their home country. In contrast, very few grade 7 and grade10 students identified their drawings with a scientist they knew. Drawings of students in higher grades displayed more detail especially with regard to the equipment (symbols of research) used by scientists to conduct their experiments, such as beakers, conical flasks, and burners.

By Gender

Although a statistical analysis revealed that there was no difference between female and male participants in the mean scores of stereotype, female participants predominantly depicted their scientists wearing lab coats and eye glasses, working in the laboratory surrounded by symbols of research. In particular, for grade 3, more females than males drew their scientists in a laboratory setting with symbols of knowledge, such as books, charts, etc. Meanwhile, a majority of male participants portrayed their scientists as a male Caucasian. It is not surprising that males tended to draw their scientist as a male, while females drew both male and female scientists. For grade 7, female students described scientists with eyeglasses, while male students drew their scientists with symbols of technology and mythic stereotypes. For grade 10 students, the overall analysis confirms a predominantly "manly" image of a scientist irrespective of the country of origin of the students.

Table 6. Distribution of Career Choice by Country and Grade Levels

Country	Grade	Career Choice		
		Non-science related (%)	**Scientist (%)**	**Science related position (%)**
Korea	Grade 3	63.3	20.0	9.2
	Grade 7	79.2	10.0	9.2
	Grade 10	81.7	12.5	2.5
	Total	74.7	14.2	6.9
India	Grade 3	53.3	9.2	37.5
	Grade 7	55.0	5.0	40.0
	Grade 10	47.5	11.7	40.8
	Total	51.9	8.6	39.4
Turkey	Grade 3	60.8	7.5	31.7
	Grade 7	55.0	4.2	40.8
	Grade 10	23.3	2.5	74.2
	Total	46.4	4.7	48.9
US	Grade 3	62.5	6.7	30.8
	Grade 7	83.3	5.8	10.8
	Grade 10	65.8	3.3	30.8
	Total	70.6	5.3	24.2
China	Grade 3	52.5	20.0	27.5
	Grade 7	75.8	13.3	10.8
	Grade 10	72.5	10.8	16.7
	Total	66.9	14.7	18.3
Total	Grade 3	58.5	12.7	27.3
	Grade 7	69.7	7.7	22.3
	Grade 10	58.2	8.2	33.0
	Total	62.1	9.5	27.6

Table 7. Gender Difference in Career Choice in Each Country

Country	**Career Choice**	**Gender**				
		Male		**Female**		
		N	**%**	**N**	**%**	χ^2
Korea	Non-science career	117	44.3	147	55.7	15.352***
	Science/science-related career	62	68.1	29	31.9	
India	Non-science career	75	44.6	9`3	55.4	2.323
	Science/science-related career	91	52.9	81	47.1	
Turkey	Non-science career	78	51.0	75	49.0	4.205*
	Science/science-related career	119	62.0	73	38.0	
U.S.	Non-science career	137	56.6	105	43.4	11.583**
	Science/science-related career	39	36.8	67	63.2	
China	Non-science career	108	50.8	128	54.2	0.825
	Science/science-related career	62	50.8	60	49.2	

Note: *p <.05 **p <.01 ***p <.001

Part B: Draw a Student Doing Science in School

In part B of the survey administered, we asked participants to draw a picture of a student doing science in school and explain what the student was doing. The data were grouped into three categories: active, passive, and other. Drawings that represented the student reading or sitting at a table and taking notes were classified as passive learners. In contrast, active learners were those participating in an activity such as setting up and conducting their own experiment. A third category titled "other" included those drawings where student's activeness or passiveness was not clearly represented.

Table 5 represents the results obtained for these categories and indicates the differences in each one of them across countries and grade levels. More than half

Table 8. Difference of Stereotype Score by Career Choice Group in Each Country

	Mean score of stereotype				
Country	**Non-Scientist**	**Scientist**	*df*	*t*	*p*
Korea	4.53	4.37	353	0.7	0.484
India	3.93	4.16	336	-1.277	0.202
Turkey	4.35	4.63	343	-1.247	0.213
U.S.	4.10	3.77	346	1.487	0.138
China	3.58	3.80	356	-1.153	0.250

Note: The results indicate that there is no significant at the p <.05 level.

Table 9. Difference of Stereotype Scores by Perceptions of Doing Science in Korean and India

	Doing Science				
Country	**Passive**	**Active**	**Other**	*F*	df_{total}
Korea	4.55	4.50	4.27	0.121	352
India	3.83	4.32	2.81	8.424***	351

Note: ***p <.001

of the students from all countries perceived doing science as an active practice. Interestingly, students from India (37.5%), US (36.9%), and South Korea (30.6%) perceived doing science passive more than those from Turkey (12.3%) and China (15.0%).

Part C: Future Career Choice

Chi-square test indicated that students' career choices were different by countries (chi-square = 100.260, df=4, sig.=0.00; see Table 6 for the differences). When asked about their future career choice, more than half of the entire participant group (62.1%) stated they would not want to have career in science or science related fields. In particular, 74.7% of Korean students and 70.6% of US students expressed no interest in pursuing career in science as shown Table 6. In our analyses, it became evident that participants at all grade levels differentiated between "scientist" and "science related careers" as future career choice. As seen in Table 6, the students from India, Turkey and US wanted to pursue science related careers such as engineer, doctor, or inventor more than scientist; on the other hand, Korean students prefer scientist (14.2%) to science related position (6.9%). Interestingly, students who reported they wanted to pursue various medical and engineering related fields were very specific about the field, for example, veterinary, gynecology, biotechnologist, computer engineer etc.

Among Indian grade 10 students, while only about 10% of participants chose scientist as their future career choice, more than 40% of students chose science and technology related fields to pursue as a future career choice. However these results were not seen with the participants from the US. Non-science related careers that the participants reported include sportsmen, especially football, basketball and baseball players mostly for male students and teacher, model, makeup artist and fashion designer for female students.

In the interviews, the students 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 mean 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 (pseudonym), 5th grader, India).

This directly speaks to how globalization has the ability to make science transformative in the lives of young people (Lee & Micheal-Roth, 2007).

Chi-square test was performed to examine gender differences in career choice in each country. As a result, the association between gender and career choice was significant in Korea, Turkey and US at the 0.05 significance level (Table 7). In particular, in Korea and Turkey, male students tended to choose science related careers more frequently than female students for their future career. In contrast, the pattern was reverse in US: female students tended to choose science/science-related career more frequently than male students at the 0.01 significance level.

Relationship between Students' Perceptions of Scientist and Career Choices

The results of t-test with the two groups (wanting to pursue science or science-related career; wanting to pursue non-science related career) indicated that there is no statistically significant difference in the stereotype scores of the two groups for all the participating countries (Table 8). In other words, if a student has strong stereotypic images of scientists it does not impact his or her choice to pursue science or science-related career.

Relationship between Students' Perceptions of Scientist and Perceptions of Doing Science

Three indicators of student perception of doing science (passive, active and other) were present in the students' drawing of themselves doing science. Table 9 displays the difference in mean score of the stereotypes by student perceptions of doing science. As indicated in the table, students in India have significantly different perceptions of doing science. Indian students who perceived doing science as an active practice tended to have stronger stereotypes than others who perceived it as passive practice. However, there were not statistically significant differences by student perceptions of doing science in the four other countries: South Korea, Turkey, US, and China.

Relationship between Students' Perceptions of Doing Science and Career Choices

Table 9 displays crosstabulation of students' perception of doing science and career choices for each country. As indicated in Table 10, only in Korea and US there was a significant relationship between an active perception of doing science and choosing a science related career. In other three countries no relationship between the perception of doing science and career choice was found.

DISCUSSION AND IMPLICATIONS

This study shows that the students from the five participating countries held similar stereotypic images of scientist to those that previous studies identified. For example, most students in this study portrayed scientists as males wearing lab coats working in laboratories and earlier studies reported (Barman, 1996, 1997, 1999). In particular, the students' predominant "manly" view of scientist also appeared in this study (Fung, 2002). Moreover, the tendency that male students draew male scientists, while females draew both male and female scientists (Maoldomhnaigh & Hunt, 1989; Song & Kim, 1999) was salient in this study. In all of the five countries, 3rd graders held lessfewer stereotypes that than 7th and 10th graders. This supports that the stereotypic images of scientist are fully formed by 5th grade suggested by Chambers (1983) and Schibeci and Sorensen (1983). These commonalities in the stereotypic images of scientist that both this current study and previous studies revealed imply that stereotypes are highly resistant to change. On the other hand, some differences that existed by grade, gender and country in the stereotypes suggest that stereotypes are not only individual phenomenon but also collective, cultural phenomenon (Marcus & Zajonc, 1985; Tajfel, 1981). The difference is in the degree to which the prevailing culture of a country allows negative stereotypes to deter a student's learning of science.

A larger number of the students appeared to perceive doing science as an active practice. In terms of countries, students from India, US, and South Korea perceived doing science passive more than those from Turkey and China. Assuming that their perceptions of

Table 10. Crosstabulation between Students' Perception of Doing Science and Career Choices

Country	Doing science	Career Choice		χ^2
		Non-Scientist	Scientist	
	Passive	84.6%	15.4%	8.873*
Korea	Active	69.8%	30.2%	
	Other	63.6%	36.4%	
	Passive	52.4%	47.6%	0.754
India	Active	47.4%	52.6%	
	Other	50.0%	50.0%	
	Passive	38.2%	61.8%	2.655
Turkey	Active	43.0%	57.0%	
	Other	53.3%	46.7%	
	Passive	75.0%	25.0%	6.575*
U.S.	Active	65.0%	35.0%	
	Other	88.2%	11.8%	
	Passive	57.4%	42.6%	2.102
China	Active	67.2%	32.8%	
	Other	68.9%	31.1%	

*Note: *p <.05*

doing science are partly reflection of their learning experience in science classrooms, it is not surprising that Korean and Indian students had a more passive view than those from the other countries given their education context where science is often taught for preparing high-stake test with teacher-centered and memorization-based approaches. However, the passive view from US students is unexpected considering the activity-based approach the participating schools had adopted to enhance the science learning of their students. In a similar vein, it is interesting that Turkish participants depicted students doing science in "active" ways given that science is most typically taught through lecture-based instruction based upon textbook information with little first-hand explorations in Turkey.

An interesting result of our study was that more than half of the entire participant group stated they would not want to pursue a career in science. The decline in the interest among youth in pursuing science careers has been well documented (Varghese, 2008; Xie & Killewald, 2012; Ozden, 2007). Several factors might contribute to these results. As the data was being collected, it became apparent that participants at various grade levels and in different countries exhibited a plethora of views about what it is a scientist really does. In practice the occupation-based definition specifies that those involved in scientific occupations are scientists. However, according to Citro and Kalton (1989) and Xie and Shauman (2003), the education-based definition considers individuals with or working toward science degrees as scientists or potential scientists. Our participants subscribed to both the education based as well as the occupation based definition. The lack of understanding and clarity about what it is a scientist really does give rise to myths such as "science is boring" or that "science is only for clever people "often deterring further perusal of science. Archer et al. (2012) argued that tagging science careers as 'clever'/'brainy', 'not nurturing' and 'geeky' sits in opposition to the girls' self-identifications as 'normal', 'girly', 'caring' and 'active.' Other social, political and economic reasons also influence students' perusal of science careers.

While collecting and analyzing data, it became evident that participants at all grade levels differentiated between "scientist" and "science related careers" as future career choice. While some participants chose scientist as their future career choice, several others both male and female chose very specific fields related to science and technology such as veterinary, gynecology, biotechnologist, computer engineer etc. Non-science related careers that the participants reported include sportsmen, especially football, basketball and baseball players mostly for male students and teacher, model, makeup artist and fashion designer for female students. Further, the stereotypic images student held about scientists do not impact students choices regarding future science careers.

The gender analysis with regards to career choices in each country revealed unexpected results. While in South Korea and Turkey, male students tended to choose science related careers more than females did, the pattern was reversed in US. The gender difference in South Korea and Turkey is reinforced by extensive literature reporting that male students choose science-related career less than female students because of females' negative attitudes towards science (Johnson, 1987; Kahle & Lakes, 1983; Robertson, 1987). However, there are also studies that support the gender difference in US that females tended to choose science/ science related careers more frequently than males did. Whitehead (1996) found that even though there were significant gender distinctions about students' perception of subjects, this did not extend to their subject choice or career choice. Lightbody & Durndell (1996) also reported that there was no significant difference between male and female career aspirations and it was not so much as science and technology being perceived as masculine. Given those contradictory results on the gender differences in career choice, further research needs to be conducted for a better understanding of the gender issues in science.

Another interesting finding is the significant relationship between perceptions of doing science and career choices only in Korea and US. In these two countries, students who perceived science as active practice were inclined to choose science-related career more than students who perceived science as passive practice. However, we found no relationship between the perception of doing science and career choice in China, India and Turkey. Among the five participating countries, US and Korea have higher per capita income that the other countries. It can be expected that in wealthy countries more resources and opportunities are available for general student population to follow their career inspirations. Those students who perceived science as active practice in US and Korea might have a more realistic view of science through personally meaningful science learning experiences and have exposed to rich opportunities to explore science-related careers with relatively abundant resources in the countries.

Although this international comparison study was ground in sound research methods, it should be acknowledged that the findings of this study cannot generalized towards a larger population of the participating countries due to the relatively small sample size. In particular, given the large population of China and India, 360 students are too small to properly represent the student population of the countries. However, the detailed analysis of the student samples provides important insights into students' perceptions of scientist and doing science, and their career choices in the participating countries. In addition, it should be acknowledged that even though the best effort was made to accurately translate the prompts and questions of the survey to different languages, students' interpretations of them might be different from what they meant to be due to possible changes in nuances resulting from the translation.

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