5-6-2008

Preservice Elementary Teachers' Images of Inventors

Audrey C. Rule
University of Northern Iowa

E. L. Bisbo

See next page for additional authors

Author
Audrey C. Rule, E. L. Bisbo, and V. Waloven

Preservice Elementary Teachers' Images of Inventors

Audrey C. Rule
Department of Curriculum and Instruction
University of Northern Iowa
Cedar Falls, IA 50614

Erica Lyn Bisbo and Valerie Waloven
State University of New York at Oswego
Oswego, NY 13126

May 6, 2008

Abstract

Technology and invention are an integral part of the elementary school science curriculum, addressed by national standards. Student drawings of scientists have been studied extensively, but little is known of student mental conceptions and drawings of inventors. To uncover student's images of inventors, ninety preservice elementary teachers at a mid-sized college in central New York State drew images of both inventors and scientists, which were analyzed and compared. Both sets of drawings portrayed white, mostly male figures. Scientists were shown wearing lab coats and working with fuming chemicals in a lab, while inventors more often wore casual clothing and were shown working with inventions and tools. Two-thirds of the images showed figures of different sex than the sketchers, indicating that the elementary preservice teachers did not readily identify with either inventors or scientists. We suggest that future studies explore effective ways to increase preservice elementary teachers' understanding of and identification with the work of inventors. [17 references, 3 tables]

Introduction

Images of Scientists and Inventors

A student's attitude or mental predisposition, carries a mental state of readiness with it (Martin, Sexton, Wagner, & Gerlovich, 1997). Student attitudes toward scientists and inventors are important because they affect student performance in related coursework and choice of career. Students' images of and ideas about scientists have been studied for over fifty years through the Draw-A-Scientist projective test (Finson, 2002). Projective tests are more useful for determining student attitudes than self-reports because they measure the motives that automatically influence behavior, including mental attitudes of which the test-taker may not be consciously aware (McClelland et al., 1989). Projective tests are not as susceptible to self-presentation bias, gender bias, and instructor manipulating as self-reports (Bomstein, 2002).

Student-drawn images may be scored for stereotyped characteristics. Recognition of these factors is important in science education, as research has shown that the more stereotypes included in a drawing of a scientist, the less likely the student is to choose science coursework and a career in the sciences (Hammrich, 1997). The most common stereotypes of scientists reported in the literature are male Caucasians working indoors with chemistry equipment wearing lab coats, eyeglasses, and facial hair (Chambers, 1983). In contrast, students who draw less-stereotyped images of the same gender race/ethnicity, and physical characteristics as themselves are *projecting* themselves in the position of a scientist and therefore are more likely to pursue science in their educational path and career (National Science Teachers' Association, 1992). Fortunately, multiple exposures to real scientists coupled with other interventions may reduce the number of stereotyped characteristics in students' drawings and change student attitudes toward science (Bodzin and Gehringer, 2001; Finson, Beaver, & Cramond, 1995; Flick, 1990; Mason, Kahle, and Gardner, 1991; Smith and Erb, 1986).

The Importance of Teaching about Invention in Elementary Schools

Technology and invention is an important part of the elementary science curriculum. Science and Technology Content Standard E of the National Science Education Standards (National Research Council, 1996) states that as a result of activities in grades K-4, all students should develop abilities of technological design. Invention supports scientific inquiry, allows students to make connections to the real world and other subject areas. The authors of the *Benchmarks for Science Literacy* (American Association for the Advancement of Science, 1993) in chapter 3, The Nature of Technology, discuss how elementary students need to know about the connections between science and technology, the nature of engineering and design, and societal issues related to technology.

Invention lessons address the often-neglected domains in science education of "Imaging and Creating" (Domain III) and "Using and Applying" (Domain V) as defined by Yager (2000). Invention allows students to combine objects in new ways, produce alternate or unusual uses for objects, and to design and test devices and machines. Through invention, students apply learned science concepts and problem-solving skills to everyday technological problems and household devices. Students involved in invention also work in Domain VI, "Viewing Science and its History as Human Enterprises." They may consider the motives of scientists, engineers and technologists, along with investigating the history of technology and tits effects on our society.

America needs inventors and innovators to competitively keep pace with the rest of the world and to solve global environmental problems. "Sustainable development is the practice of protecting the environment while improving living standards for all, and invention and

innovation is the key to its success. Invention and innovation for sustainable development isn't just developing new technology, but includes new processes and new ways of solving old problems – creative thinking is the rubric… Despite the fact that people everywhere have an innate ability to be creative, rich countries are not doing enough to stimulate and harness invention and creative thinking… due to a combination of factors …[including] education systems that don't inspire or value creativity…" (Lemelson-MIT Program, 2003). Therefore, for invention and creativity to be adequately addressed in elementary school, elementary teachers need to be involved in invention themselves during their career preparation.

Research Investigation

As we have described previously, students' attitudes toward science, as revealed in their drawings, need to be positive and minimize stereotypes so that they enjoy the study of science and consider science career possibilities. Similarly, student images of inventors may reveal their attitudes toward this creative and important endeavor. No other studies reported in the literature have described student drawings of inventors. Therefore, because teachers' attitudes strongly influence how and what they teach, affecting students' attitudes and learning, we will compare preservice elementary teacher drawings of both scientists and inventors to discern the differences in their characteristics and infer how this impacts attitudes toward invention.

Method

Participants

Ninety preservice elementary teachers (78 females, 12 males; 83 Euro-Americans, 2 Asian-Americans, and 5 Hispanic- Americans) enrolled in a science methods course at a mid-sized public college in central New York State participated in the study. Permission was obtained from all participants and from the overseeing university's Committee for Research in Human Subjects for the study to be conducted.

Procedure

On the first day of class, preservice teachers were asked to complete a drawing of a "scientist" and a drawing of an "inventor." These were analyzed for characteristics of the person and setting.

Results

Table 1 shows characteristics appearing in both scientist and inventor drawings. Students portrayed both scientists and inventors as white and most frequently male with just a few more female inventors than scientists. Two-thirds of the preservice teachers drew scientists and inventors who were of a different sex than their own, demonstrating their lack of identification with these activities. Additional characteristics that were very similar for both scientist and inventor drawings were the frequency of wild hairstyles or balding heads, indicating respectively, eccentric personality and middle age. Additionally, both scientists and inventors were most often drawn as standing, perhaps indicating the perceived active nature of the work of these professionals.

Table 1. Characteristics appearing both in "scientist" drawings and "inventor" drawings.

Characteristic	Frequency on Drawings	
	Scientists	Inventors
Race: White	90	90
Sex: Male	75	71
Sex: Female	15	19
Sex of student different from drawn figure	59	60
Standing	88	83
Clothing: Lab coat	65	9
Clothing: Man's dress shirt	12	8
Clothing: Regular tie	7	3
Clothing: Casual clothing	3	46
Setting: Indoor	63	38
Setting: Outdoor	1	13
Setting: Chemistry lab equipment: beakers, test tubes, flasks	70	7
Setting: Lab bench or table	54	31
Setting: Fumes/ vapors	43	2
Technology/Tool: Computer/ telephone	1	9
Accessory: Eyeglasses	52	25
Accessory: Pocket protector	27	3
Accessory: Safety goggles	6	1
Appearance: Wild hair	23	22
Appearance: Balding	19	16
Name written on person	9	5
Blackboard or bulletin board	12	1
$E = mc^2$	8	2
Facial Hair- Moustache	7	1
Symbol of Knowledge equation(s)	2	1
Symbol of knowledge: Light bulb	2	25
Indications of danger – poison	1	1

However, there were marked differences in the frequency of other characteristics. Scientists were much more commonly shown wearing eyeglasses and laboratory coats with pocket protectors and working indoors with fuming chemical solutions in glassware near a lab bench.

Scientists were more often shown near black boards or bulletin boards, indicating a college setting. Inventors, in contrast, were more often portrayed in casual clothing and outdoor settings (or without any setting indicated) with a light bulb drawn near the head to symbolize ideas being generated. Perhaps inventors were less often drawn next to a lab bench because they are visualized as people who tend to be moving around, trying different things out, and experimenting with ideas and tools. Alternatively, preservice teachers may have been less familiar with the work of inventors, therefore finding it difficult to visualize a setting.

Table 2 shows characteristics of scientist drawings that did not appear in the drawings of inventors. Common items were technology tools such as microscopes, telescopes, and thermometers, along with animal or plant specimens, periodic tables, and books. Table 3 shown characteristics of inventors that did not appear on the scientist drawings. A variety of inventions and gadgets, along with wheels (probably spurred by the saying, "reinventing the wheel") abounded. Crumpled papers symbolized the trial and error process, while tools such as screwdrivers, wrenches, and hammers drew attention to the mechanical aspects of many inventions. Question marks, surprised or frustrated expressions, scratching the head or holding a finger on the face indicated the thought involved and the unpredictable nature of the invention process. The named scientists and inventors in both Tables 2 and 3 show that preservice teachers thought of famous or personally familiar people as they drew and named their images.

Table 2. *Characteristics appearing in "scientist" drawings but not "inventor" drawings.*

Characteristic of Scientist Drawing	Frequency
Technology/Tool: Microscope, telescope, thermometer	11
Setting: Animals	4
Setting: Plants	1
Symbol of knowledge - Periodic table	6
Symbol of knowledge – books	3
Symbol of knowledge – chemical formula	1
Symbol of Knowledge: Graph	1
Symbol of Knowledge: Planet	1
Slogan: I love science)	2
Named Einstein	2
Named Sir Isaac Newton	1
Facial Hair - Beard	2
Clothing: Bow tie	1
Appearance: Crazy or "mad" expression	1

Table 3. *Characteristics appearing on "inventor" drawings but not "scientist" drawings.*

Characteristic of Inventor Drawing	Frequency
Inventions: Toys, kites, gadgets	22
Invention: Wheel	8
Crumpled papers	5
Tools: screwdriver, wrench, hammer	12
Symbol of knowledge – question marks	9
Appearance: Surprised or frustrated	9
Scratching head or finger placed on face	7
Pointing finger	5
Named Dad	1
Named Ben Franklin	1
Named Alexander Graham Bell	1
Named Dr. Edwin	1
Named Thomas Edison	1

Conclusion

The results of this study show that preservice elementary teachers perceived scientists and inventors quite differently. Lab-coat-clad scientists were generally perceived as engaged in chemistry experiments while drawings of inventors showed figures in everyday clothing and emphasized generation of ideas, tinkering with gadgets, and trial and error. The large proportion of scientists and inventors drawn of a different sex than the preservice teacher sketchers indicates that preservice teachers do not readily identify with these professionals. Rule, Cavanaugh, and Waloven (in review) found that preservice elementary teachers' images of scientists and clay scientists changed positively after participation in a science education methods course. Because of the importance of invention and innovation to our nations' future and the global environment, we suggest that future studies explore effective ways to increase preservice teachers' understanding of and identification with the work of inventors.

References

American Association for the Advancement of Science. (1993). *Benchmarks for science literacy.* Washington, DC: Author.

Bodzin, A., & Gehringer, M. (2001). Breaking science stereotypes. *Science and Children*, *39*(1), 36-41.

Bornstein, R. F. (2002). A process dissociation approach to objective – projective test score interrelationships. *Journal of Personality Assessment, 78*(1), 47-68.

Chambers, D. W. (1983). Stereotypic images of the scientist: The draw-a-scientist test. *Science Education, 67*, 255-265.

Finson, K. D. (2002). Drawing a scientist: What we do and do not know after fifty years of drawings. *School Science and Mathematics, 102*, 335-345.

Finson, K. D., Beaver, J. B., & Cramond, B. L. (1995). Development and field test of a checklist for the Draw-A-Scientist Test. *School Science and Mathematics, 95*, 195-205.

Flick, L. (1990). Scientists in residence program improving children's image of science and scientists. *School Science and Mathematics, 90,* 204-214.

Hammrich, P. L. (1997). Confronting the gender gap in science and mathematics: The Sisters in Science program (Report No. SE059829). Oak Brook, IL, National Association for Research in Science Teaching. ERIC Document Reproduction Service No. ED 406 167.

Lemelson-MIT Program. (2003). Invention and Innovation for sustainable development: Report of a workshop sponsored by the Lemelson-MIT Program and LEAD International, London, November 23, 2003. Retrieved February 9, 2007 from: http://web.mit.edu/invent/n-pressreleases/downloads/sustainable.pdf

Martin, R., Sexton, C., Wagner, K., & Gerlovich, J. (1997). *Teaching science for all children (2nd edition).* Boston: Allyn and Bacon.

Mason, C. L., Kahle, J. B., & Gardner, A. l. (1991). Draw-A-Scientist Test: Future implications. *School Science and Mathematics, 91*, 193-198.

McClelland, D. C., Koestner, R., & Weinberger, J. (1989). How do self-attributed and implicit motives differ? *Psychological Review, 96*, 690-702.

National Research Council. (1996). *National science education standards: Observe, interact, change, learn.* Washington, DC: National Academy Press.

National Science Teachers Association. (1992). September, Researchers are attempting to improve the image of scientists, NSTA Reports!, 46.

Rule, A. C., Cavanaugh, B., & Waloven, V. (2007). Preservice Elementary Teachers' Images of Clay Scientists. *Journal of Geoscience Education, 55*(4), 321-325.

Smith, W., & Erb, T. (1986). Effect of women science career models on early adolescents. *Journal of Research in Science Teaching, 23*, 667-676.

Yager, R. E. (2000). A vision for what science education should be like for the first 25 years of the new millennium. *School Science and Mathematics, 100,* 327-341.