DOCUMENT RESUME

ED 370 785 SE 054 447

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TITLE	Images of Scientists: Gender Issues in Science Classrooms. What Research Says to the Science and Mathematics Teacher. Number 4.
INSTITUTION	Curtin Univ. of Tech., Perth (Australia). National Key Centre for Science and Mathematics.
REPORT NO	ISSN-1033-3738
PUB DATE	Dec 89
NOTE	9p.
PUB TYPE	Information Analyses (070)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	Educational Research; Elementary Secondary Education; Foreign Countries; *Science Careers; Science Education; Scientific Attitudes; Scientists; *Sex Differences; *Student Attitudes; *Womens Education
IDENTIFIERS	*Attitudes Toward Science

ABSTRACT

According to research reports, the negative image that a large number of students have concerning scientists has been remarkably stable over the past 30 years. This document provides an overview of the present and past research conducted to obtain a better view of student's perceptions of scientists, students' attitudes toward science and science careers, and strategies to help improve both attitudes and achievement in science. (ZWH)

The Key Centre for School Science and Mathematics

What Research Says to the Science and Mathematics Teacher Number 4

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IMAGES OF SCIENTISTS: GENDER ISSUES IN SCIENCE CLASSROOMS

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The scientist is a brain. He spends his days indoors, sitting in a laboratory. He is so involved in his work that he doesn't know what is going on in the world. He has no other interests and neglects his body for his mind. He can only talk, eat, breathe, and sleep science. ... He works for long hours in the laboratory, sometimes day and night, going without food and sleep.
(Composite statement of USA high school students, Mead & Métraux, 1957)

A scientist's totally involved in work. Therefore, they don't care about appearance. [They] wear white coats, have beards - 'cause they're men. They just seem to care only about their science work. ... They don't care about meals. Somedays they starve themselves. They walk around with their science brain all day, and they've got their laboratories.
(Interview with an Australian secondary student, Kahle, 1987a)

The above comments, collected approximately 30 years apart, paint a vivid, negative image of the scientist which has been remarkably stable over time. Why is that image so stable? What can we do to change it?

YESTERDAY'S IMAGE

OVER 30 YEARS ago, the Board of Directors of the American Association for the Advancement of Science (AAAS) decided to investigate the 'great disparity between the large amount of effort and money being devoted to interesting young people in careers as scientists or engineers and the small amount of information we have on the attitudes that those young people hold toward science and scientists' (Mead & Métraux, 1957, p. 384). It commissioned a well-known scientist, Margaret Mead, and her colleague, Rhoda Métraux, to investigate the attitudes towards scientists held by high school students. Students were asked to respond to an open-ended statement which probed their *impersonal* and *personal* image of a scientist.

The responses of 35,000 students produced a dichotomy. Although students' impersonal images of scientists were very positive, their personal perceptions were negative. That is, students described scientists in general as people who were responsible for progress, who improved the quality of life and who improved the health of the population. But, when the question concerned science as a career choice for themselves or for their spouse, the responses were overwhelmingly negative.

Unfortuntely, students' opinions about scientists have changed little in 30 years. A stereotypic image of a scientist has persisted in spite of the sexual revolution of the 1960s, the women's liberation movement of the 1970s and the equal opportunity legislation of the 1980s. What does research indicate about the basis of that image? How can teachers change children's images of science and scientists? Is it worthwhile to focus on that issue in a busy school day?

TODAY'S IMAGE: THE DRAW-A-SCIENTIST TEST

WHAT IMAGE do children hold of science and scientists in the 1980s? Is it persistent across countries, or are there important or subtle differences? How do children form an image of a scientist?

Teachers and researchers have sought simple, reliable ways to assess students' images of science and scientists. Because Mead and Métraux's study showed a dichotomy between impersonal and personal images of scientists, researchers have focused on the personal image, hoping to gain understanding of students' negative attitudes about science and about becoming a scientist. Therefore, researchers have asked students to respond to scales concerning their attitudes to science and scientists and to paint a visual or verbal picture of a scientist.

In 1983, Chambers described a simple, quick and easily scored instrument, the *Draw-A-Scientist Test (DAST)*. Very simply, he asked students to draw a scientist and then coded the number of indicators which suggested a stereotypic image. Those indicators are listed in Figure 1.

Lab coat (usually but not necessarily white)

Glasses

Facial hair

Symbols of research (scientific instruments or laboratory equipment of any kind)

Symbols of knowledge (principally books and filing cabinets)

Technology: the 'products' of science

Relevant captions: formulae, taxonomic classification, the 'eureka' syndrome, etc.

[From Chambers (1983)]

Figure 1: Indicators Used to Determine Stereotypic Images of Scientists

Over an 11-year period, Chambers analysed drawings from over 4,800 children in Canada, Australia and the USA. Chambers (1983), Schibeci and Sorensen (1983), Schibeci (1986) and Maoldomhnaigh and Hunt (1988) have assessed primary school children's images of scientists with DAST. Recently, DAST has been used with secondary school students and with teacher trainees (Kahle, 1987b). Because DAST requires no reading or writing, it minimizes the possibility of 'socially desirable' responses. However, with older students, care should be taken to ensure that it is presented as a serious, not frivolous, activity. In addition to the standard indicators used earlier, our research involves examining DAST drawings in terms of the sex of the scientist in the drawing in order to assess any sex-role stereotyping of science and scientists. Also, students are asked to indicate whether they are males or females in order to assess differences between boys' and girls' images of scientists.

Drawing by 15-Year-Old Australian Male Student

Figure 2 provides a summary of the results for DAST drawings done by secondary students in both Australia and the USA. The similarities are surprising. Most drawings include several of the stereotypic indicators. For example, 90% of scientists in the USA and 47% of scientists in Australia are drawn wearing a lab coat. Nearly 80% of Australian and American students envisage scientists wearing glasses. Over 90% of Australian students and 75% of American students draw male scientists, while the remaining students draw either female scientists or 'sexless' scientists (ie. no sex identity is evident in the drawing). In both Australia and the USA, around 40% of students draw scientists with facial hair.

DAST provides an easy way to assess if students hold stereotypic (and often negative) images of scientists. For example, while scoring drawings, coders have noted that many drawings depicted eccentric or sinister people (Mason, Kahle & Gardner, 1989). Definitions were formed and drawings from several countries were recoded to identify personality types. Scientists' drawings were considered sinister if they included violent explosions, evil facial expressions, Frankenstein-type characters, etc., and eccentric if they included wild hair, unfashionable clothes, unkept appearance, bloodshot eyes, blemished complexions, etc. The sample consisted of a total of 682 students, with 548 from the USA, 110 from Australia, 16 from Norway and eight from New Zealand.

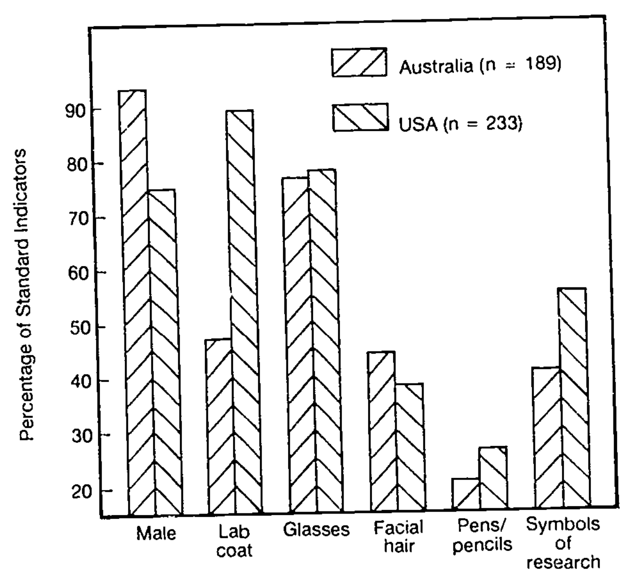


Figure 2: Percentage of Standard Indicators for Secondary Students' DAST Drawings

Although international results involving personality type vary somewhat by country, the basic finding is that children in several countries, including Australia, view science as harmful or evil and view scientists as eccentric or sinister men. For example, 8% of Australian students and 15% of students in the sample overall drew scientists classified as sinister. As many as 78% of Australian students and 62% of the sample overall drew scientists who looked eccentric. Our analysis of thousands of drawings paints the following picture:

> *A scientist is a white male, who wears a lab coat with a pocket full of pens and pencils. He's middle aged and is either bald or has wild hair framing his myopic eyes. Comments on drawings suggest that he is antisocial or poorly adjusted, but that he is very busy with his experiments.*

DAST is simple and its use is enjoyed by students and teachers. However, we must be concerned about both its *reliability* (the consistency with which test scores measure an attribute) and its *validity* (the accuracy of test scores). Researchers have established the reliability of scoring DAST by assessing the level of agreement between different people who independently code the same student drawings. They have established inter-rater reliabilities, or correlations among different people doing the coding, of 0.86 and 0.87 (Maoldomhnaigh & Hunt, 1988) and 0.97 (Mason, Kahle & Gardner, 1989).

The validity of the test, however, is another matter. Does DAST accurately reveal the images of scientists held by children? Schibeci and Sorensen (1983) suggest that interviews with students can provide an indication of the validity of DAST. When an Australian researcher interviewed Year 10 students after they drew scientists, in most cases their verbal images matched their visual ones (Tobin, Kahle & Fraser, in press).

TRAINEE TEACHERS' IMAGES

IN ADDITION to school children around the world holding similar images of scientists, do teachers hold stereotypic images? Leonie Rennie (1986) asked Australian primary teacher trainees both to draw a scientist and to write a short verbal description of one. Their written descriptions validated their drawings. Her analysis of 79 drawings of scientists by Australian teacher trainees in their last year of preparation yielded the following picture: a white male (82%) with unruly hair (58%) who wears a lab coat (57%) and holds test tubes (56%). When Rennie tried to describe the nature of the scientists drawn, she classified 51% as looking 'somewhat unusual', 21% as appearing 'definitely crazy', 16% as looking 'puzzled' and only 12% as seeming 'ordinary'.

I replicated Rennie's study in the USA with 233 students preparing to become primary teachers and 33 students preparing to be secondary science teachers. Figure 3 shows the differences and similarities among the three groups of teacher trainees. Although slightly more women scientists were drawn in the USA samples, only women students drew them. Overall, the percentage of trainee teachers drawing male scientists was around 80% for the Australian and American samples of primary teachers and approaching 60% for the American secondary teachers.

Also, teacher trainees in Australia and the USA hold fairly stereotypic images of scientists as revealed by DAST (see Figure 3). For example, almost 60% of Australian trainee teachers drew facial hair, whereas approximately 20% to 30% of American primary and secondary trainee teachers included facial hair in their drawings. Lab coats were worn by 60% to 80% of the scientists drawn by the various samples of preservice teachers.

IMPLICATIONS: IMPROVING TOMORROW'S IMAGE

WHAT DO STUDENT drawings and descriptions tell us about their attitudes towards science? From around the world, they indicate that students from primary school through to teacher trainees hold stereotypic views of scientists. In particular, the sex of the scientist (male) can be established in a high proportion of the drawings. For example, all of the women scientists drawn in Chambers' sample, as well as all those drawn by Australian Year 10 students and teacher trainees, were done by female students. Interviews conducted with students have helped to substantiate the accuracy of the drawings. Therefore, it can be said that most students hold a masculine image of both science and scientists and that this image probably detracts from a girl's interest and self-confidence in doing science. It is to be hoped that teachers and researchers might find ways to infuse school science with an accurate and neutral image of science and scientists which appeals to a wider variety of students, both girls and boys.

Some research evidence suggests that teaching in a particular way can affect students' images of scientists. For example, after a year-long American intervention program which was designed to foster a non-masculine image of scientists, 10% of the 15-year-old boys drew women scientists, and students' depictions of female scientists involved non-stereotypic indicators, such as a neat, attractive appearance and the presence of jewellry (Kahle, 1987b).

Also, there is a growing body of evidence that teacher behaviours and instructional strategies affect students' skills, interests and retention rates in science. This research suggests ways in which a science teacher can change tomorrow's vision of a scientist. Research conducted in England (Smail, 1984), the USA (Kahle & Lakes, 1983), Norway (Jorde & Lea, 1987) and Australia (Parker & Rennie, 1986) shows clearly that fewer girls than boys handle science equipment, perform science experiments or participate in science-related activities in primary classrooms. The differential backgrounds that boys and girls bring to the primary school are perpetuated in them. For example, equal numbers of girls and boys might be present in science lessons, but they participate in them in unequal ways. Both primary and secondary teachers need to organise classroom activities so that girls have extra time and opportunities to do science, and so that they are expected to perform at the same level as boys.

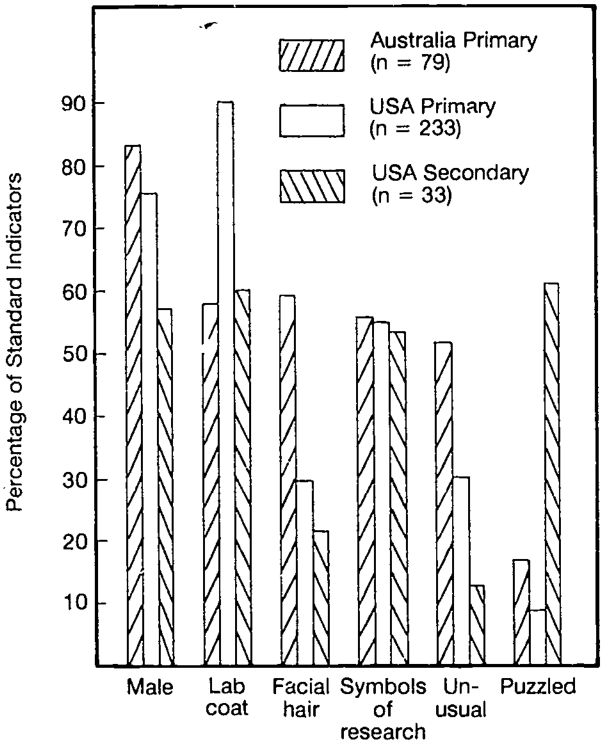
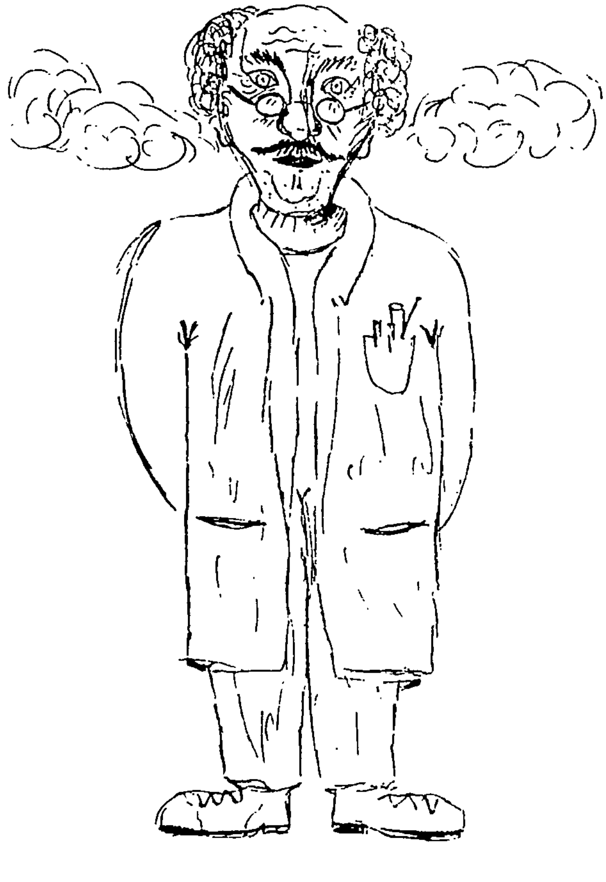


Figure 3: Percentage of Standard Indicators for Trainee Teachers' DAST Drawings

Frequently, teachers complain that girls choose not to participate in science demonstrations and experiments. Because girls might be socialised away from science by parents and others, teachers are afraid that forcing involvement could produce increasingly negative attitudes. However, a study of USA high school teachers who were particularly successful in retaining girls in optional science classes (chemistry and physics) showed that such teachers consistently practiced 'directed intervention' (ie. girls were called upon to perform demonstrations, were selected as leaders of laboratory groups and were actively encouraged to go on out-of-school science excursions) (Kahle, 1985). Because girls' reluctance to participate could be due to a lack of self-confidence based on fewer prior experiences, directed intervention helps to equalise the equation.

Different methods and modes of teaching science can improve both the achievement levels and the attitudes of girls and boys. For example, the American study revealed that visually stimulating classrooms improved student attitudes and interest in biology (Kahle, 1985). In addition, studies in both Europe and the USA indicate that a change in mode of teaching can result in more science experiences for girls. For example, the *Girls Into Science and Technology (GIST)* project stressed the importance of including 'tinkering' activities in school science in order to overcome the lack of such experiences by girls in everyday life (Whyte, 1986). Furthermore, science lessons can provide experiences which enhance the visual-spatial abilities (eg. mentally rotating three-dimensional figures) of all children. Because girls usually have less experience with the toys, games and activities which enhance visual-spatial ability, teachers need to incorporate such opportunities into the curriculum. Building and using laboratory equipment and models, drawing cross-sections of three-dimensional objects, and using mapping activities are examples of ways to develop visual-spatial abilities.

In addition, USA researchers have found that small-group activities and cooperative learning strategies provide a less competitive classroom atmosphere, which is preferred by most girls and by many boys. For example, Tobin (1987) reports few gender differences in teacher-student interaction patterns during individualized activities; that is, teachers are equally accessible to all students. However, during laboratory activities, gender differences can arise. Because whole-class activities, supplemented by laboratories, are the usual instructional modes, girls generally have less involvement in science classes than do boys.



Drawing by American Female Preservice Primary Teacher

Different expectations can contribute to teachers unconsciously calling more often on particular students, called 'target' students, to answer questions. Tobin (1987) reports that target students are almost always male. He and Whyte

(1986) report that male students tend to dominate science classes by calling out answers, by 'hogging' the science equipment and by demanding more of the teacher's attention. The simple practice of requiring all students to raise their hands before responding to questions might lessen the number of opportunities for boys to control the class.

What can you do as a teacher? One of the possible ways for you to participate actively in changing your students' inaccurate and masculine image of science is for you to play the role of *teacher as researcher*. You could assess your students' images by using the DAST, analyse the results for your classroom and then implement some of the equitable teaching strategies suggested. In addition, you might ask your students to write a description of a scientist to complement their drawings. After a period of time, you might want to readminister DAST to ascertain whether any changes have occurred in your students' images of scientists. As a concerned teacher and as an active researcher, you could bring about change in children's images of scientists which, in turn, could affect the career choices of both girls and boys.

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ISSN 1033-3738

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