Curricular Images of Scientists
Textbooks and Popularity of Science
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Vol. 50, Issue No. 36, 05 Sep, 2015

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Preconceived notions of scientists lead students to picture them as "different" kinds of people and view science itself as an "exclusive" practice. These images, and the students' ability or inability to identify with them, influence students' involvement with science. The role of the school curriculum and curricular material needs to be examined to understand how our curricular materials, especially textbooks, respond to these stereotypes. This article examines the standard textbooks for Classes IX and X to understand if they reinforce or counter the stereotypical images of scientists.

Students' perceptions of science and scientists and the implications of such perceptions for science education evoke animated research interest among educationists. Studies carried out in varied contexts have highlighted that students at all levels subscribe to certain stereotypes about scientists: what they look like, what kind of people they are, how they “do science,” etc. Scientists are very often visualised as people who look a certain way (white males, wear glasses, carry a lost look, etc), may have idiosyncrasies (absent-minded, disorganised), demonstrate certain habits of thought (objectivity, rationality), work in a certain manner (wear lab coats and use special apparatus like test tubes) and in certain surroundings (laboratories).

According to the theory of circumscription and compromise developed by Linda Gottfredson, people hold certain images of occupations and also of the people in those occupations. The preference individuals have for a certain occupation would be determined by the compatibility of these images with their own image of themselves (Gottfredson 1996). Taking this into consideration, an extensive study of the various images held by students and their formation is warranted.

However, it requires focused attempts to unearth students' ideas which may not exist at a conscious level and therefore may not be amenable to overt articulation. We may have to think in terms of identifying certain indicators that could be pathways to access children’s ideas that exist at a more subconscious level. For instance, Sumrall (1995) took statements such as those that used generalisations—for example they used words like “all”—or made derogatory remarks about another race or gender to be indicative of stereotypes held by
children. Sumrall also took statements marked by use of words like “most” or “usually” to be indicative of perceptions of students.

**Hat, Coat, Glasses**

The Draw-A-Scientist Test (DAST), developed by Chambers (1983) based on a study by Mead and Metraux (1957), tries to find out how students form stereotypes about scientists. It analyses students’ drawings for elements they associate with scientists: eyeglasses, lab coat, lab equipment, etc. The DAST has been used in a variety of contexts (Medina-Jerez et al 2011), rubricated (Farland-Smith 2012) and served as the basis for development of similar tools. The conjured-up images of scientists that studies have revealed are similar in many aspects across cultural and ethnic (Finson 2003) contexts and have been found to be persistent in nature.

Preconceived notions lead students to picture scientists as a “different” kind of people and view science itself as an “exclusive” practice. Their own inability to identify with such “images” could negatively influence their involvement with science. This could possibly deprive the field of science of many bright sparks while simultaneously denying many students the opportunity of contributing to and enriching the field. While these images could be the outcome of several factors such as media influence (Steinke et al 2007), literature, popular culture and community attitudes (Schibeci 1986), and teachers’ ideas, the role of the school curriculum and curricular material needs to be especially examined because they enjoy state sanction and therefore may be regarded as the “formally endorsed perception.”

It becomes pertinent to examine how our curricular materials, especially textbooks, respond to these stereotypes—or do not respond—because students’ perception of a scientist may be circumscribed, in varying degrees, by the portrayal of scientists in the school texts. This becomes especially true in the Indian context where science continues to be regarded as a “hard” stream meant for a select few and where for a great majority of schoolgoing children, especially from rural areas and poor homes, as also for their teachers, “the textbook is the only accessible and affordable curriculum resource” (NCERT 2006c: 19). The textbooks will therefore need to cultivate and nurture a multi-perspective, multicultural and gender inclusive position.

Gender sensitivity of textbooks is the subject of many studies in the progressive research paradigm. It has been shown that students as well as teachers harbour gender stereotypes about occupations; science and technology are widely held as male domains (Chunawala et al 2009).

Text analysis requires sharp observation and intensive study based on certain pre-decided parameters. For instance, as a part of a mega international project on Science Education for Diversity (Choksi et al 2011), a review of textbooks in various countries was carried out to see if they responded appropriately to different aspects of diversity. This was done by
raising questions pertaining to balanced representation of male and female scientists in text and visuals. The review also tried to interrogate association of occupations with ethnicity and sought to find out if different contexts in different geographical regions were well-represented.

It is pretty much evident that the micro-stance of the textbook can only be sculpted in light of the minute texture of the textual matter (and therefore of the science curriculum). Life histories of scientists that provide a “persona” of the scientist are likely to influence students’ orientation towards scientists and science. Hong and Lin-Siegler (2012), for example, studied how learning about the struggle of scientists motivates students to study physics.

The present study was carried out to study the biographical notes on the lives of scientists in the standard textbooks for Classes IX and X. It tries to analyse if these have elements that reinforce or counter stereotypes of scientists.

**Selection of Textbooks**

Secondary school textbooks were used for this study. At this level, there are two science textbooks prescribed by the National Council of Educational Research and Training (NCERT), one for Class IX and the other for Class X.

These two textbooks mediate standards between the upper primary and the senior secondary level. They were chosen because at the senior secondary level the students are required to “choose” their academic stream and the secondary stage may be regarded as the academic “run-up” to their choice. The projection of different kinds of academic disciplines at this level could, therefore, be a significant factor in shaping students’ perception of these areas of study, thereby also influencing their choice of stream. Scrutinising this projection would be helpful in deciphering the messages about science that are being communicated to young minds.

The biographical notes on the lives of various scientists appear in boxes in the texts. There are two kinds of “boxed items” in the textbooks—those pertaining to additional information about a topic, some of them titled “More to Know,” and those that pertain to the lives of scientists. Some scientists do figure as part of the boxes meant for content enrichment. For example, visuals of Albert Einstein, Satyendra Nath Bose are included in the box titled “More to Know” that shares additional information on states of matter. Edward Jenner is included as part of the box providing additional information on vaccination. Robin Warren and Barry Marshall appear in the box titled “Peptic Ulcers and the Nobel Prize”. Since the focus of these boxed items is on content rather than on the scientist, they may not be amenable to direct comparison with the biographical sketches. However, since the visuals, as perceptual cues, are likely to influence students’ images of scientists, they have also been examined and included in the final data. The textbooks have brief biographical notes about 17 scientists. There are five others whose visuals find a place in the boxed space meant for
supplying additional information on the subject.

**Methodology**

The work of Driver et al (1996) takes into account three important aspects that typically characterise the “images of science”: purposes of scientific work, nature and status of scientific knowledge, and science as a social enterprise. Dagher and Ford (2005) draw on these aspects to analyse scientists’ biographies. They ask three broad questions: How does a scientist’s biography describe its subject? What is the nature and process of scientific knowledge it depicts? How are the social processes of science portrayed in the biography?

Each broad question was understood in terms of sub-questions which pertained to different aspects of the depiction of science and the scientist.

This study draws upon this analytical framework. While its broader research questions remain the same, the sub-questions were framed on the basis of the data at hand. Some of Dagher and Ford’s sub-questions were retained, some were added, some were deleted and others merged. For instance, the description of the scientist was examined at two levels: the visual and the verbal. Visuals (photographs/portraits) that accompanied the life notes were thought to merit a separate and especial examination because as pieces of ready imagery, they are likely to exert a strong influence on the students’ perception of scientists.

Verbal description was analysed to understand how the scientist is depicted as a “person,” the nature of the scientific knowledge and scientific enterprise that gets communicated to the readers and how the social influences on science are acknowledged. This study’s framing questions and sub-questions are:

(1) How is the scientist depicted visually?

(a) What is the apparent age of the scientist in the visual? (young, middle-aged or old). If it was difficult to tell, for instance between middle aged and old then both slots could be ticked.

(b) What is the facial expression of the scientist? (smiling/neutral)

(c) What is the scientist’s attire? (formal—bow, tie, closed collar, casual)

(d) What is the scientist’s gender?

(e) In what surroundings is the scientist depicted? (academic—pen, books, lab equipment, etc/non-academic)

(f) Is the scientist depicted alone, in a pair, or in a group?

(2) How is the scientist described?
(a) What is the place of birth of the scientist? (North America/Europe/Asia/ Australia/ South America)

(b) What personal characteristics are attributed to the scientist?

(c) What are the hobbies/interests/aspirations of the scientist?

(d) How is the socio-economic situation of the scientist described?

(e) What were the scientist’s academic experiences? (school and college studies)

(f) What were the other formative experiences of the scientist? (life, career, etc)

(3) How are the nature and process of scientific knowledge as presented?

(a) What are the methods employed by the scientists and how do they shape their contributions?

(b) What is the purpose of scientific work that emerges from the scientists’ endeavours?

(c) How is the worth and significance of the scientist’s work conveyed?

(4) How are the social processes of science portrayed?

(a) What social situations or societal factors influenced the scientist’s work?

(b) What is the nature of intersection of science and community? That is, how does the community interact with scientific knowledge?

(c) How is the public recognition received by the scientist described?

**Data Tabulation and Analysis**

The biographical notes of different scientists constituted the data of the study. A table depicting the content of each biographical note on the decided criteria, visual of the scientist, personal description, depiction of nature of science and portrayal of scientific process, was prepared. The various sub-columns under the broader columns were:

(i) Visual: age, expression, attire, gender, surroundings (academic/non-academic), whether the scientist has been shown alone, in pairs or in group.

(ii) Personal description: place of origin, personal characteristics, hobbies, socio-economic situation of family, school experiences and formative experiences.

(iii) Depiction of nature of science: Contribution of the scientist and methods employed (purpose), how is the worth of scientific work evaluated.
(iv) Portrayal of social processes of science; what social situations/societal factors shaped scientists’ work, science community interaction and nature of public recognition.

Each biographical note was analysed on each of the above criteria. The name of the scientist was entered in the first column and the other columns were filled based on the content of the biographical note of the scientist.

**Observations and Discussion**

The discussion on curricular images of scientists needs to be located in the discourse around diversity in science curriculum and inclusion of multicultural perspectives and contexts therein.

Twenty-two scientists featured in the textbooks and 18 of them are from Europe, one is from Russia, two from Australia and one from India. While there is one from ancient times (Archimedes), most belong to the period between late 16th and the early 20th centuries. Two scientists belong to the late 20th and early 21st centuries (Warren and Marshall). More physical space has been devoted to scientists like Isaac Newton and Galileo Galilei, possibly to indicate and acknowledge their influence and contribution to science.

All the scientists are males. They are of different ages. All the scientists, except Einstein, are formally attired.

Five scientists have been depicted in their surroundings. Four of them are in seemingly academic settings or with academic accoutrements—what Chambers calls the symbols of knowledge (pen, filing cabinet, etc) or research (laboratory, etc). Edward Jenner is the lone scientist shown against a homely background. He is injecting a young boy and is accompanied by a woman—presumably the child’s mother. The visuals are of that of individual scientists. Warren and Marshall are an exception; they are shown in the same frame and the fact that they shared the Nobel Prize is mentioned.

**Serious-Looking Savants**

The dominant visual is that of a formally attired, serious looking Western male (who could be young or middle aged or old). Interestingly, the “white male” or “Western male” stereotype that has surfaced in many studies is reinforced here as well. The attire communicates a sense of formality and thereby certain aloofness. The temporal distance renders the scientists even more remote and inaccessible and the neutral expression of the scientists resonates with the “emotional reticence” (Rampal 1992) typically attributed to scientists.

In contrast, showing scientists in more human contexts (such as family photographs, working in group, etc) would help children perceive them as more accessible figures. While it may be difficult to access the context of the embedded visuals of scientists in the 18th and
19th centuries, that should not be a hindrance in case of 20th century scientists like Niels Bohr and Ernest Rutherford.

**Male Preserve**

That all featured scientists are males and most of them are from a certain part of the world shows that a “gendered perspective along with other marginalised perspectives” (NCERT 2006d: 32) has failed to permeate textbooks.

Since realities about the world (including gender) are “constructed” and “negotiated” inside the classrooms, with the curriculum providing the medium, projection of a gendered image of a scientist raises problematic issues of unequal gender relations within school science. This may cause young girls to feel alienated—an omission particularly serious because the students are just beginning to develop personalities, identities and frame career choices. The curriculum’s outlook towards gender has to be progressive.

Textbooks need to initiate a discussion on the phenomenon of under-representation of women in science in consonance with the perspective of position paper on Teaching of Science of National Curricular Framework 2005 which advises: “The curriculum should strive to make the contribution of women to the field of science and technology ‘visible’” (p 30).

Students have to be helped to view the participation of women in science in a sociological perspective rather than that as a matter of inherent abilities. This can be accomplished by explaining the relative invisibility of women in science in terms of the historical bias and discrimination against them. Sharing certain gendered information can facilitate this reflection. For instance, the fact that many of our prestigious and reputed international educational institutions did not allow women to graduate till as recently as early- or mid-20th century—and other such facts pertaining to gender discrimination—can be used as triggers for contemplation.

**Sans Persona**

Personal characteristics of scientists are generally not mentioned. In four cases, where some sort of personal traits are identifiable, one pertains to aptitude—Newton being poor at farming. Gregor Johann Mendel’s zeal for science is substantiated by noting that he continued to work undeterred by his failure to obtain a teaching certificate. The mention of Archimedes’ Eureka moment seems to indicate his absent-mindedness—though this characteristic is not mentioned.

The “absent-minded scientist” stereotype, that often surfaces in popular culture, results from the perception that scientists’ work requires such absolute focus that it renders them oblivious to worldly compulsions.
There is an interesting reference in the note on Dmitri Mendeleev: he is said to have been deeply attached to his mother. Interests of only three scientists have been mentioned and these, by and large, pertain to academics. Galileo is said to be interested in mathematics and natural philosophy and Carl Linnaeus in the study of plants. Michael Faraday is said to be interested in science and it is stated that “he loved his scientific work more than any other.” Galileo, though, is also described as a good craftsman.

The textbooks describe the socio-economic condition into which John Dalton and Newton were born. Dalton is said to have belonged to a poor weaving family and Newton hailed from a poor farming family. They do not tell us anything about the socio-economic background of the other scientists.

The academic experiences of seven of the scientists have been mentioned. These exhibit a varied range. While Faraday had no formal education, Mendel was educated at a monastery. Galileo enrolled for a medical degree but never completed it. Johann Wolfgang Döbereiner studied as a pharmacist and studied chemistry later. Others went to respectable universities.

The textbooks mention the careers of 10 scientists. Teaching, research and medicine dominate here. Faraday worked in a bookbinding shop and also worked as an assistant in Humphry Davy’s lab.

From these accounts, the scientist comes across as a passionately focused person, whose interests and hobbies are also related to science. Science, in these accounts, comes across as a hard pursuit requiring undivided attention. Description shorn of personal quirks, interests and hobbies—other than science—contributes in communicating a monodimensional and decontextualised picture of scientists.

The words used to describe the work and activities of the scientists span a wide range. These include—presenting a theory (Dalton, Galileo), discovering (Thomson, Rutherford, Archimedes, Hertz, Oersted), working on (Rutherford, Bohr, Newton, Archimedes), writing books (Bohr, Galileo, Linnaeus), developing specific techniques and improving them (Golgi), observing and studying (Galileo, Dobereiner, Darwin, Warren), formulating laws and hypotheses (Galileo, Joule, Mendel, Newton, Darwin), designing equipment (Galileo, Newton), experimenting (Heinrich Hertz, James Presscot Joule, Darwin), verifying (Joule), applying knowledge (Mendel), proposing (Mendeleev) and even synthesising the contributions of other scientists (Newton). The terms used are loaded with implication and this helps in putting the “science in action” in perspective.

The act of discovery could refer to the discovery of entities (Rutherford), relationships (Archimedes), phenomena (Hans Christian Oersted) or patterns (Dobereiner). While certain terms like “working on” and “studying” are foggy and do not clearly spell out the nature of the activities, they do convey a sense of the scientist’s sustained engagement with the subject.
Scientists have been shown to learn from and build upon each other’s work. For instance, it is mentioned that Hertz verified James Clerk Maxwell’s theory and that Newton synthesised the contributions of Copernicus, Galileo and Johannes Kepler. Marshall is said to have become interested in Warren’s findings and there are two references to the scientists sharing a Nobel Prize. Collaboration also gets emphasised as desirable when it is remarked that “Darwin would have benefited from Mendel’s work if there were some means of faster communication available at that time.”

Cross-disciplinary interests and contributions have also been highlighted in case of scientists like Rutherford (physics and chemistry), Newton (mathematics and physics) and Archimedes (mathematics and physics). The aims of scientific endeavours that seem to emerge from these notes are: describing, explaining and investigating nature, devising means for carrying out these investigations, finding applications for the scientific knowledge acquired, synthesising and consolidating existing knowledge and encouraging growth of knowledge.

The idea of science as a “body of knowledge” and “as a way of doing” gets communicated a little more strongly as compared to “science as a way of thinking.” This especially so with phrases such as “presenting” or “proposing a theory” and “formulating laws.” These, to an extent, communicate science as an intellectual pursuit.

The note on Newton has a noteworthy comment. Newton based his (gravitational) theory on sound reasoning and backed it with mathematics. The comment mentions that though Newton’s theory could not be verified in his time, there was hardly any doubt about its correctness. There is also a mention of Oersted making an accidental discovery.

The narrative on Jenner affords an interesting opportunity to get a proximate account of “how science proceeds.” It mentions that he came up with the idea of vaccination after realising that milk maids who had had cowpox did not contract smallpox, even during epidemics. The worth of scientific knowledge is evaluated on various parameters. These include providing a basis for further studies, possessing utilitarian value, and providing fresh insights.

While the practice of science is represented in its multifarious forms, the social processes in the growth of scientific knowledge remain grossly under-portrayed. Social contexts and situations are rarely mentioned. There are references to Mendeleev’s mother supporting him and teaching him values, Mendel using the garden in his monastery to grow peas and make observations, Golgi using the kitchen of the hospital, where he worked, as a laboratory and Linnaeus studying the diversity of plants in the garden of his employer. But these are mostly anecdotal references. The intersection of science with politics, religion or economics has not been touched upon. Their absence may indicate an assumption that societal contexts are irrelevant to the growth of scientific knowledge. This assumption needs to be corrected.

The dynamics of the interaction between scientific knowledge and community beliefs has
also not been captured. For example, Galileo made assertions contrary to popularly held views. But the textbooks tacitly assume the apparent supremacy of the “scientific view” over the “popular view” and the tumultuous conflict is not even alluded to.

Winning a Nobel Prize is cited as a major parameter of public recognition. Other criteria of public acknowledgement that have been cited include honorary epithets (Father of Chemistry for Rutherford), having a unit of a physical quantity named after a scientist and being famous for one’s work. Failed or “unrecognised” attempts, and the ways in which they contribute to development of knowledge, do not find any mention.

Conclusions

There are two significant ways in which the projected images of science and scientists deviate from the stereotypes. These are (i) scientists frequently carry forward each other’s work and learn from each other and that science benefits from this tendency, and (ii) scientists may harbour cross-disciplinary interests. Both these characteristics strike at the individual and disciplinary “insularity,” aloofness and exclusivity typically associated with scientists and science.

These appreciable digressions notwithstanding, the broader image of scientist and science remains typecast in the traditional mould. The image of the scientist as a stern-looking Western, hard working male still holds and perception of science as a laborious discipline pursued by single-minded people, largely unaffected by social factors, remains uncontested. The tone of the biographical notes is largely what Hong and Lin-Siegler (2012) would call “achievement oriented.” The scientist is therefore an “achiever” despite challenges such as adverse socio-economic situations—as in the case of Newton. Depicting the successes of the scientists endows them with a “larger than life” persona and removes them from the more real and human intellectual struggle.

The old observation that “biographical sketches highlight only the formal professional aspects of a scientist’s life, generally never portraying him or her as a normal social being” (Rampal 1992) continues to hold true. The scientists appear visually and temporally remote—and in the case of Asian students even geographically so. Such distanced biographical sketches lend a curious inaccessibility to the scientific enterprise and academic endorsement and popularisation of these hegemonically monochromatic images of scientists takes away from the more realistic description of science as an epistemologically rich and culturally diverse pursuit. Moreover, a description of scientific knowledge with a complete indifference to the sociological factors cannot be expected to help students achieve “an operational, contextual school conception of the social construction of science” (Richard and Bader 2010). Studies aimed at changing children’s stereotypical perception of scientists have reported favourable (Sharkawy 2012) as well as unfavourable (Steinke et al 2007; Buck et al 2002) outcomes and the stubbornness of the stereotypes should in fact lead us to strengthen the efforts to counter these.
Understandings gained through research in the area of science education need to be carried forward to inform the process of development of curriculum and curricular material. Inclusion of biographies in texts must be preceded by an extensive discussion around their purpose and pedagogic use. While the Class IX textbook does not mention these biographical notes in the initial pages, the preface of the Class X textbook makes an informative mention:

Difficult and challenging ideas, which are not to be covered at this stage, have often been placed as extra material in the boxes in light orange...All such box items, including biography of scientists, are, of course, non-evaluative (NCERT 2006b).

Though it needs to be appreciated that boxed items are non-evaluative, some guidance on how to look at and learn from them and use them would have been extremely helpful. While a holistic and targeted cross-grade and cross-curricular approach would be required to build a well-rounded perception of science among students, exposing children to the multidimensionality of the scientific endeavour could be the starting point. Standard textbooks could be apt for this purpose.

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