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Dispelling the Stereotypical Myths of a Scientist through an Integrated Literature Approach

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Abstract

It has been seen that few young people are interested in Science. In fact, very few actually pursue science as a career and from this pool; boys are usually more likely to take the science route as compared to girls (Lee, 1998). In addition, comments about Scientists and the nature of their work show narrow-minded perceptions. In a survey commissioned by the American Association for the Advancement of Science, it has been found that college and high school students share a common preconceived stereotype of scientists. The typical stereotype is mostly a queer, eccentric male (with "mad scientists" looks and "Einstein hairdos") wearing a white coat. Consequently, students having negative images of scientists can discourage them from pursuing careers in the sciences (Gardner, 1986; Mason, 1986). Hence, an authentic and engaging worldview of scientists is critical for motivating students' interests toward pursuing careers in science, mathematics, and engineering where there is a critical shortage of trained professionals (Jones and Bangert, 2006).

Over the last 10 years, numerous articles on strategies that can be used to help dispel the various misconceptions that children in particular have about Scientists have been published. These include highlighting the achievements of women in Science with special mention of the various female Nobel Prize winners (Hoh and Boo, 2003), Scientists-Student partnerships (Flick, 1990; Kesselheim, 1998) and the use of literature (Melber, 2003). In particular, the use of literature about Scientists for children seems to be a rather unique way to introduce Science to children (Melber, 2003).

In this paper, the "Draw a Scientist-Checklist (DAST-C)" (Chambers, 1983) was used to elicit children's perceptions of Scientists. A literature programme was then used as an intervention to help dispel the various myths of Scientists. These literature sources included autobiographies, information texts and Internet websites.

Dispelling the Stereotypical Myths of a Scientist through an Integrated Literature Approach

Introduction

Stereotypes have most likely been in society for as long as human culture has been in existence. A stereotype is defined as a fixed, commonly held notion or image of a person or group. This is often based upon oversimplification of an observed or imagined trait of behaviour or appearance. As we look back on our everyday experiences, stereotypes have often served as a blessing or a curse to man. For example, we often look at African Americans as talented musicians or sportsman; on the other side, movies and the media have also portrayed them as the "hood", hanging out in "tough" neighbourhoods, making a life on the streets through gangs and drugs. On a lighter note, we often hear remarks by men saying that an errant driver who has cut into his lane must be a woman driver. In the Asian context, we often talk about the Chinese as good business people, often making a successful living through business enterprise. In Universities, Indian nationals are seen mostly as having an inclination towards the Math and Sciences, striving in disciplines like engineering and medicine. The list goes on.

As have been mentioned so often, various stereotypes have appeared largely through the influence of writers, directors, producers, editors and reporters. However, it can also be argued that stereotypes can also be useful to the media because they provide a quick identity for a person or group that is easily recognised by an audience. When deadlines loom, it's sometimes faster and easier to use a stereotype to characterise a person or situation, than it is to provide a more complex explanation.

Looking to Science Education, stereotypes and their effects have also been seen. During my first year as a beginning teacher, I remember having a conversation with a Primary Five class when the topic came up about Scientists. I posed this question to them, "Have any of you met a Scientist?" To my surprise, a lot of chattering was heard among my students and common phrases I heard were comments like "Those men in white coats", "The Mad Scientist", "Biology", "Chemistry" and "Crazy Inventions". Apparently, these were what students thought about Scientists. At that moment, other comments from children about how "boring Science was", "so much to remember" and "difficult to

understand" came to my mind. To add to my already baffled mind, I started to realise that of these comments, many seemed to have come largely from the girls. Were these ideas connected to their perceptions of Scientists? Did these preconceived stereotypes of Scientists somehow creep into their subconscious to think of Science in this manner?

This paper serves to highlight the various studies that have been carried out in relation to students' images of scientists. It also covers the various strategies that have been proposed to dispel the negative stereotypes many students and teachers alike have of scientists. In particular, it looks into the effectiveness of a literature-based programme and how it can help dispel the various misconceptions students have of Scientists.

Objectives

This paper aims to determine the effectiveness of a "Literature Programme" about Scientists in dispelling the myths and various misconceptions that children have on Scientists.

Figure 1: Typical stereotypical features of scientists as illustrated by children

Review of the literature

The plan to embark on a research project involving student images of scientists began a year ago with a research article by McDuffie (2001) on the mental images students have on scientists. It was the reading of the article that triggered the recall of a class discussion in which I had five years ago with a class of Primary Five students. From that discussion, I began to realise that my pupils did not seem to have a very practical and accurate view of science. To make matters worse, many of their comments were somewhat negative. These comments included the following: "science experts are nerds", "there is too much to remember in science" and "science is boring". In addition, many of these comments came from the girls.

After a literature review into student images of scientists, I decided to administer the DAST-C to a group of primary five pupils (Figure 1). The purpose of this was to elicit any stereotypical mental images pupils have of scientists. As predicted, the results produced from the test were similar to those of what was available in current literature. These findings (Table 1) were subsequently presented at the International Science Education Conference that was held at the National Institute of Education, Singapore in December 2006.

Table 1: Results of the DAST-C from a group of primary five pupils in Singapore (Yam, 2006)

Students' Stereotypic Images of a Scientist	
Common Stereotype	**Students responding (%)**
1. Scientist wearing a lab coat	67.7%
2. Scientist wearing eyeglasses	52.0%
3. Scientist with facial hair	26.0%
4. Symbols of research displayed	86.4%
5. Symbols of knowledge	18%
6. Technology represented	10.4%
7. Relevant captions	5.2%
8. Male Gender only	89.6%
9. Caucasian only	NIL
10. Scientist in middle age/older	66.7%
11. Scientist has Mythic Stereotypes	5.2%
12. Indications of Secrecy	NIL
13. Scientist is working in a lab	96.8%
14. Indications of danger	2.1%
15. Drew a scientist with a smile	27.1%

The study of students' perceptions of Scientists began as early as 1957 with the publication of classical papers like those of Mead and Metraux (1957) and Chambers (1983). With these articles and subsequent studies, it was found that students and even teachers have a shared stereotypical view of a scientist (Moseley, 1999). Accompanied by these findings were the illustrations of numerous drawings that depicted the scientist as an "eccentric man in white". The drawings which were a component of the Draw-a-scientist test and developed by Chambers (1983) have since been a popular tool used in eliciting student images of scientists (Schibeci, 2006).

The earliest indication that students were having inaccurate perceptions about science and scientists, most likely emerged from the studies from Mead and Metraux (1957). From a

nation wide analysis of essays from high school students, it was found that many students shared a common negative image of a scientist.

''The scientist is a man who wears a white coat and works in a laboratory. He is elderly or middle aged and wears glasses. He is small, sometimes small and stout, or tall and thin. He may be bald. He may wear a beard, may be unshaven and unkempt. He may be stooped and tired. He is surrounded by equipment: test tubes, bunsen burners, flasks and bottles, a jungle gym of blown glass tubes and weird machines with dials. The sparkling white laboratory is full of sounds: the bubbling of liquids in test tubes and flasks, the squeaks and squeals of laboratory animals, the muttering voice of the scientist. He spends his days doing experiments. He pours chemicals from one test tube into another. He peers raptly through microscopes. He scans the heavens through a telescope. He experiments with plants and animals, cutting them apart, injecting serum into animals. He writes neatly in black notebooks.''

"His work may be dangerous. Chemicals may explode. He may be hurt by radiation, or may die. If he does medical research, he may bring home disease, or may use himself as a guinea pig, or may even accidentally kill someone."

"He neglects his family-pays no attention to his wife, never plays with his children. He has no social life, no other intellectual interest, no hobbies or relaxations. He bores his wife, his children and their friends-for he has no friends of his own or knows only other scientists-with incessant talk that no one can understand……" (Mead and Metraux, 1957)

While it is acknowledged that students also have a positive image and respect for scientists and their work, the overall impression of a scientist's work as one that reaps little or no rewards is a cause for worry.

In the above study, various recommendations were also proposed to help counter such negative stereotypes. They included changing the way mass media projected science and scientists (to a more humanistic and collaborative working environment), changing the

way science are taught in schools and a new emphasis on the life sciences, just to name a few.

With the introduction of the Draw-A-Scientist Test (DAST) by Chambers (1983), numerous other studies were carried out and from the results, most students seemed to view Scientists as people who spent their days wearing white lab coats and conducting experiments in solitary laboratories. These include those of Schibeci (1983, 1986 & 1989), Rosenthal (1993), Huber (1995), Bowtell (1996), Rahm (1997), Fort (1989), Evans (1992) and Barman (1997).

Adding to the DAST findings, which were conducted mostly in western countries, similar stereotypical images of scientists were also found in the studies of She (1998), Song and Kim (1999), Fung (2002) and Rubin (2003). These studies involved students of Taiwan, Korea, Hong Kong and Israel respectively. In contrast, however, Arab students viewed a scientist as an Arab male while many Hebrew speaking students viewed a scientist as a western male.

Overall, the fact that students from many countries, exposed to different cultures, having similar stereotypical images of scientists is indeed a worrying trend. In response, numerous studies focusing on intervention programmes to help alter students' stereotypical perceptions of Scientists have been carried out.

Mason and his co-workers described the effectiveness of a teacher intervention programme in altering students' perceptions on Science and Scientists (Mason et al., 1991). The study was conducted in the view that '*in addition to the pervasive social and curricular perspective, a major factor in attitude formation and/or change is the classroom learning environment.'*

The study in question was conducted with the aim to improve the enrolment of females in Science. Mason believed that positive attitudes and a broad-based, less stereotyped image of Science was needed. It is with this that the teacher intervention programme was carried out and evaluated.

From the results obtained from the DAST, it was found that the experimental group drew a significantly higher percentage of female scientists. In addition, interviews were also used as a follow-up.

TABLE 2. Percentages of common sterotypes that appeared on students' illustrations of a scientist—before and after a working scientist visited the classroom. (69 students participated)

Common Stereotype	Reponses Before Scientist Visit	Reponses After Scientist Visit
Lab coat	85.5%	60.9%
Eyeglasses	53.6%	46.4%
Facial hair	21.7%	18.8%
Symbols of research	75.4%	87%
Symbols of knowledge	53.6%	31.9%
Technology	29%	17.4%
Relevant captions	15.9%	24.6%
Male gender	76.8%	72.5%
Caucasian	85.5%	85.5%
Middle-aged or elderly scientist	11.6%	14.5%
Mythic stereotype	13%	2.9%
Indications of secrecy	10.1%	2.9%
Scientist working indoors	95.7%	88.4%
Indications of danger	42%	21.7%

Table 2: Taken from Bodzin & Gehringer (2001).

In another study, Bodzin and Gehringer carried out an investigation to determine the effect classroom visits by Scientists had on students' perceptions of Scientists. The study involved using the DAST before and after the visit of a Scientist. Over the course of the study, the three classes under investigation were visited by a female chemical engineer from a worldwide technology company and a male physicist from the local university (Bodzin and Gehringer, 2001).

In the study, the students were first administered the DAST; the drawings analysed and the various key features as put forth by Chambers were collated. Following that, the classrooms were visited by the Scientists as mentioned above. During the visit, the visiting scientists talked about themselves, both on a personal and professional level. They then conducted activities with the students.

On comparing the pre and post test results, it was found that the drawings revealed a change in students' perceptions of scientists. For example, the posttest data revealed a decrease in many stereotypic features after the scientist visited the classroom. Also, more female images were drawn during the post-test. In addition, fewer indications of danger were illustrated in the post visit. This was in contrast to the pre-test drawings where pupils depicted a scientist as a man in a white lab coat, dealing with dangerous equipment

(Table 2). Hence, the scientists' visit did play a role in altering students' misconceptions about Scientists.

Other similar studies relating to partnerships with scientists were also carried out by Moreno (2001). In such partnerships, it is believed that all parties benefit as scientists are able to enhance their communication, teaching, and community outreach skills while teachers gain a deeper understanding into the subject matter in question, hence creating confident teachers

In addition to the classroom visits by Scientists, another strategy that was discussed involved the use of children's literature in altering students' misconceptions of scientists. This involved immersing students' in various texts about Scientists and their work. Also, this provided an opportunity for an integration of the English language with Science.

Melber (2003) proposed such an approach in the study "*Science stories: A day in the life of a scientist"*. In her opinion, *'there (is) no better way to understand the work of a scientist than have it explained firsthand-in the scientists own words…… This direct connection with scientists gives students an authentic view of the scientific process. It is an important step towards getting students excited about science and the work of scientists, while countering any misconceptions or stereotypes that may have already developed.*

In ensuring that students understand the material (Table 3) that is given to them, Melber also suggested various strategies that could help in comprehension. Such strategies include *Living Science!*, where students assume the persona of a scientist (a drama approach). Other strategies that were mentioned were the use of *creating field journals*, *designing a travel brochure* (highlighting the place where the scientist in question had carried out the study) and *debates.*

Suggested literature selections that highlight various processes of science.

Bishop, Nic. 2002. ***Digging for Bird-Dinosaurs: An Expedition to Madagascar***. Boston: Houghton Mifflin.

Dingus, Lowell, and Luis M. Chiappe. 1999. ***The Tiniest Giants: Discovering Dinosaur Eggs***. New York: Doubleday.

Higginson, Mel. 1994. ***Scientists Who Study Wild Animals***. Vero Beach, Fla.: Rourke.

Kramer, Stephen. 2001. ***Hidden Worlds Looking Through a Scientist's Microscope***. Boston: Houghton Mifflin.

Lehn, Barbara. 1999. ***What Is a Scientist?*** Brookfield, Conn.: Millbrook Press.

Mallory, Kenneth. 2001. ***Swimming with Hammerhead Sharks***. Boston: Houghton Mifflin.

Maze, Stephanie. 1999. ***I Want to Be a Veterinarian***. San Diego, Calif: Harcourt.

Montgomery, Sy. 1999. ***The Snake Scientist***. Boston: Houghton Mifflin.

Table 3: Taken from Melber (2003).

Methodology

In this action research study, the Intact Pretest-Posttest One Group Design was used.

The candidates selected for the literature programme was a primary three class who was taking Science as an official curriculum subject for the first time. As students in this age group were beginning their foundational years in Science, this was a good platform for them to find out their misconceptions and through the intervention programme, allowed them to begin their foundation years on a positive note. This view was also taken as a result of the previous study on a Primary Five class (Yam, 2006). It was found that after these students graduated to Primary Six, less time was available on addressing scientists' misconceptions. Hence, it was with the impression that when this batch graduated to secondary school, many might have carried over their misconceptions. On the other hand,

with a Primary Three batch, it is with the aim that these students would be immersed with a science education based on both content and real-world application.

The Pretest-Posttest One Group Design was carried out as follows:

Pretest-Posttest One Group Design (Intact class)				
Treatment group	**I**	**O**	**X**	**O**

The "Draw a Scientist-Test Checklist (DAST-C)" (Chambers 1983) (Appendix A) was administered to an intact class (I) as a pretest (O) to determine the current misconceptions students have on Scientists. From the test, the various misconceptions that students have on a particular scientist stereotype were calculated as a percentage of the whole class.

Following the test, the class was put on a 10-week "Literature Programme" (X) where in addition to the current syllabus requirements; literature was incorporated into the lessons. This was in the form as book introductions to selected Scientists, websites and student introductions (Table 4). In addition, students were tasked activities to reflect on the above. The frequency of such introductions was on a weekly basis (every Monday).

After the 10 weeks, the "Draw a Scientist-Test Checklist (DAST-C)" (Chambers 1983) was administered as a posttest (O) to the class. The percentages of students indicating the particular stereotype was calculated and compared to the pre-test.

In such an experimental design, the threat to internal validity may have included factors such as maturity, gender and attitude towards text (in the case of the literature programme). In an attempt to control this, book introductions in the form of text and

websites helped to vary and cater to the various learning styles of students. Texts were also chosen with effective illustrations in mind to help cater to both the auditory and visual learners.

Table 4: Book Resources for the 10 week Literature Programme	
1	**Forecast Earth: The Story of Climate Scientist Inez Fung** (Women's Adventures in Science) by Renee Skelton (Joseph Henry Press (December 31, 2006))
3	**Beyond Jupiter: The Story of Planetary Astronomer** Heidi Hammel (Women's Adventures in Science) by Fred Bortz (Joseph Henry Press; illustrated edition (December 31, 2006))
4	**Bone Detective: The Story of Forensic Anthropologist Diane France** (Women's Adventures in Science) by Lorraine Jean Hopping Joseph Henry Press; illustrated edition (December 31, 2006))
5	**Robo World: The Story of Robot Designer Cynthia Breazeal** (Women's Adventures in Science) by Jordan D. (Brown Joseph Henry Press; illustrated edition (December 31, 2006))
6	**Nature's Machines: The Story of Biomechanist Mimi Koehl** (Women's Adventures in Science) by Deborah Parks (Joseph Henry Press; illustrated edition (December 31, 2006))
7	**A Life in the Wild: George Schaller's Struggle to Save the Last Great Beasts** by Pamela S. Turner (**Publisher:** Farrar, Straus and Giroux (BYR); 1st edition (October 28, 2008)
8	**Sea Life Scientist: Have You Got What It Takes to Be a Marine Biologist?** (On the Job) by Lisa Thompson (Compass Point Books (January 2008))

Results and Discussion

With the intention of getting students perceptions of Scientists, the DAST-C checklist (Chambers, 1983) was adopted and a survey was administered to a class of Primary Three students (sample size of 38) in a local school. Among the group, the sample of students (an even mix of boys and girls) comprised a mix of high and low ability students. This formed the pre-test component of the pre-test post-test one group experimental design.

Table 5: Student's Stereotypic Images of a Scientist (Primary Three Class)

Common Stereotype	**Students responding (Pre-Test) (%)**	**Students responding (Post-Test) and difference (%)**
1. Scientist wearing a lab coat	31	14 *(-17)*
2. Scientist wearing eyeglasses	11	11
3. Scientist with facial hair	11	5 *(-6)*
4. Symbols of traditional research displayed	64	32 *(-32)*
5. Symbols of knowledge	25	14 *(-11)*
6. Symbols of high or modern technology represented	8	22 *(+14)*
7. Relevant captions	0	0
8. Male Gender only	61	62 *(+1)*
9.Caucasion only	NOT OBSERVED	NOT OBSERVED
10. Scientist in middle age/older	NOT OBSERVED	NOT OBSERVED
11.Scientist has Mythic Stereotypes	3	14
12. Indications of Secrecy	NOT OBSERVED	NOT OBSERVED
13. Scientist is working in a lab	81	65 *(-16)*
14. Indications of danger	31	22 *(-9)*
15. Scientist with a smile	53	65 *(+12)*

On analysis of the results (Table 5), it was found that of the students in which the survey was administered, a large percentage of students held the common stereotypical image of a Scientist. As with most studies that were done with students of other nationalities, students here held the common perception that scientists were *men* (we stress the gender

in this instance as 61% of those surveyed drew a male scientist) who wore lab coats (31%). Many students viewed a scientist's predominant role as mixing chemicals solitarily in a laboratory. In other words, they were perpetually engaged in "experimental work". In addition, the "mad scientist" was also shown in a number of drawings.

Fortunately, in a large majority of instances, the drawings of the scientists were generally positive with two images depicting a negative image (the "deranged" scientist). Of all the drawings, less than five depicted a scientist working in the outdoors.

In a separate study by Rahm (1997), only 4% of the images depicted a computer. In his view, student's perceptions of science seemed to be stagnant with mental images of their last chemistry class. With a strong emphasis with information technology and the use of the internet as an information tool in today's curriculum, it was certainly unusual that these were absent from a scientist's laboratory. Though the results obtained were of a relatively small sample, the stereotypical images depicted are still a cause for concern as they produced common stereotypes as with other studies of much larger sample sizes. Similarly in this study, technology ranked a mere 8% in which a computer or other modern device was depicted in the laboratory. In the majority of all other images, a scientist's inventory of tools consisted of nothing more than test tubes, chemicals, books and microscopes.

During the literature programme, various introductions were made on the personal and professional lives of Scientists. In the selection, many were based on both the life and physical sciences. On a personal note, it was observed that many students were interested to learn more on the lives of scientists. They were especially interested when a scientist like Amy Vedder was presented. During the lesson, students were presented with illustrations and a short description on Amy's professional life in her study of the behaviors and life of the Gorillas, followed by her growing up years as a child and a wife and mother. In addition, pictures like the one showing Amy in the field with the gorillas and one where she was cuddling it struck a powerful note in the hearts of the students (Figure 2). In particular, this sharing was especially useful as it tied in with the topic that students were studying; animals.

In all, a total of 8 book introductions were made and activities ranging from student sharing of reflections to classroom discussion were carried out. Due to the need to integrate the literature approach and at the same time maintain the curriculum needs and

Figure 2: Amy Vedder's personal and professional life

Meet the Human Family

FUN FACTS

BORN: March 24, 1951, in Palatine Bridge, New York
LOVES: sports and being barefoot
DISLIKES: inequality in the world
SPENDS HER FREE TIME: coaching girls' lacrosse and reading novels set in other countries
AUTHOR OF: *In the Kingdom of Gorillas*
APPRECIATES: individuality. She and her husband Bill Weber gave their sons Noah Weber and Ethan Vedder different last names.

standards, a conscious effort was made to keep the duration of such activities to half an hour a week. As a result of students' displayed interest, many of these books were left in the class library where students were allowed to bring the book home for further reading. The web addresses for the various related sources were also given to students.

Following the post-test, it was found that students showed an increased awareness towards the mental image of a Scientist. In terms of the typical image of a Scientist in a lab coat, a large proportion of pupils drew a Scientist in more casual clothes. In the case of students depicting Scientists in a lab coat, they were illustrated in the context of a laboratory. The reason for this positive change of mindset could have been attributed to the classroom book introductions where Scientists who were out of the laboratory were mostly in normal outdoor civilian attire. Such pictures that were shown included a Scientist working underwater, Amy Vedder working with the Gorillas in the field and George Schaller's conservation expeditions.

The corresponding decrease in traditional research symbols such as test tubes, Bunsen burners and microscopes also reinforced the change of the stereotypical mindset. In many

post-test drawings, the perceived exclusive uses of traditional research symbols were abandoned for high technology equipment. This shift was important as it highlighted a change in stereotypical mindset to reality.

Another interesting finding was that in terms of traditional research symbols, the percentage of occurrence in students' pictures showed a drop of 32%. In the post-test, more variety of pictures were seen with Scientists working in the field with animals, studying the weather, observational studies of plants and teaching. Relating to the use of technology, an increased proportion of pupils in this instance included modern high technology devices into their pictures (increase of 14%). Such modern technology included computers, weather studies apparatus, microscopes and hydroponics.

On the other hand, it was also seen that while many negative misconceptions were observed to have decreased, the depicting of a scientist as a mythical character increased by 11%. The other indicators of Scientists wearing eyeglasses, male gender only and a scientist with a smile showed a small difference in percentage occurrence. With the exception of male gender, these other aspects were deemed as minor and hence were not a cause of concern for the study findings.

Although steps have been taken by our Science curriculum and educators to highlight the contributions of women in Science as well as the relevance of the subject to real life situations, it is seen that the pre-test revealed students stereotypical thinking of Science and scientists. Such images were observed namely in the area of the stereotypical tools of the scientists, male scientist and the tendency for scientists to work in a laboratory. In many students' drawings, students' image of a scientist at work revolved around test tubes and the laboratory. These were consistent with other studies done in other societies. They include those of Schibeci (1983, 1986 & 1989), Rosenthal (1993), Huber (1995), Bowtell (1996) and Rahm (1997). Other studies include Fort (1989), Evans (1992) and Barman (1997). As the results were revealed by Primary 3 students who are officially beginning their journey in Science, the results did not bring about a serious cause for concern as remedial steps taken at this early stage could bring about changes in our students' stereotypical mental images of Scientists.

Our findings in this study seemed to indicate that a literature approach as put forth by Melber (2003) towards the changing of students' mental images of scientists did to a certain degree change a proportion

of our students' stereotypical images. In the case of student A, a major change was seen in his view of a scientist and his work. In the pre-test, the mental image of a scientist at work revealed a man (mustached) in a lab coat, mixing chemicals in the laboratory. His picture description was:

'The scientist is creating something. He is making something with his tube.'

In contrast, his picture in the post-test revealed a scientist in a weather station, looking through a weather scope (Figure 3). His picture description revealed more insight into his change of perceptions:

'The scientist is studying the weather and outer space. He is studying the weather because he is a climate

(I believe he meant climate scientist)……'

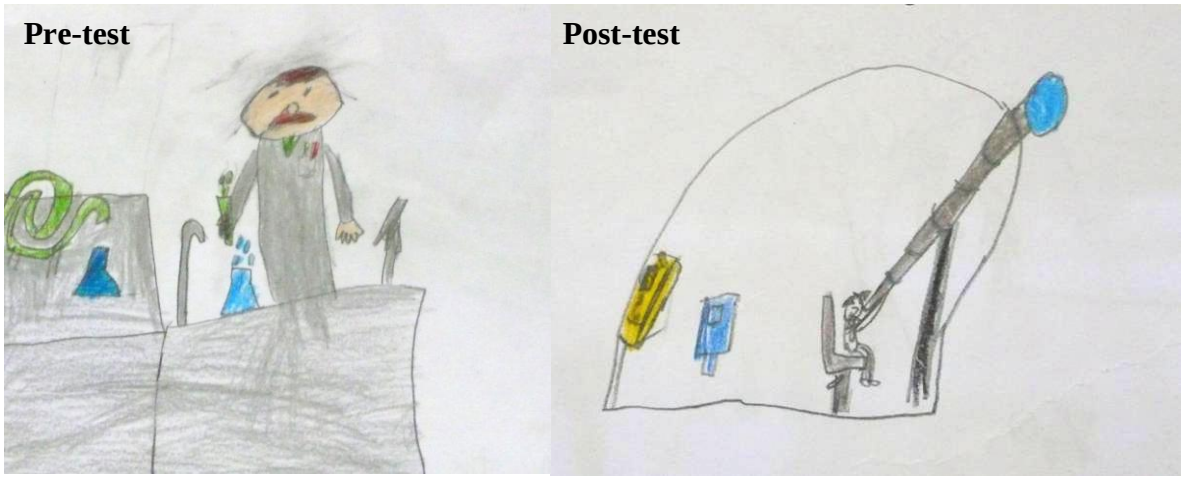

Figure 3: Student A Pre and Post-test depiction of a scientist at work

Even though his description and illustration were not exactly accurate, it was clear that a change of perception had occurred. He had realized that a scientist's work was not just mixing chemicals. The term climate scientist probably came from the class lesson on climate scientist Inez Fung (Figure 4). It has to be noted though that despite the introduction of a female scientist, this student still went back to a climate scientist of a

male gender. This preference for a scientist of a male gender was also seen in the overall percentage result that in both pre and post-tests, no significant change was seen in the incidence of drawing a male scientist.

In another instance of perceptual change, student B drew in her pre-test a female scientist in a laboratory. On her work desk, a chart of living and non-living things was laid over, suggesting that the scientist was carrying out a classification exercise. She wrote:

'This is a scientist. A scientist knows how to solve the problem about science.'

In the above, we see a pupil who has little or no knowledge of a scientist and her work. This could be seen in her picture which showed minimal details and the description which only communicated the notion that a scientist solves scientific problems.

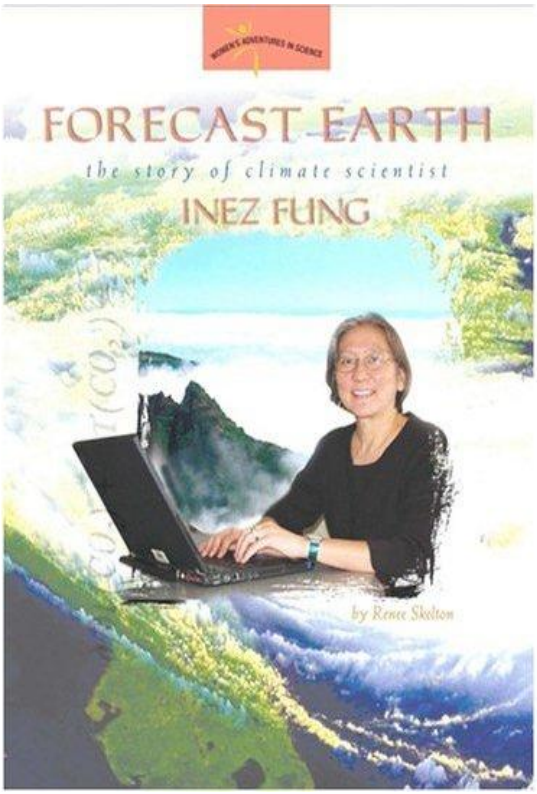

Figure 4: Inez Fung from Forecast Earth; the story of climate scientist Inez Fung.

On the other hand, the post-test showed a picture of a female scientist working in a hydroponics facility. The detail of the picture and the arrangement of seedlings in a water bed indicated that student B did have an accurate idea of what hydroponics is. In fact, she even went into details like the labeling of a plant such that the scientist would know what she is studying. This was in contrast to her initial picture (Figure 5).

She wrote:

'Scientist will water the plant and put the plant on the sun….. She will write the sign at the back than she will know what is the plant.'

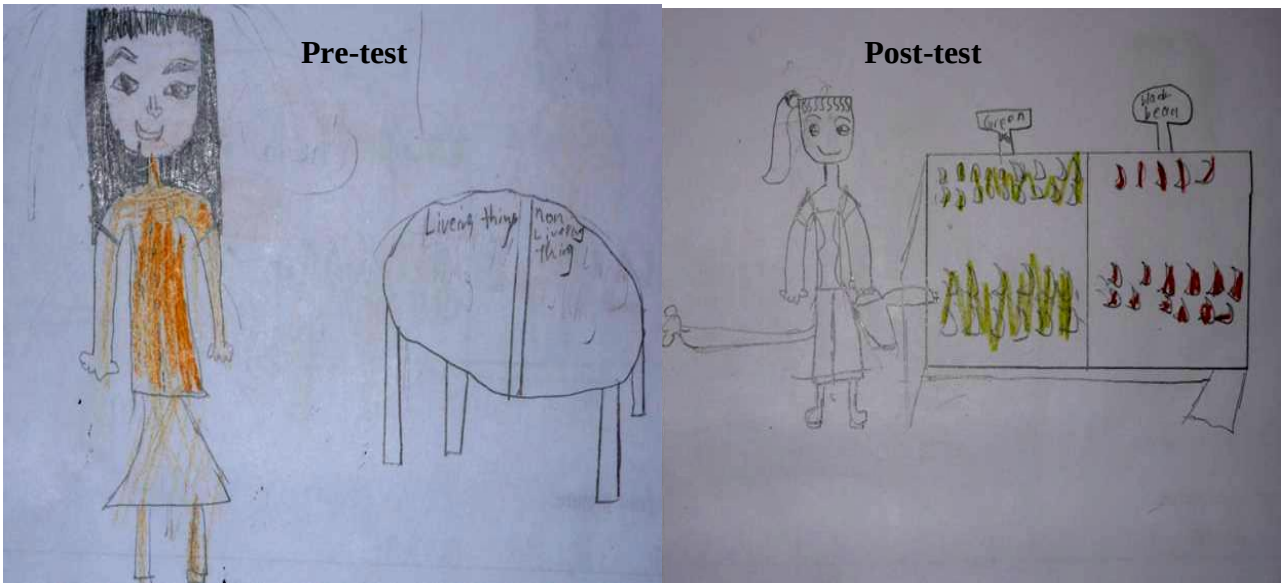

Figure 5: Student B Pre and Post-test depiction of a scientist at work

A possible explanation for the knowledge of hydroponics was most likely from a social studies lesson where pupils were studying the changes in Singapore's farming methods. This lesson was steered in the direction on the work of a scientist.

Another illustration that is worth highlighting would be the work of student C. In her pre-test, she indicated a female scientist caring for a flower. During that particular test, she could not write in words what her scientist was doing. However, in her post-test, not only did she draw a detailed picture of a scientist rescuing a whale, she also drew an additional scientist, indicating the inter-dependent and collaborative nature of scientists (Figure 6). She wrote:

'The scientist like whale. They help for when the whale sick they take care of whale they really like it.'

Again like the previous lessons, the illustration could have come from the lesson where the work of a sea life scientist was shared (Figure 7). In that particular book, a case was mentioned about scientists saving whales.

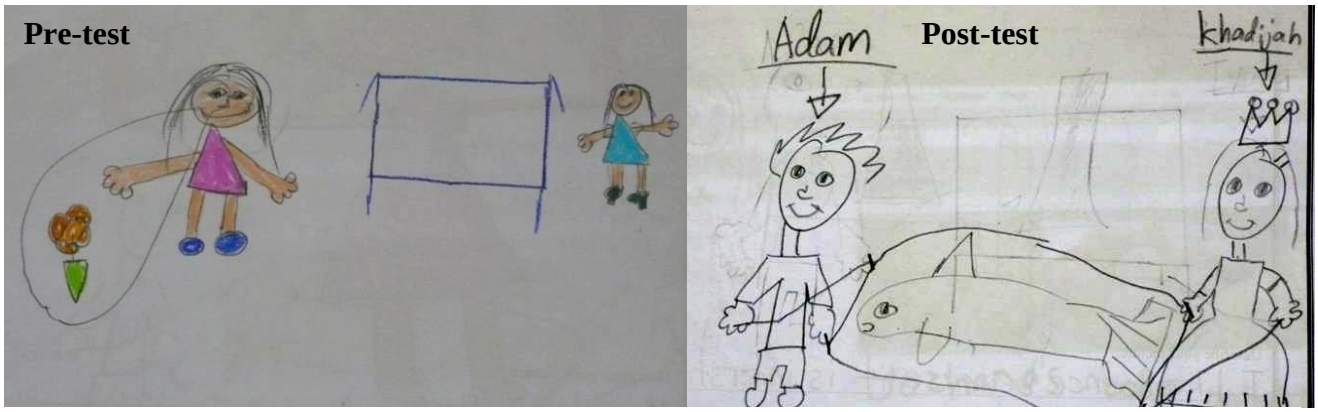

Figure 6: Student C Pre and Post-test depiction of a scientist at work

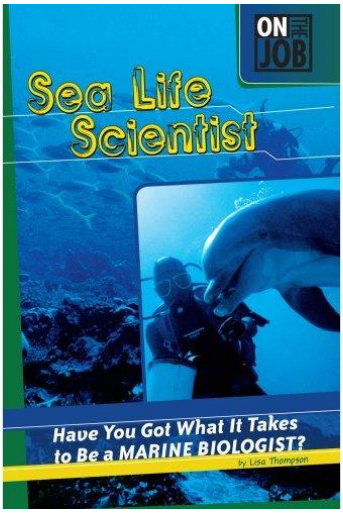

Figure 7: Sea Life Scientist

In addition to the above examples, there were also other illustrations that indicated a conceptual change. Using literature and pictorial sources to illustrate the life of a scientist presented them in a dynamic mode. From the collaboration of Chinese and western scientists to save the pandas, the life of sea life scientists, the marriage of Amy Vedder and pictures of her family to the love a scientist have for animals and nature brought forward a very sincere and human perspective to not only the work but the 'heart and soul' of a scientist.

Despite indications of a positive shift towards a more accurate depiction of a scientist, the one aspect which still proved difficult to change was the male gender of the scientist. Despite the introductions of the various female scientists in the literature programme, the post-test results still remained relatively the same. Looking at the before and after pictures, pupils still showed a strong tendency to draw a male scientist. An interesting point to note was that of the girls that participated in the study, all but three depicted a female scientist at work. This could be

an indication that the girls in the study at the very least viewed the possibility that women could be professional scientists. However, in the post-test, the numbers remained the same with one girl drawing a female instead of a male scientist. Needless to say, all the boys in the study depicted a male scientist.

In reviewing the literature approach, the use of real life examples of scientists and their work in a real life context did seem to be an effective strategy in altering pupils' stereotypical view of scientists. However, it is also recognized that as pupils reach further maturity, actual involvement in the work of scientists might be a more fruitful learning experience. In addition, more could also be done in the immersion process. This could take the form of the inclusion of scientists' autobiographies in English comprehension worksheets or grammar cloze exercises. In schools where the curriculum is built around the sole discretion of the school, with little or no conformity to subscribed texts, a whole thematic unit could also be built around scientists and their work. The possibilities are endless.

Looking at the practice of some schools, it seems that such shared opinions exist. In the March 2004 edition of Contact, a publication of the Ministry of Education, Singapore, a feature was made on three junior college students and their attachments to Research Institutes in Singapore. For 17-year-old of Eugene Chua, his experience changed his perceptions of scientists:

"It is not like your stereotype of people sitting in a lab, not talking to each other, just doing their work. It's actually a very alive place, with a lot of interaction among the researchers and what they are doing."

Another student, 19-year-old Liu Yan of Raffles Junior College spoke of her experience at the Institute of Infocomm Research (I2R):

"Before this attachment, I thought researchers were serious and work-oriented people who never had any kind of entertainment. But I found that they are very friendly and helpful, and they have a great sense of humour"

From these experiences, it can be seen that actual attachments and the close proximity that they bring to scientists leave a deep impression on students. Hence, from the primary school journey towards higher institutes of learning, it is important that class-based experiences eventually should lead to real-life application.

Adapting Moreno's (2001) study on creating school-scientists partnership programme, primary schools can invite students who have been to research attachments share their experiences with the younger children. In cases where parents of children are scientists, what more a paternal or maternal figure to give an assembly talk to the whole school or target levels. Having a much narrower age difference, primary school pupils might benefit more from such arrangements.

In enhancing the literature approach, other aspects of English such as drama and debates could be added to increase the benefits of the programme. Such examples include Living Science and debates as put forth by Melber (2003).

Conclusion

Adopting a literature approach towards the altering of students' stereotypical images of scientists has showed promise from the perceptual changes that took place in the study. With the development of more structured activities built around the theme of scientists, such a programme implemented on a school or nation wide level can help to give primary school children a more accurate view of science, the roles of scientists and their work. Implemented at the age where students are in their foundational years of science might help to create a sense of awareness on the equity of the genders in science. Indeed, this could help increase the enrolment of females in science courses in the long run.

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Appendix A

Name: _____

Class: _____

1. Draw a picture of a Scientist doing Science.

Describe your picture.

_____

_____

_____

_____

2. Draw a picture of yourself doing Science.

Describe your picture.

_____

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