

## MEXICAN STUDENTS' IMAGES OF MATHEMATICIANS

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*The aim of this research was to investigate the images that Mexican high school students hold about mathematicians and the type of activities that they develop. A particular feature of the pupils who participated in the study is that they are high achieving mathematics students. To investigate the images that the students hold, a research method based on the Draw-A-Scientist Test (DAST) was applied. The students participating in the study seem to possess images about mathematicians similar to those reported in the literature, such as mathematicians being mostly males. However, we also found that in general the students depicted mathematicians as ordinary people.*

*Keywords: Images of mathematicians, Mexican students' images, Draw-A-Scientist Test (DAST).*

### INTRODUCTION

Over the past 50 years, a great deal of research on the images and perceptions that students hold about scientists has been produced (see Finson (2002) for a general overview of such investigations). In the research area of mathematics education, there are also several studies that focus on investigating the images that students have about mathematicians and mathematics itself (see for example Picker & Berry, 2000; Rensaa 2006; Moreau, Mendick & Epstein, 2010; Furinghetti, 1999). However and despite this large body of research, there is a lack of research on images held by students in Latin American nations. For example, in the particular case of Mexico where this research project was developed, the latest study on the images that Mexican students hold about scientists was published in 1975 (see Rodríguez Sala de Gómezgil, 1975). As pointed out by Medina-Jerez, Middleton & Orihuela-Rabaza (2011), it is known that the conceptions about science and scientists that the students hold are influenced by their socio-cultural realities. It is therefore necessary to develop more studies that could clarify how and to what extent the Latin American socio-cultural realities shape the students' conceptions of science and scientists.

The main contribution of this research is to provide up-to-date results on the images of scientists held by students from developing countries. Particularly, we investigate the images that Mexican high school students hold about mathematicians and the type of activities that they develop. This study contributes to expand our knowledge about the images of mathematicians held by Latin American students, which is an aspect that has not been studied in depth so far.

We will start our research report by presenting an overview of studies dealing with images of scientists and mathematicians. Following, we present our working definition of image.

Next, we describe the research method implemented in the study. Finally the obtained results are presented and discussed.

## **AN OVERVIEW OF STUDIES DEALING WITH IMAGES OF SCIENTISTS AND MATHEMATICIANS**

The research on the images that people have about mathematicians can be considered as a subset of the research studies dealing with the images that people hold about scientists in general. These studies can be classified into three categories: (1) studies focused on determining the images that people have about scientists; (2) studies focused on determining the origin or sources of the images that people have; and (3) educational interventions that attempt to modify people's images of scientists. Next we illustrate each of these categories.

### **Studies focused on determining the images that people have about scientists**

These kinds of studies were initiated with the seminal work of Mead and Métraux (1957). These studies have identified stereotypes that people associate with scientists. Many of these stereotypes appear to be stable over time and across different cultural contexts. The classic stereotypical image of a scientist among students is that of an elderly or middle-aged white male working in a laboratory, with facial hair and wearing a white coat and eyeglasses (Mead & Métraux, 1957; Chambers, 1983). Several studies in mathematics education have shown the existence of stereotypes associated with mathematicians. Such stereotypes have similarities with the stereotypes associated with scientists in general. Grevholm (2010) reports a study where some Norwegian students depict mathematicians as being men, old, lonely, often using spectacles and sometimes beard. Piatek-Jimenez (2008) studied the images held by undergraduate women mathematics students; these women described mathematicians as being exceptionally intelligent, obsessed with mathematics and socially inept. When pupils are asked to mention the kind of work that a mathematician develops, it is common that they represent mathematicians as mathematics teachers (see for example Picker & Berry, 2000).

### **Studies focused on determining the sources of the images that people have**

There are other studies trying to unveil the sources where the images about scientists come from. There is a shared hypothesis in this research area about the origin of these images: The images of scientists that people have are generated through social experiences. These experiences can take place at school settings or through interactions with parents, friends and mass media (Schibeci, 1986). Rensaa (2006) has represented graphically these relations as shown in figure 1.

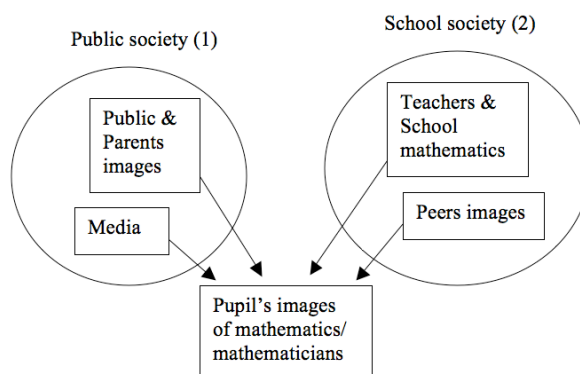


Figure 1. Influences on pupils' images of mathematics and mathematicians. Diagram taken from Rensaa (2006).

Studies such as those of Furinghetti (1993) and Moreau, Mendick & Epstein (2010) have focused on studying the representations of mathematicians and mathematics in movies, books and other mass media. These studies have found several negative representations such as incompatibility between femininity and mathematics (Furinghetti, 1993) or the association between mathematicians and some form of mental disorder (Moreau, Mendick & Epstein, 2010).

### **Educational interventions that attempt to modify people's images of scientists**

Student's negative images of scientists can exert an enormous influence on their attitudes and behaviours. For example, research has shown that possessing a negative image of scientists can inhibit the choice of scientific careers among students (Finson, 2002). This is one of the reasons why several educational interventions have been designed to try to modify such negative images. Several of these interventions have focused on bringing students closer to the world of science, thus trying to show them a truer picture of how scientists are and what type of activities develop. Flick (1990) for example, asked some university scientists to visit selected elementary classrooms and share with the students their enthusiasm for science. The students in turn visited the laboratories of the scientists. The results of this intervention show that this type of approach can positively modify students' images. Another educational intervention of this kind is reported in the work of Gadanidis & Scucuglia (2010). This paper refers to a video-based project called *Windows into Elementary Mathematics* where mathematicians are interviewed about their perspectives on elementary mathematics topics; the interviews are video recorded and shared through a website. The aim of this project is to provide alternate images of mathematics and mathematicians. The videos from this project have been used in an online course for pre-service mathematics teachers with positive results. For example, the researchers have found that some pre-service teachers, who identified themselves as fearing and/or disliking mathematics, express positive views about the activity of mathematicians after watching the videotaped interviews.

The research reported in this manuscript may be included in the first category presented in this section: The one referring to the studies focused on identifying people's images of

scientists. Particularly, our research tries to identify the images that Mexican students have about mathematicians and the type of activities that they perform. As mentioned, the images that Latin American students hold about scientists have been an under researched area, and this study contributes to its development.

## **ON THE CONCEPT OF IMAGE**

The main theoretical concept used in this research is that of image. Although in this paper we have used it as synonymous of stereotype, we adopt the definition of image proposed by Sam (2002): “[T]he term image is defined as some kind of mental representation (not necessarily visual) of something, originated from past experience as well as associated beliefs, attitudes and conceptions. Since an image originates from past experience, it comprises both cognitive and affective dimensions. Cognitively, it relates to a person's knowledge, beliefs and other cognitive representations. Affectively, it is associated with emotions, feelings and attitudes.”

## **RESEARCH METHOD**

In this section we discuss how the empirical data used in this research were collected and analysed.

### **The study population**

Two mathematics classrooms from a Mexican public high school were selected for this study. In all, 63 students in an age range of 17-18 years took part in the study. 54 of them were males and 9 females. A particular feature of the pupils who participated in the study is that they are high achieving mathematics students; this is, they belong to a high school that during three consecutive years (2011, 2010 and 2009) has been top-ranked on mathematical skills on a national test applied by the Mexican ministry of education (*Prueba Enlace*, <http://www.enlace.sep.gob.mx/>). Additionally, these students plan to pursue a mathematics-related career such as engineering or computer science.

### **The instrument applied**

To try to get access to the images that students had about mathematicians and their activities, we applied a research method based on the Draw-A-Scientist test developed by Chambers (1983). Particularly, we applied a written instrument divided into three sections. In the first section we asked the students to draw on a sheet of paper “a person whose profession is mathematics”. We avoided asking them to draw a mathematician, because in Spanish the word “mathematician” is not gender-neutral: While the word “matemático” refers to a man, the word “matemática” refers to a woman. Thus, we used the term “a person whose profession is mathematics” to avoid inducing or suggesting any gender in the drawings of the students.

In the second section of the written instrument the students were asked to describe in words what they had drawn. The function of this second section was to clarify and expand the information contained in the students’ drawings.

Inspired by the work of Rock & Shaw (2000) and Picker & Berry (2000), in the last section of the instrument the students were asked to describe the type of activities or jobs developed by a person whose profession is mathematics.

This instrument was administered at the beginning of March 2011. To apply the instrument we received the support from the teacher in charge of the two classrooms that participated in the study. He allowed us to apply the instrument during the regular class time. The students answered the instrument in an average time of twenty minutes.

### **Data analysis**

To analyse the drawings collected, we defined a set of categories that would help us to focus our attention on certain aspects of the drawings when analysing them. Examples of such categories are hair type, use of eyeglasses, gender, kind of clothing, environment or context, and tools used by the depicted person. These categories were defined through an interplay between specialized literature and the collected data. This means that we consulted the kind of categories used in other research and then we analysed which of those categories were pertinent or useful to analyse our own data. After this process we ended up with a final set of categories to analyse the drawings.

To try to ensure the validity and reliability of the final set of categories, the team of researchers participating in this study (which was originally composed of four researchers), was split into two teams which analysed the drawings independently. Later we met to compare our results. If the results obtained in any of the categories were significantly different among the teams, we discussed how each team was interpreting this category and looked for a consensus on how it should be interpreted.

The answers to the second and third sections of the written instrument were analysed differently. The answers to the second section of the instrument allowed us to confirm or reconsider the interpretations that we made of the drawings. The answers to the third section of the instrument were classified according to the type of job or activity reported by the students (teacher, statistician, engineer, etc.).

## **RESULTS**

The presentation of our results is organized into three categories: (1) mathematicians' gender and appearance; (2) settings and tools used by the mathematicians; and (3) type of jobs developed by a mathematician.

### **Mathematicians' gender and appearance**

One of the most notable results is that only 4 of the students who participated in the study drew a woman. In fact, only female students drew women. No male student drew a woman. This result coincides with those reported in other studies on pupils' images of scientists and mathematicians where scientific careers are perceived as "non-female" domains.

Contrary to our expectations, less than half of the students (42.8%) represented a mathematician wearing eyeglasses. A higher percentage of students drew a person without eyeglasses (47.6%), while in rest of the drawings it was not possible to determine the

presence of eyeglasses because the person was represented with his/her back to the observer.

Very few students represented a mathematician with an extravagant, slovenly or dirty outfit. 55.5% of the students drew a person with a casual outfit (regular shirt and pants or dress), while 33.3% represented a person using more formal clothing (jacket and tie).

Regarding the hairstyle, only 19% of the students represented a person with a flamboyant hairstyle (with spikes, Einstein-like). 76.1% of the students drew people with common hairstyles, and only 4.7% drew bald people.

### **Settings and tools used by the mathematicians**

Most of the students (39.6%) drew people without a context, that is, their drawings included only a person without any surroundings. In the case of the students that included some kind of setting in their drawings, the predominant settings were a classroom in the first place (25.3%), and an office in the second place (7.9%). In the rest of the drawings it was not possible to determine the context in which the represented person was inserted.

There is a relationship between the settings in which mathematicians were represented and the kind of tools depicted in the drawings. In other words, mathematicians were represented surrounded or using tools that are usually found in a classroom or an office. We refer to tools such as blackboards, pencils, books, desks, and erasers. Interestingly, no student drew a computer and only four students drew a calculator.

### **Type of jobs developed by a mathematician**

When the students were asked to describe the type of activities or jobs developed by a person whose profession is mathematics, the students often mentioned more than one type of occupation. The five most frequently mentioned jobs were: mathematics teacher (26 mentions), statistician (20 mentions), administrator (13 mentions), researcher (11 mentions) and mathematical modeller (10 mentions).

## **DISCUSSION**

The image of a mathematician that is prevalent among the students who participated in this study may be summarized as a middle-aged man with a common appearance. He uses a regular hairstyle and a common outfit, and not necessarily uses eyeglasses (see figure 2).

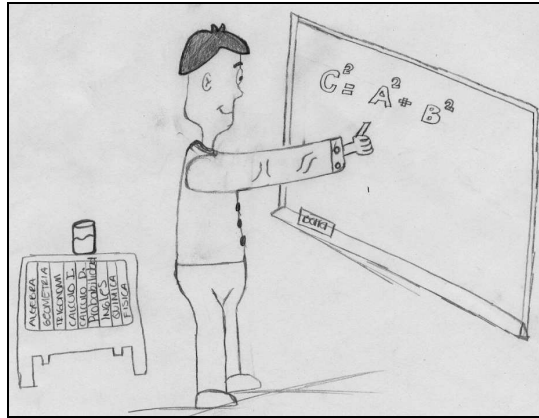


Figure 2. Archetype of a person whose profession is mathematics as depicted by most of the students participating in this study.

Also, the mathematician is mainly imagined as a mathematics teacher or as a person performing statistical calculations (see figure 3). The mathematician is also associated with traditional tools such as blackboard, books and pencils, but not with technological tools like computers.

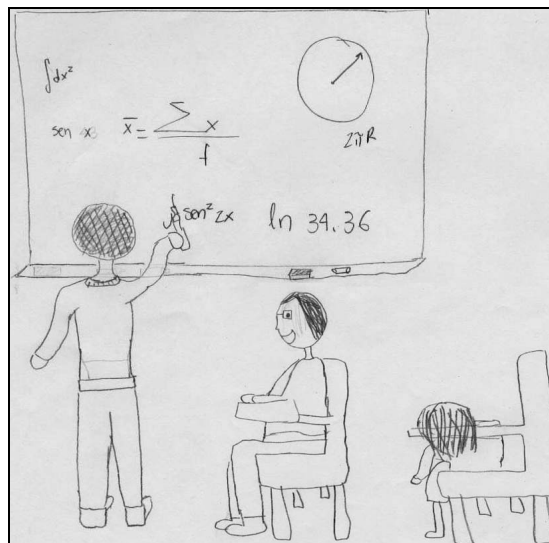


Figure 3. A mathematician was usually represented as a mathematics teacher.

As reported in previous studies, most students do not draw female mathematicians. In our study we noticed that some of the drawings representing a woman were actual representations of real women that the students met at some point in their life. For example, one of the students who drew a woman explained that her drawing represented a successful engineer who she had known and was a source of inspiration for her (see figure 4). This situation highlights the influence that female role models can have on the constitution of students' images.

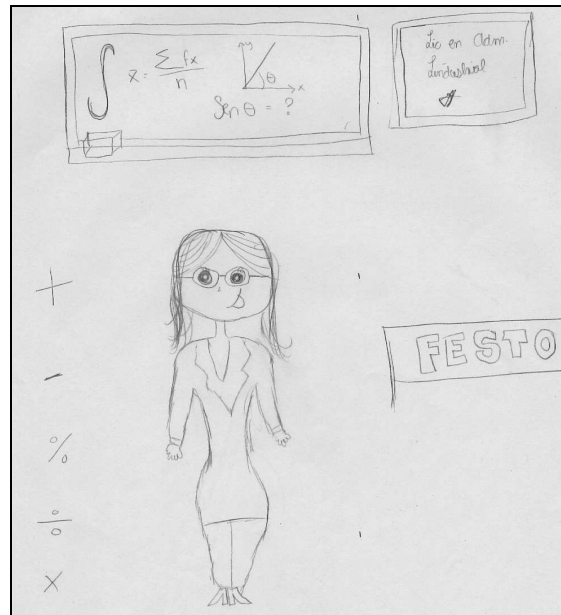


Figure 4. A Representation of a female engineer made by a female student.

One of the most significant results of this research is the fact that, in general, students have a positive image of mathematicians and represent them as people with a common appearance. In other words, our results are different from those reporting that students mainly represent mathematicians as people of extravagant or slovenly appearance and usually using lenses. Why the Mexican students who participated in this study tend to represent mathematicians as ordinary people? There are at least two possible answers to this question:

A first possible answer is that mathematicians' exposure to the Mexican media (magazines, TV shows, newspapers, etc.) is quite limited. The public image of Mexican mathematicians is virtually non-existent. One consequence of this lack of public exposure is a vacuum in Mexican citizens' images of mathematicians. Our hypothesis is that such vacuum tends to be occupied by other professions close to mathematics, like administrators or mathematics teachers. Thus, when students are asked to represent a person whose profession is mathematics, they tend to draw their own mathematics teachers. In the case of the students who participated in this study, most of their mathematics teachers are men, and none of them has a quirky or unusual look. This could explain the type of representations produced by the students.

Another possible answer is related to the type of students who participated in the study. As previously mentioned, they are high achievers in mathematics. Moreover, they plan to pursue a mathematics-related career when finishing their high school. They are likely to be better informed about mathematicians and their work. For this reason we believe that their representations of the appearance of a mathematician are closer to reality. In order to test this hypothesis it would be necessary to replicate the study using a different sample, that is, to work with less outstanding students who are not necessarily interested in pursuing mathematics-related careers.



In any case, the drawings analysed show that most students represent mathematicians as mathematics teachers. We interpret this as an indicator of the influence of the teachers on the images of their students. We think that teachers should be aware of the big influence that they exert on the formation of images of their students. We believe that they could play an important role in modifying negative images of mathematicians and mathematics in their students, although this possibility will require further explorations.

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