Towards Gender Transversality in Mathematics Education

Uma perspectiva de gênero em matemática educacional

Una perspectiva de género en matemática educativa

María Guadalupe Simón-Ramos orcid.org/0000-0002-0140-4184
Rosa María Farfán-Márquez orcid.org/0000-0003-1229-8521
Claudia Rodríguez-Muñoz orcid.org/0000-0003-0566-0385

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Abstract

From the socio-epistemological, the feminist, and the social representation theories, this article analyzes a broad panorama of Mexican research studies about gender differences, considering several dimensions of school mathematics. It highlights the incidence of teacher and family expectations; the sociocultural aspects; and the gender stereotypes as elements that go across the school mathematics discourse. All these elements make girls and women have limited possibilities to participate in the construction of mathematical knowledge. In this sense, we pose the following discussion: How does the school mathematics discourse exclude women? The work presents several future research paths that seek incorporating the gender perspective in the teaching of mathematics from the socio-epistemological theory.

Keywords

gender; mathematics education; socioepistemology; feminism; social representations

Resumo

A partir da Teoria Socioepistemológica, Teoria Feminista e Teoria das Representações Sociais se analisa um amplo panorama de pesquisas mexicanas sobre as diferenças de gênero e suas várias dimensões na matemática escolar; destacando a incidência de expectativas educacionais e familiares, os aspectos socioculturais e estereótipos de gênero como elementos que atravessam o discurso matemático escolar, influenciando para que as meninas e mulheres se vejam limitadas na possibilidade de construção de conhecimento matemático. Ao longo do trabalho discute-se a pergunta: Como o discurso matemático escolar exclui as mulheres? Por esse motivo, este texto propõe futuras rotas de pesquisa, desde a socioepistemologia, que contribuam à transversalidade da perspectiva de gênero no ensino de matemática.

Palavras-chave

gênero; matemática educacional; socioepistemologia; feminismo; representações sociais

Resumen

Desde la teoría socioepistemológica, la teoría feminista y la teoría de las representaciones sociales se analiza un panorama amplio de investigaciones mexicanas sobre las diferencias de género en diversas dimensiones de la matemática escolar, el cual destaca la incidencia de las expectativas docentes y familiares, los aspectos socioculturales y los estereotipos de género como elementos que atraviesan el discurso matemático escolar. Todos estos elementos propician que niñas y mujeres vean limitada la posibilidad de participar en la construcción de conocimiento matemático. En este sentido, planteamos la siguiente discusión: ¿Cómo el discurso matemático escolar excluye a las mujeres? El texto expone varias rutas de investigación futuras desde la socioepistemología que buscan incorporar la perspectiva de género en la enseñanza de las matemáticas.

Palabras clave

género; matemática educativa; socioepistemología; feminismo; representaciones sociales

Why are we interested in gender studies in mathematics education?

Mathematics education is concerned with the systematic study of the phenomena that characterize the teaching of mathematics and its continuous improvement (Cantoral & Farfán, 2001). The national and international results of standardized tests such as Planea (Secretaría de Educación Pública [SEP], 2017; 2019) for Mexico and PISA (OECD, 2019; 2020) for all the countries belonging to the Organization for Economic Cooperation and Development (OECD) show that for certain sectors of the population the traditional school mathematics discourse has not met the specific characteristics and needs for them to fully develop their potential. Among these, we can find groups with different characteristics: ethnic, economic, or social background; different drives and interests; attitudes and skills (both intellectual and physical) developed at different levels; and indeed, one of the most notorious and neglected difference: the students' gender. Each one of these characteristics represents the diversity found in the classrooms. This is why it is important to bear them in mind to achieve one of the most important objectives in the educational system: to make inclusive, egalitarian, comprehensive, and quality education. This could make that every person participated and enjoyed the mathematical culture, so deeply rooted in their own lives (Cantoral *et al*., 2014).

Throughout time, the teaching of mathematics has been a concern of all societies on account of its importance for the development of other areas of knowledge; and at present, for science, technology, engineering and mathematics (STEM). These disciplines have brought about progress in many fields, such as health, infrastructure, renewable energies, to mention a few. Moreover, it is considered that mathematics is key to prepare students of any gender to have access to these undergraduate programs which will be in high demand in the future, especially because they are the foundation for inclusive and fair sustainable development (Unesco, 2019).

Nonetheless, it is precisely in these areas where women have less participation, regardless of their country of origin. Worldwide, there is a trend when choosing undergraduate programs in higher education. Women are more prone to choose education, health sciences, social sciences, humanities and arts, while men will be more inclined to choose majors oriented to technology, architecture, and engineering. Thus, there are clear differences between disciplines since only very few women are present in majors related to technology, mathematics, and engineering (Unesco, 2019). In Mexico, we analyze more in depth these specificities in the matriculation in higher education and identify that the same trend holds

true for graduate programs although the percentage of women pursuing a doctoral degree in these areas decreases considerably. For example, in programs related to mathematics, women's registration diminishes by 30% (Simón, 2018).

On account of women's little participation in the STEM areas, the Unesco (2019) has paid special attention to ensure the egalitarian access to these areas for girls and women. From the gender perspective, it is considered that their participation will enrich and broaden the outlook in these areas since different perspectives add creativity, reduce potential biases, and generate more knowledge and solid solutions, all of which, according to Unesco perspective, promote scientific excellence. In addition to our loss of women's talent, it entails a great loss for society (Farfán & Simón, 2016; Unesco, 2019) and significant consequences for them, since it has been identified that women's economic, work, academic, and personal development is biased due to an androcentric culture.

The gender studies have brought to the table how such segregation is a product of the gaps that are present throughout life within the family circle, social life and, of course, within the school system, where the gender stereotypes are reproduced and lead to categorize certain professions as essentially "masculine" and others as "feminine" and that they work as determining factors when choosing a major (Aros *et al*., 2017).

The mathematics classroom stands for one of these spaces since the interactions and representations that occur in it (family and school relationships, pedagogic interventions, interactions within the classroom, the students' interests and drives, school achievement and performance) are regulated by the stereotype built over mathematics as an androcentric paradigm of knowledge (Farfán & Simón, 2016).

On account of this situation and because of other phenomena described in numerous research studies, promoting equality between women and men will allow the empowerment of the former as an integral part of the international public policies of the United Nations through the objectives for sustainable development (ONU, 2019).

Of the seventeen objectives for sustainable development, the fifth corresponds to gender equality and it has six goals, three of which correspond to the analysis made from the educational field: 1) end discrimination against women and girls; 2) promote women's empowerment through the use of instrumental technology, and 3) approve and enforce policies and laws focusing on gender equality.

Objective 4, "Quality Education," is also concerned with the goals referred to as gender equality. In addition to considering knowledge on gender equality as fundamental to promote sustainable development, it proposes eliminating gender disparities in the access to all levels of teaching and

college education and offering the physical conditions needed to attend the differences in gender within safe, non-violent, inclusive, discrimination-free, and effective learning environments.

The main theoretical lines from mathematics education in Mexico that have dealt with this problematic are the socio-epistemological and the one of social representations; both meet in a particular point: placing the learner in the center, including their cultural baggage, knowledge, history, experience, and community; in other words, their social representations.

Throughout this article, we will show how from the mathematics education we have analyzed the binomial gender and mathematics, taking as a reference the first research studies on the topic worldwide (Fennema, 1974). Indeed, we take into account the outlook from Latin America, considering the research done by Rosa María González (2010), a pioneer in dealing with these topics in Mexico and that done by research groups within our discipline that emerge from the Department of Educational Mathematics of the Center for Research and Advanced Studies of the Instituto Politécnico Nacional.

The feminist epistemology and its relationship with our standpoint

The feminist epistemology has reflected, among other things, about how gender has an influence on the methods, theories, and organizational structures of science as well as on the way in which it reproduces andro-centric patterns and social prejudice of gender, especially how gender influences the person they meet, the way in which they research, ask, and justify (Harding, 1998). To illustrate, we can mention those research studies done at the end of the 19th century and at the turn of the 20th century that assured that the form, size, and structure of a female brain made them unfit to develop certain kind of intellectual abilities, and thus, it became par for the course for them to only do house chores (Maffia, 2007). Other social and ethnic groups went through the same kind of biological biases: slaved people, black people, and jews (Museo Memoria y Tolerancia, 2020). This kind of scientific results show how social prejudice of gender —passed on by the person that knows— reflects on the object of study chosen, the methods used, the conclusions drawn, etc. In Patricia Castañeda's words, "There is no objectivity without subjectivity" when it comes to the value load that the researcher brings along as a subject of gender (Castañeda, 2016).

In this kind of analysis, it is possible to mention the first research studies done about the relationship between gender and learning of mathematics, even those that pretended to leave the biological differences aside. Within these, we can refer to the one done by David Tzuriel &

Gila Egozi in Israel (2010), who ascertained that women had some backwardness in the development of the spatial ability, as a result of the lack of spatial experiences lived by the girls outside school, but that it could be compensated with a period of remediation or training at a young age to prevent the gender differences. In other words, from our perspective, we believe that this research from an androcentric perspective disdains the skills women develop in daily activities. Other studies, such as Bethencourt & Torres (1987), drew the conclusion that the differences in mathematical achievement in standardized tests were due to the differences of gender while being raised and their social adaptation in school; furthermore, it depended on the type of mathematical task required. Even though these two studies do not attribute the gender gap to a biological factor, they do rest value to that which is traditionally feminine as a space that also allows the construction of mathematical knowledge.

On account of this kind of results, one could think that the remedy for the evil that afflicts women in regards to low academic performance is to make them feel more confident, encourage them in different ways for them to develop their joy and skills in mathematics and to bring them close to the female scientists who would be their role models as well as to reduce the obstacles that stop women from being interested in this area. Nevertheless, the feminist epistemology has also concluded that women are excluded from the spaces where knowledge is built; her epistemic authority is denied, her feminine ways and styles of knowledge are belittled, and women's interests and activities are made invisible (Blázquez, 2012).

Since the classroom is a space that promotes the construction of knowledge, these situations start coming up even at an early age (3-5 years) (Flores & Guevara, 2018) and are strengthened each step of the way throughout the educational system.

A similar phenomenon can be seen in the mathematics classroom. In its role of transmitter of a hegemonic culture, the school reproduces —in both its structure and its socializing media— the practices, beliefs, representations, and social mandates that serve for sexual difference; in other words, the attributions according to gender (Lamas, 2000) throughout the hidden curriculum. Thus, the activities that are traditionally done by women are devalued and excluded from any kind of analysis in the classroom, which diminishes importance and value when considered as contexts that could lead to the construction of knowledge. Evidence of this can be found in textbooks since it has been recorded that the activities that are prepared with women are mostly in the cases occurring within the private circles even after several analyses and interventions made. Likewise, since it is done within the contexts of knowledge production, the qualities attributed to the feminine, such as emotions, subjectivity, singularity, or narrativity are less appreciated in their epistemic value (Maffia, 2007) compared to

others such as rationality, the capacity for logic, abstraction, universalization and objectivity, all associated to the masculine and highly valued in the mathematics classroom.

Some research in educational mathematics has identified the uses of mathematical knowledge by ethnic, cultural, and economic groups whose ways of building knowledge had not been considered in the traditional curriculum (Cervantes & Reyes, 2016; Cordero *et al*., 2014; Covián & Romo 2014; Yojcom, 2013). We have not identified any research study that analyzes, from the gender perspective, the uses of mathematical knowledge in activities and professions that are traditionally developed by women.

Doing so, on one hand, would give us evidence of women's roles as constructors of mathematical knowledge, and on the other hand, it would allow us to describe how women build mathematical knowledge in spaces which are traditionally feminine.

The socio-epistemological theory has provided evidence of how from a patriarchal culture with an androcentric viewpoint (male, white, with access to private property, heterosexual, westerners, etc.), the so-called *mathematics school discourse* has been built. It is characterized for being a hegemonic and utilitarian reasoning system that lacks a reference framework; it is a discourse that imposes meanings, arguments, and procedures all of which are centered on mathematical objects and men. It privileges argumentation supported by characteristics of what is masculine; and competition in the classroom and the most valued forms of knowledge, such as mathematics, keep the structure of power from where women and other social groups are excluded (Cantoral & Soto, 2014).

What questions have we wondered about from the mathematics education perspective?

Gender studies in mathematics education in Mexico have been done from different theoretical schools for more than fifteen years. The reflections around the topic arose from empirical evidence of research studies that showed that by making a differentiation by gender, new categories for analysis emerged. The research studies done in the discipline took those works that had shed light on the gender gaps in the learning of mathematics as a primary source. By the seventies, Fennema had highlighted elements that we are still analyzing: the gender gap in the achievement and performance in the mathematics class, and how these differences increased when starting middle school (aged 12-15), the low self-concept of the female students as learners of mathematics, and the explanation of this gap attributed to sociocultural factors associated to gender (Fennema, 1974; 1979; 1990, cited in Espinosa, 2010).

More recent research studies have pointed out the differences in mathematics performance between female and male students of different levels, and they gave account of the great variety of sociocultural factors to which these differences are attributed (Eccles, 1989; Vale, 2008). Some report the factors that place female students' academic performance below that of their male classmates; for example, beliefs and conceptions (Andrews & Hatch, 2000); motivation (Middleton & Spanias, 1999); some cognitive and attitude-towards-math variables (McGraw *et al*., 2006; Pierce *et al*., 2007); and self-confidence to work on mathematics (Eccles, 1989; Jacobs *et al*., 2002). These factors were later identified in the Mexican population; however, we were pursuing the objective of advancing in the knowledge of how to face them, seeking to go deeper in the questions we were wondering about.

Pertinence of the theoretical frameworks in mathematics education

We pursue leaving evidence of the coexistence and complementarity of the theoretical frameworks that support the research studies referenced in this article. First, we will say that both the feminist theory and the social representation theory are born at the same time of social change as alternatives to hegemonic models within socio-epistemology (Arruda, 2010). Even though the socio-epistemological theory is younger, its history within mathematics education is also accompanied by the need to construct a theory characterized by understanding the phenomenon of social construction of mathematical knowledge and its institutional diffusion (Cantoral, 2013)

At a theoretical level, the socio-epistemological, the feminist, and the social representation theories have their onset at the construction of human realities from social, cultural, and historical contexts. Ontologically, the three theories understand the human being as a producer of senses and focus their analysis on the symbolic productions, meanings, language, through which human beings construct the world in which they live.

From the feminist theory, the woman's condition is a historical creation whose content is the set of circumstances, qualities and essential characteristics that define a woman as a sociocultural generic being (Lagarde, 1990).

From the social representation theory, the woman represents above all declarative knowledge that fixes its characteristics and meaning in the social contexts and by means of understanding the everyday acts since it is there where the real symbols, values, costumes, and traditions for the social group crystalize (Berger & Luckman, 1972). It is in the same everyday life where it is defined that being a woman is a generic category and at the same time the parameters of a woman within society are determined (Flores, 2001).

The socio-epistemological theory supports the idea that everybody, men and women, should be able to use and enjoy the mathematical knowledge in their lives (Cantoral, 2013); however, it has been documented that specially women have not reached the opportunity or the freedom to build mathematical knowledge or enjoyed putting it into play (Farfán & Simón, 2016). Such research seeks to characterize how the school mathematics discourse excludes women, and in this way set the keys that will contribute to strengthen them as constructors of mathematical knowledge (Simón, 2018).

In these theories, another meeting point is the method. The socio-epistemology conceives that in the construction of mathematical knowledge not only do the adaptation of theoretical explanations and empirical evidence intervene, but it also enhances the fundamental role played by the historical, cultural, and institutional stages in which the human activity develops when knowledge is produced. Therefore, different pre-existing research tools and techniques in several areas of social sciences have been useful to explain the dynamics of situated knowledge (Cantoral, 2013).

Social representations consider that the complexity of the represented phenomenon legitimizes combining approaches or theoretical perspectives that are articulated and assume different approaches that favor a more in-depth and multidimensional close-up (Rodríguez, 2009); and they allow to be constructed through symbolic elements, mainly verbal or written, endowed with meaning and social and personal sense.

In the case of the feminist theory, when talking about method and methodology, "they are often referred to viewpoints and the epistemological focus rather than to procedures and research techniques" (Kaplan, 1995, p. 89). Nevertheless, in practice, a great variety of research methods are used. In these, subjectivity has increasingly become a more sought focus of approximation in correspondence with that emerging trend in the set of human and social sciences that propose communication with all female and male actors as well as self-awareness of their own identity (Borderías, 2009). It is important to mention that a characteristic in the evolution of the research done from this viewpoint is based on re-taking women's experience as an empirical and theoretical resource, in words of Castañeda, thinking of them and organizing research in relation to them (2016). In a way, it is a criterion shared by the three theoretical approaches analyzed, since they focus on the person and on their condition as builders of mathematical knowledge.

Another element of closeness among the three theories is the vindicating essence of the subjects and the irrevocable posture for social change. In the case of feminism, both concerns drove the movement. Just as expressive and constructive of the social, the social representation is not only a means of knowledge, but it is also an instrument of action. Its particularity lies on

the possibility of deconstructing and reconstructing; thus, it becomes a methodological tool that serves as a trigger for reflection, interpretation, and change. Likewise, just as the social representations, the other two perspectives serve as a reconstructive methodology that seeks achieving more just, equitable, and egalitarian relationships.

Research development and evolution from these theoretical perspectives

Socio-epistemological theory. Democratizing learning

For the socio-epistemological theory of mathematics education (SET), the educational problem is not the apprehension of abstract objects but the democratization of learning; in other words, female and male citizens enjoy and participate in the mathematical culture rooted in their own lives (Cantoral *et al*., 2014).

From this theory, not only the environment in the classroom but also the actions of teachers and students play an important role in building knowledge, including that to be taught (mathematics); its construction; and its historical, social, and cultural uses.

Observations show that in the traditional classroom, women and other social groups (ethnic minorities, those with low economic resources, those with a disability, etc.) are excluded from the construction of mathematical knowledge for reasons different from their abilities in mathematics. From this theory, several characterizations have been given, increasingly in more detail, about the discourse lived in the classroom, which is denominated from the SET as "school mathematics discourse" and it is defined as "a reasoning system that produces symbolic violence […] that extends beyond the organization of theme contents or their declarative function in the classroom […] when setting the bases for communication to reach consensus and to build shared meanings" (Cantoral, 2013; Cantoral & Soto, 2014). Such discourse is accompanied by a form of hegemony, responsible for this phenomenon of exclusion (Cantoral & Soto, 2014). This discourse has been characterized by giving special emphasis to platonic mathematics, full of abstract objects, away from the learner's reality (Cantoral *et al*., 2006). Throughout time, this discourse has formed as an accumulation of concepts and algorithms that have to be mechanized or memorized without considering the contextual, historical or individual aspects that allow the construction of knowledge and have sidestepped the fact that mathematics responds to other human activities where the bases of natural meanings are found.

Since women still represent a minority in the STEM areas, it is worthwhile to wonder: How does the school mathematics discourse exclude women? (Simón, 2018) This is a question whose answer from the theory has been approached little by little. We will further describe the evolution of research in this regard.

Being school one of the most influential institutions in the transmission and perpetuation of gender roles, it has become one of the main aspects considered for research in the studies of socio-epistemological edge.

Our first reflections about "gender in the teaching of mathematics" focused on the learning environment, within which one of the most important elements were the female and male teachers in their role as managers of knowledge construction, by generating a space that considered each student's experience and knowledge, among other things. Several research studies have identified there are gender stereotypes promoted inside the classrooms that block women's learning (Mingo, 2006). Such is the case in Espinosa's research (2010), whose main interest was to study the interactions between students and higher education teachers in the mathematics class (Economics undergraduate program). A lot of the findings reported had already been confirmed, just not in higher education. Espinosa concluded that both, female students and teachers, considered that women's success in mathematics was the result of their effort and not their capability, which is different from the "natural ability" that both attributed to male students. For the former, the demand in the use of procedures, tools, and right answers were higher than those for male students. Espinosa also identified some differences in grading the tests of female and male students. For the former, the demands in the use of procedures, tools, and right results were higher than those for male students for whom the right answer was the only requirement. Something similar happened in the teacher-student interactions; male students received more opportunities to participate, and the only thing expected from them was the right answer; no reflection or detailed explanation was required as they were from female students. This way of promoting and evaluating the students' performance, permeated by gender stereotypes in relation to female and male's capacities, affects and blocks the development of all the student's potential. This research confirmed what other studies from the gender perspective had reported on interactions in the classroom, and it keeps appearing in more recent studies (Mingo, 2006; Ursini & Ramírez, 2014).

It was time to go further beyond; that is, analyzing the role mathematics plays in this phenomenon of exclusion by gender; a kind of exclusion that has its origins according to the attributions and associated roles for each gender. The following approach came about in a natural way while working with groups of outstanding students in a social program in several mayoralties

of Mexico City. We once again confirmed that which had already been reported in other countries about the students' attitudes and behavior (Freeman Joan, 2003; Goetz *et al*., 2008; Lee & Sriraman, 2012; Poblete, 2012). We observed that by working with science activities specially designed for the program (different from those of the traditional school), the female students who were 7-10 years of age demonstrated being motivated and interested because of the satisfaction provided by the learning experience or for trying out new things; while the 11-12-year-old girls just limited their work to the activities assigned and barely showed interest or excitement for few minutes; furthermore, their interactions with teachers and male peers were limited. These observations resulted in Simón's doctoral research (reported in Farfán & Simón, 2016), in which there was an advancement by proposing a model for the analysis of women's talent development in mathematics which considers mathematical knowledge in its relative use to the individual and their context. Such model centers on how the gender associated to the individual allows to consider a function within their social group, the way in which they relate to the practices developed within this group, and thus, the ways of building mathematical knowledge will be in function of the sociocultural attributions to their gender.

Under this perspective, they followed up a group of five students (three girls and two boys) within the mentioned program. By analyzing the performance of this group in scientific workshops and in their day-to-day, they identified that the main basis of the female reasoning lay on the problematic situation itself; in other words, it is through the observation and analysis of the elements pertaining the situation or the experiment that the female students evolve their mathematical deductions more than in the mere procedural or conceptual aspects.

López (2016) developed a research study that focused on the high school level (15-18 years of age) with the objective of studying with a gender perspective, how students perceived the concept of function. By means of a survey and semi-structured interviews, it was analyzed how the concept of function is perceived through the use of inequalities and their two main representations, graphic and algebraic.

One of the findings was that female students prefer graphs and that their arguments are different from those of male students. According to the work done by the Modelling-Chart Making group in which it is ascertained that the graphic precedes the function, since graph making conforms the building elements for the development of variational ideas (Buendía, 2012), we concluded that the gender differences in mathematics performance could be strongly related to women's preferences of functional mathematical knowledge that integrates the uses and meanings of a mathematical object in a specific situation (Cordero *et al*., 2015), more than in the sense of achievement or competition, which are characteristics attributed to male students.

In the two studies done by Carranza (2016; 2019) with a population that has solid education in abstract mathematics (Physics and Mathematics undergraduate programs), it was identified a phenomenon called *stereotype confirmation* (Steele, 1997). This means that belonging to a group which has been identified with a negative stereotype can lessen the academic performance, and it is confirmed by the strong reluctance to participate in class or discuss results; showing little value and trust in their own mathematical abilities.

One of the most recent research studies analyzes the development of women's mathematical thought at the cognitive level (Farfán & Ortiz, 2019), and it is a by-product of the critique to results of numerous works in the seventies and eighties that affirm the existence of differences between women and men in spatial reasoning (Spelke, 2005). Such results come mostly from standardized tests that point out the differences by sex, since women present a lower development of spatial reasoning compared with that of men. The researchers concluded that the traditionally used standardized tests presented a limited outlook of spatial reasoning and proposed a hypothetical trajectory that allows to re-signify their role when it is sought to value spatial reasoning in both men and women.

Social, mathematical, and gender representations

In regards to mathematics, gender and social representations, the gender differences have been approached in different aspects of school mathematics in grade school (female and male students, 6-15 years of age). Flores' work (2007), which analyzes the gender social representations of the mathematics faculty in regards to their students' learning, shows that the expectations and beliefs of female and male teachers have an influence on the pedagogical interactions set with the students in the everyday life in the classroom, and thus, condition the women's mathematics learning. The work highlights the relations of power, the kind of language, the attention span, the number and kind of questions towards female and male students. The combination of all these elements benefits the mathematical learning of male students, but excludes female students.

Ursini's longitudinal research (2010) analyzes the gender differences in the social representation of mathematics learning. In the study are shown the changes in students' attitudes towards mathematics when they are in middle school. The statistical analysis reveals that female students have a more negative attitude towards the courses in comparison with male students. The author's theoretical framework reveals that the attitudes are a sociocultural construct highlighting the gender differences in relation to their intellectual, cognitive and behavioral capabilities to be successful in mathematics; in other words, stereotypes are strengthened. While male students are

oriented by the social consensus to develop more aptitude, female students face the social representation of having less intellectual capability, and thus, they conclude they need to be more focused and obedient, and make a greater effort to reach positive or equivalent results. This is how gender stereotypes are intertwined with self-perception, printing a gender bias in the learning processes; and it is only through deconstruction and reconstruction that these socially imposed stereotypes can be overcome.

Mosquera & González (2015) pose as the main concern the social representation of gender contained in the mathematics textbooks used in school. Such representations contribute to reproduce, reflect, and strengthen conceptions that go around these gender inequalities. Their work acknowledges the impact of textbooks as learning tools, since their contents have an influence on legitimizing the social representations of gender that build up in the present and future generations that go through the school system. The authors report three gender representations: a) androcentricity (masculine prominence in the analyzed school textbooks); b) separate environments, public and private space (tendency to differentiate stages, characteristics, and roles according to sex, attributing what is public to male students and what is private to female students); and c) gender stereotypes (referred to the resources used to illustrate people with the tendency to differentiate men and women.) This study recommends illustrating books bearing in mind the presence of humankind in its diversity and in conditions of equality with the end of reflecting a society with equal opportunities for women and for men.

In a study with elementary school teachers, Rodríguez & Ursini (2008) proposed identifying the gender differences in the social representation of the teaching staff in regards to teaching mathematics with a multimedia resource. Thirty teachers participated (22 female teachers and 8 male teachers), and they used multi-methodology. Almost all of the teachers used the resource in an ongoing fashion and declared having good command of it. However, classroom auditing of its use revealed contradictions in this discourse. Only the female teachers acknowledged the need of teacher training to handle this resource. The female teachers showed solidarity when exploring and sharing their findings with colleagues. These last two results and our work in "professional teacher training" have led us to think about the need to analyze how the characteristics of these female teachers allowed them to be more flexible to reflect on their teaching practice.

From the feminist theory and the social representation theory, Rodríguez & Ursini (2014) analyze the relationship between the gender identity processes, the representational construction of mathematics, and the successful performance of female students in this course, using a qualitative and interpretive methodology, combining techniques used in anthropology and social psychology. Twenty elementary school students were followed

up during three school years. Data triangulation allows to describe the gender identities that favor the construction of social representations of school mathematics that characterize the female students with successful performance. Throughout time, positive changes were seen in some students when building up an awareness of being women and being mathematics learners, in addition to being better prepared to face the math assignments. By analyzing the in-depth interviews, this study shows evidence of the elements that clear the construction of generic identities. The most successful female students of mathematics are those who are raised in environments where gender equality is promoted more frequently and in families that foster the development of abilities, knowledge, capabilities, values, and affection in the same way for women and for men.

These research studies invite us to open up the possibilities in face of the emerging categories and gender constructions, not with the intention of promoting pigeonholes to categorize people, but to acknowledge and enable human diversity without hierarchies.

From our theoretical position, we consider that the studies about differences do not give us the elements for an intervention at the public policy level nor instruments to build ad hoc designs that enable us to have interventions in the classroom. We moved from centeredness and we are interested in systematizing and make visible all the ways of feminine construction that will give us a hypothesis for the redesign of the school mathematics discourse.

Research prospective: where recent findings point at

From the perspective of the presented theories, it is worthwhile to wonder: How does a woman think about mathematics? We have no answer for the time being, but we can assure that because her culture, knowledge, and history have been disrupted by the social attributions made to her gender, the way in which a woman thinks about mathematics cannot have the same bases as that of a man's. The same situation can be present in each individual in the classroom; their history, their culture, the knowledge of their community, their experiences and their social representations will be specific to each one. However, there are things that are shared and can be considered when it is sought to intervene in the classroom.

The results bring about another matter of concern: Is it possible to consider the design of a learning situation with gender perspective? Research studies based on the theory of social representations have allowed to show evidence of the advantage of building didactic environments where the female students can legitimize their identity as mathematical communicators; this condition modifies their participation, self-concept,

and self-confidence as learners (Rodríguez & Ursini, 2014). Other findings allowed us to identify that the learning situations proposed from the social epistemology led women to participate with more motivation and interest in the mathematical activity when they were valued and when their experience, arguments, and reasoning were included as part of the knowledge construction (Farfán & Simón, 2016; Carranza, 2019). By then, it seemed that our problem had been solved; however, the analysis and putting into practice our designs have taken us to identify that more research is needed about how the school mathematics discourse leaves women out.

We believe that the next step is to increase the value of what is feminine, in such a way that the female students can bring to the game their experiences and arguments when working on mathematics; and at the same time that what is traditionally feminine can be valued by providing contexts that allow construction of knowledge. We need in-depth research about how to create learning environments that are inclusive, egalitarian, and fair to our girls at a very early age. We also need broader knowledge about how women put into play their mathematical knowledge, how it was done in the past and how it is done at present, inside and outside the classroom, in everyday and in crafted activities. This way, we will have more elements to consider when the activities are designed to participate in the classroom.

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