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STEM EDUCATION AND GENDER: A CONTRIBUTION TO DISCUSSIONS IN BRAZIL

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Abstract

This article presents reflections on gender equality in secondary education, particularly regarding the inclusion of female youths in the areas of science, technology, engineering and mathematics (STEM). Our empirical source for these reflections was a review of studies indexed in the Education Resources Information Center (ERIC) database. Using the concept of gender as part of the analysis of women's access to these areas, 55 articles were selected and divided into four groups. Considering that, in recent years, Brazil has launched several initiatives to promote women's access to exact science programs, learning about research in other countries may contribute to a critical reflection on how gender inequality may be addressed.

GENDER • EXACT SCIENCES • HIGH SCHOOL • STEM

A EDUCAÇÃO STEM E GÊNERO: UMA CONTRIBUIÇÃO PARA O DEBATE BRASILEIRO

Resumo

Este artigo apresenta reflexões sobre a igualdade de gênero no ensino secundário, em especial no tocante à inclusão das jovens nas áreas de ciências, tecnologia, engenharias e matemática (STEM), tomando como fonte empírica um levantamento da produção acadêmico-científica realizada na base de dados Education Resources Information Center (ERIC). Tendo o conceito de gênero como um componente de análise do acesso das mulheres a essas áreas, foram selecionados 55 artigos e divididos em quatro agrupamentos. Considerando que, nos anos recentes, o Brasil tem apresentado diversas iniciativas que incentivam o acesso das mulheres às áreas das exatas, conhecer os estudos internacionais pode contribuir para uma reflexão crítica acerca de como a desigualdade de gênero pode ser enfrentada.

GÊNERO • CIÊNCIAS EXATAS • ENSINO MÉDIO • STEM

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ÉDUCATION STEM ET GENRE: UNE CONTRIBUTION AU DÉBAT BRÉSILIEN

Résumé

Cet article présente quelques réflexions sur l'égalité de genre dans l'enseignement secondaire, concernant plus particulièrement l'inclusion des jeunes dans les domaines de la science, technologie, ingénierie et mathématiques (STEM) à partir de l'examen des études sur la production académique et scientifique de la base de données Education Resources Information Center (ERIC). L'analyse de l'accès des femmes au domaine des sciences exactes appuyée sur le concept de genre a repertorié 55 articles subdivisés en quatre groupes. Considérant que, ces dernières années, le Brésil a mis en place diverses initiatives qui favorisent l'accès des femmes aux sciences exactes, les études internationales auront un apport important à une réflexion critique sur comment faire face aux inégalités de genre.

GENRE • SCIENCES EXACTES • LYCÉE • STEM

LA EDUCACIÓN STEM Y EL GÉNERO: UNA CONTRIBUCIÓN PARA EL DEBATE BRASILEÑO

Resumen

Este artículo presenta reflexiones sobre la igualdad de género en la educación secundaria, sobre todo en lo que se refiere a la inclusión de las jóvenes en las áreas de ciencias, tecnología, ingeniería y matemáticas (STEM), tomando como fuente empírica un relevamiento de la producción académico-científica realizada en la base de datos Education Resources Information Center (ERIC). Con el concepto de género como un componente del análisis de acceso de las mujeres a estas áreas, se seleccionaron 55 artículos que se dividieron en cuatro grupos. Considerando que, en años recientes, Brasil ha presentado diversas iniciativas que incentivan el acceso de las mujeres a las áreas de exactas, conocer los estudios internacionales puede contribuir para una reflexión crítica acerca de cómo la desigualdad de género se puede enfrentar.

GÉNERO • CIENCIAS EXACTAS • ENSEÑANZA MEDIA • STEM

BRAZILIAN WOMEN'S UNEQUAL ACCESS TO DIFFERENT PROFESSIONAL AND KNOWLEDGE

development areas has been the subject matter of studies in the sociology of work for many years (LOMBARDI, 2017; ABREU; HIRATA; LOMBARDI, 2016; RICOLDI; ARTES, 2016; ITABORAÍ; RICOLDI, 2016; CARVALHO; RABAY, 2013; COSTA *et al.*, 2008; BRUSCHINI, 2007; HIRATA; SEGNINI, 2007, among others). In general, these studies approach the issue by reviewing the process of inclusion of adult women into the job market with a focus on pay gaps, unequal occupation of leadership and decision-making roles, underrepresentation in certain professions and how these facts relate with the historical and cultural expectations for the usual social roles of men and women in Western societies.

A relevant research question has been attracting more and more interest, particularly in the education area: what are the factors driving women's career choice processes during their education trajectory? The study "*Elas nas Ciências: um estudo sobre equidade de gênero no ensino médio*" [Women in Science; A Study on Gender Equality in Secondary Education], conducted from 2016 to 2017,¹ mapped data related to the issue both in Brazil and around the world, particularly in the United States, due to the influence that the term "STEM" (Science Technology Engineering and Mathematics) was perceived to exert in the Brazilian context.

1 A Carlos Chagas Foundation study, it was led by Sandra Unbehaum and investigated 10 secondary education schools in the municipality of São Paulo. The study received funds from the Unibanco Institute.

Although comparisons with Brazil are inevitable, they must be carefully considered as they involve two different educational systems with different needs and priorities. However, such comparisons are necessary since Brazil has launched a number of initiatives (including awards) in order to promote women's access to exact science programs. Initially, these actions focused on higher education and the access to the labor market, but from the early 2010's there also emerged initiatives aimed at children and adolescents.

Thus, the present article aims to discuss and share an analysis of the review we conducted in the Education Resources Information Center (ERIC) database for the period from 2001 to 2015, the latter being the year before that of "*Elas nas Ciências*". Bibliographic reviews like the present one can provide further insights into a given area by revealing theoretical and methodological dispositions within it, as well as its trends and gaps (VOSGERAU; ROMANOWSKI, 2014).

Our intended contribution consists in approaching from a gender-based perspective our review of papers in the ERIC database. When feminist scientists criticized the degree of access that women had, as well as the limitations faced in occupying positions and contributing to science and technology, they were calling for a more equitable attitude in the scientific field, which would necessarily include the denaturalization of hierarchies and inequalities found both in research and in common sense (SENKEVIC; POLIDORO, 2012).

One hypothesis associates the social representation of that situation, experienced by several women in the field of exact sciences and technology, with their small engagement in careers in these areas. Indeed, by examining data on women's engagement in knowledge areas and considering the proportion of genders in careers and higher education programs, one can see a concentration of women in the fields of education (pedagogy) and health care (nursing and primary care), both of which are related with care. This phenomenon has been observed worldwide, even though relevant change can be seen – e.g., women's increasing presence in areas where male predominance was previously the norm, such as law, medicine, engineering and other prestigious ones such as exact sciences and technology. In Brazil, Arlene Ricoldi and Amélia Artes (2016) conducted a study on professional prestige contexts from a gender perspective, where they highlight that women's good performance in basic and even higher education was not found when it came to their choosing a higher education program or in their later professional trajectory.

The recognition of a context of inequality regarding the presence of women in the exact science and technology programs has fostered, since the 2000's, several initiatives by governments, companies and civil society organizations² to promote women's inclusion into exact science programs, particularly in Science, Technology, Engineering and Mathematics, also known as STEM areas. However,

2 CNPq's "*Mulher e Ciência*" [Women and Science] program, L'Oréal's Women in Science Awards and the Project *Elas nas Exatas* [Women in Exact Sciences] - this last being a partnership between the Unibanco Institute, the ELAS Investment Social Fund and the Carlos Chagas Foundation - are a few examples of initiatives carried out in the past few years in the country.

it is worth noting that this acronym is related to an U.S. educational policy designed to respond to American students' poor academic achievement in these knowledge areas and to the country's loss of international competitiveness in them. One of the strategies proposed was to promote an increase in the number of students from underrepresented groups in higher education programs in the STEM fields. Not for no reason are girls focused on by several programs, policies and studies. The *ABC of Gender Equality in Education: Aptitude, Behavior, Confidence* (ORGANIZATION FOR ECONOMIC COOPERATION AND DEVELOPMENT – OECD, 2015) shows that, among OECD member countries, less than 5% of girls intend to pursue a career in engineering or computer science. On average, the number of boys hoping to find a job in engineering or computer science in OECD countries is nearly four times that of girls with the same expectation.

The concept of gender (SCOTT, 1995) is understood here as an analytical component to think about women's unequal access to these areas, and to seek strategies to make situation this situation evident:

[...] historically specific knowledge about sexual difference allows feminists to forge a double-edged analytic tool that offers a way to generate new knowledge about women and sexual difference and to inspire critical challenges to the politics of history, or for that matter, any other discipline. (SCOTT, 1994, p. 25)

Thus, our review of foreign academic-scientific output concerning gender equality in secondary education³ in the ERIC database, particularly regarding the inclusion of female youths in the science, mathematics, technology and other similar areas, motivates a critical reading of it that can contribute to developing specific strategies for the Brazilian context.

THE OUTSET OF THE STEM POLICY IN EDUCATION

Reaffirming and strengthening America's role as the world's engine of scientific discovery and technological innovation is essential to meeting the challenges of this century. That's why I am committed to making the improvement of STEM education over the next decade a national priority.

Excerpt of the speech of President Barack Obama on 23/11/2009.⁴

³ Secondary education is the known as "Ensino Médio" in Brazil.

⁴ President Obama Kicks Off "Educate to Innovate". The Obama White House YouTube channel. Available at: https://www.youtube.com/watch?v=33_nZaOUWYw&t=13s. Accessed on: 04/04/2016.

With these words, the then president Barack Obama launched the *Educate to Innovate* campaign. This initiative was driven by American students' poor academic achievement in these knowledge areas and by the country's loss of international competitiveness in them. More specifically, the campaign established the investment of billions of dollars in STEM-specific educational projects in American schools. According to Gonzalez and Kuenzi (2012), the recent concerns with American population's technological and scientific literacy concentrate in the relationship between STEM education, prosperity and the U.S. power in the global arena. According to the authors, since World War II the United States have benefited from the military and economic progress ensured by a STEM-qualified workforce. Today, however, science and technology skills represent social and economic benefits that are critical to economic growth in the 21st century. In this respect, the educational system is the main provider of labor for these knowledge areas. Many advisory reports to the American government have been made which include recommendations for improving STEM education. In 2013, a White House office issued the *Five-year Strategic Plan for STEM Education* (UNITED STATES OF AMERICA, 2013), which emphasizes the importance of investing in that type of education considering the increasing demand for STEM-skilled professionals to work within or without the science, technology, engineering and mathematics fields. The shortage of professionals with degrees in these areas in the next few years is estimated to be at least one million.

Therefore, the document stressed the urgent need to concentrate efforts in primary and higher education, setting five priority areas for federal investments: STEM teacher education; encouraging students to engage in STEM subjects during basic education; access to STEM higher education programs; and increasing the number of students from underrepresented groups in STEM higher education programs.

Thus, women are included as one of the most underrepresented groups in these areas, despite accounting for one half of the population. Beede *et al.* (2011) cite information from the United States Department of Commerce to list some statistics as evidence of this reality. American women hold only 25% of STEM jobs, with wages approximately 33% higher than those of women working in other areas. The wage difference between men and women in STEM professions is lower than in other areas. However, fewer women graduate in STEM higher education programs, particularly engineering.

Another important fact is that women with a STEM degree are less likely to work in the areas they graduated in than men; many of them, like in Brazil, end up working in education or health-related jobs. Beede *et al.* (2011) mention factors that can explain the difference between men and women in the STEM job market, among which are gender stereotypes, the lack of female models in these areas and less flexible jobs that tend to limit the hiring of women in STEM professions.

But what is it that characterizes a STEM education? What are its principles, contents and methodologies? According to Gonzalez and Kuenzi (2012, p. 1), STEM education refers to

[...] teaching and learning in the fields of science, technology, engineering and mathematics [...] including educational activities across all grade levels, from pre-school to post-doctorate, and in both formal and informal classroom settings.

According to Laird, Alt and Wu (2009), STEM education in secondary education basically comprises advanced elective subjects – i.e., subjects that delve further into the mathematics and science contents found in the regular syllabus in addition to offering opportunities to study engineering and technology.

Most of the papers selected by our survey say that female secondary students are a minority among those who choose to prioritize STEM subjects, usually preferring other knowledge areas. This certainly makes them less likely to choose STEM areas as a priority in higher education, which further reduces their chances of pursuing careers in science, technology, engineering and mathematics.

METHODOLOGICAL PROCEDURES OF THE SURVEY

Our survey was conducted in the ERIC database, particularly with articles on STEM education and its intersection with gender and secondary education students.⁵ It is worth highlighting that this database comprehends a vast range of studies addressing specific subjects – such as mathematics, science, chemistry, physics, biology – with a focus on gender in primary education. Our purpose, however, was to explore those studies related to the keywords STEM, gender and education.

The search initially targeted articles in periodicals with the approval of reviewers and used the acronym *STEM* as the keyword, thus returning a total of 3,455 articles. Then, the descriptor *STEM Education* was applied, which reduced the number of articles to 1,598 (for the 1997-2016 period). Out of that total,⁶ 806 articles (approximately 50%) addressed STEM education in higher education; 404 (approximately 26%) focused on secondary education; and 388 (approximately 24%) were related to the other educational levels, i.e., early childhood, primary and initial years of secondary education, among others. Therefore, the first finding of our survey is the growth of investigative interest in studies on STEM education as the educational level increases, the greatest numbers corresponding

⁵ It is worth noting that, in the American educational system, *secondary education* may include grades of the previous education level, which are known as *middle school* or *junior-high school*, according to criteria adopted in each state.

⁶ Numbers updated on 30/06/2016.

to higher education, which accounts for about 50% of the academic output on the subject.

Directing the search to the intersection between STEM education and the terms ‘gender’ or ‘women’ – for all educational levels – the descriptor ‘gender differences’ was applied to these 1,598 articles, thus returning 191 articles, which corresponds to 12% of the total. When ‘gender differences’ was substituted by ‘females’,⁷ the number dropped to 167 articles, i.e., 10.5% of the total. By applying the filter with both descriptors – ‘gender differences’ and ‘females’ – the number of papers found was 55, i.e., 3.4% of the total. Therefore, the second finding of the survey is the small number of papers addressing gender and women compared to the total number of papers on STEM education.

Then, we searched for other intersections involving papers in the education area by using, in the one hand, the keywords ‘STEM’, ‘gender’ and ‘women’, and in the other, the various educational levels. First of all, of the 191 articles listed under *STEM Education + gender differences*, 59% focused on higher education; 29% on secondary education; and 12% focused on the other levels. For the *STEM Education + females* combination, 55% of the academic output (167 articles) focused on higher education; 28% on secondary education; and 17% addressed the other levels. Of the 55 articles obtained with the combination *STEM Education + gender differences + females*, 64% were about higher education, 31% about secondary education, and 5% about the other levels.

Therefore, the third significant finding of this mapping – the result of cross-referencing between descriptors and education levels – is the prevalence of studies on STEM education – at the intersection with gender differences or women – focusing on higher education. Secondary education represents less than half of the number of papers focusing on higher education. The other education levels for the same combination of descriptors appear in small number of papers. Once this scenario was outlined, we selected articles that met the following criteria: focusing on STEM education in secondary education and from a gender-based perspective.

After the selection, we read the abstracts of the 55 journal articles returned from the combination of STEM education, gender differences and secondary education in the database. The articles related to teachers, family, as well as other actors than the students themselves, were excluded. We also excluded some the studies that actually addressed other education levels though they had been indexed as dealing with secondary education in the database. However, studies using age as a criterion – rather than educational level – were maintained in the selection provided they somehow included secondary education.

After these searches, the number of articles having decreased to 39, further searching was conducted with new terms and key words: *gender gap*, *girls*,

⁷ We used the term ‘females’ because ERIC database descriptors are pre-defined, and ‘females’ was the term that best directed the search towards the field of gender; until the time this text was written, there were no other similar tags such as ‘girl’ or ‘woman’.

high school, high school students, SMET,⁸ among others, leading to new abstracts which were read, added to or discarded from the selection. After extensive reading of the abstracts, we concluded our survey with a total of 55 articles published from 2001 to 2015, which were entered into a database for crossing information.

CHARACTERISTICS OF THE SELECTED ARTICLES

Of the 55 articles selected – which addressed STEM education intersecting with gender and secondary education – only 12 had their full texts in the ERIC database. The 55 articles were published in 47 different journals, which shows these themes are scattered, not forming a scientific output with some concentration in specific journals.

Of these 47 journals, 43 specialize in education or other areas like science, technology, engineering or mathematics in the educational context. The other four are dedicated to the fields of technology, science, engineering, youth and adolescence, and career assessment.

Of these, 16 have the descriptor ‘foreign countries’, which could indicate they publish empirical research conducted in other countries than the United States or articles written by foreign authors at universities in other countries who publish in journals indexed in the ERIC database.

Generally speaking, the academic output on STEM education – in its intersection with gender, women and secondary education – began to grow after the then president Barack Obama launched the *Educate to Innovate* campaign in late 2009, when he announced billion-dollar investments to prioritize education in science, technology, engineering and mathematics. The output for the 2001-2010 period had only seven articles, whereas during the 2011-2015 period, that number increased to 49 articles.

Once the quantitative output data were mapped, the next stage was to understand the themes addressed by the selected articles in order to divide them into categories. To that end, the articles’ abstracts were extensively read to capture the similarities between themes that pointed in the same direction. After reading and comparing the information found in the abstracts, the articles were classified in four categories as listed in Table 1 below.

8 SMET (*Science, Mathematics, Engineering and Technology*) was the acronym most commonly used for that set of subjects until the 1990’s (WHITE, 2014).

TABLE 1
SELECTED ARTICLES - DISTRIBUTION BY THEMATIC AREA

NO.	THEMATIC AREAS	QTY.
1	Predictive and psychosocial factors associated to secondary education students' performance and interest in STEM higher education subjects and programs, as well as STEM careers, considering the focus on student gender and other variables.	26
2	Programs, initiatives, and partnerships for increasing secondary education students' interest on STEM subjects and STEM-related careers.	13
3	Analysis of statistical and historical data or standardized assessments related to STEM subjects, considering the focus on student gender and other variables.	10
4	Initiatives for increasing interest in STEM subjects and STEM-related careers among secondary education students, with focus on student gender.	6
	Total	55

Source: Authors' elaboration.

The thematic areas (Table 1) were defined based on the themes that emerged conspicuously during the abstract reading phase within the broader context of the survey, though other classifications might also have been possible. The thematic areas defined allow seeing clearly the work, approaches and purposes guiding academic-scientific research on STEM education with focus on student gender and secondary education in the ERIC database.

AN OVERVIEW OF THE STUDIES IN THE SELECTED ARTICLES BY THEMATIC AREA

One finding that stands out in the set of articles is the prevalence of quantitative studies (approximately 70% of the total), with a small number of qualitative studies (20%) and an even smaller number of studies combining both approaches (5%). Approximately 5% of the abstracts are not clear about the methodology adopted or do not mention it at all. The quantitative studies are based on international, national, state or regional data from standardized educational assessments, as well as statistical data provided by education departments at all government levels. As to the qualitative studies, half of these describe programs for fostering STEM subjects in schools; three of them use interviews, content analysis or student focus groups; all the others present reflections on curricula or educational policy for STEM fields – mainly on forms of attracting girls into these areas.

Thematic Area 1: Predictive and psychosocial factors associated to secondary education students' performance and interest in STEM higher education subjects and

programs, as well as STEM careers, considering the focus on student gender and other variables.

This is the largest among the four thematic areas defined, with 26 articles so classified which seek to understand the factors driving students' choice for elective disciplines during secondary education, as well as their professional interests – mainly in STEM fields. The articles examine how students' choices can be influenced by a number of variables such as school context, students' learning experiences, interests, expectations, student performance history in STEM disciplines, family and teacher support, role models, participation in extracurricular activities related to science, technology, engineering and mathematics, among other factors. All articles have a gender-related perspective, with some also including a race/ethnic-based perspective and the influence of socio-economic factors.

Some researchers use concepts from cognitive psychology like self-concept, self-effectiveness, self-assessment and self-esteem to understand to what extent these concepts are important for educational and professional decision making. These articles evaluate the weight of parent and teacher support, the obstacles perceived, the expectations in relation to professional careers, awareness of gender inequalities or proximity to feminist ideals, participation in activities and events related to STEM subjects, learning methods, and the importance of school culture.

Legewie and DiPrete (2014) examined the role of school context in students' decision to choose STEM elective subjects and found that the most widespread hegemonic beliefs on gender can manifest in different ways among schools. Thus, students' decision to enroll in any subject – considering the aspect of gender – would be affected by each school's local context. According to the authors, the schools that are more successful in attracting young students to STEM subjects are also able to reduce gender differences by at least 25%, which allows possibilities of interventions by public policy.

Using latent growth curve analysis and country-level longitudinal studies, Ing (2014) compares the differences in the relationship between external factors (perceived parent support), student performance history in mathematics and science, and persistence in STEM careers by gender. The author concludes that successful educational trajectories in mathematics and science are related to students' interest in STEM careers, both for men and women. The study's results, the author says, show a difference in the relationship between perceived parent support, performance and persistence in STEM careers, depending on the discipline and on gender.

Gottfried and Williams (2013) evaluate how students' participation in math clubs can affect their performance in mathematics, and how participation in science clubs can affect students' performance in science. The authors use data from the *National Longitudinal Study of Adolescent Health* to examine this relationship and conclude that engaging in math and science clubs can actually

impact students' academic success, as well as their persistence in STEM fields. However, the researchers emphasize that although data do not evidence gender or race/ethnic differences, they show more clearly poverty-related differences and an interaction between poverty and race/ethnic group.

Riegle-Crumb *et al.* (2012) investigate the empirical basis for often-repeated arguments that gender differences in entrance into STEM majors can be explained by differences in students' performance history. Using data from higher education enrollment records across three decades – in addition to various indicators of achievement in mathematics and science in secondary education – the authors conclude that regardless of how prior performance is assessed, it does not explain the gender gap in physical sciences and engineering over time, thus indicating the limitations of theories that focus on gender differences in acquiring and developing skills.

You (2013) used data from the 2002 Longitudinal Educational Study to advance understanding of gender and race/ethnicity differences regarding students' decision to enroll in advanced math courses in secondary education. Results show that the relationship between exploratory factors (both individual and at school level) and the decision to enroll in advanced math courses and start professional careers in STEM fields differs according to race/ethnicity and gender.

Riegle-Crumb and Moore (2013) conducted yet another study on gender inequality, this time in an upper-level high school engineering course offered by secondary schools in Texas. They found that females were a minority among the students enrolled in the program, corresponding to only 14% of the total. A questionnaire administered in the beginning of the school year showed perceptions about the engineering context, with females revealing lower interest in, lower intrinsic value for and lower confidence in their own skills in relation to the course. In addition, they described the classroom as non-inclusive and considered the engineering area as not very progressive. A questionnaire administered by the end of the school year did not show change in these opinions during the course. The authors suggest that the efforts to increase the representation of women in engineering should consider not only the obstacles to attracting high school girls into the career, but also develop actions to mitigate gender stereotypes related to engineering in the classroom.

Using hierarchical regression analysis, Cooper and Heavenlo (2013) analyzed the extent to which primary and secondary school girls' interest and confidence in problem solving and creativity/design can be predictors of their interest in the four STEM fields. Results show that there is a relationship between the girls' interest in solving problems and the four STEM fields, while their interest in creativity/design was a positive predictor for interest in computer science and engineering, but negative for interest in science.

Bottia *et al.* (2015) analyzed how inspiring and positive learning experiences with STEM subjects during secondary education can help explain differences in choosing STEM subjects as a college major, with a focus on gender and race/ethnicity. A quantitative analysis crossed data for secondary school graduates in

North Carolina who matriculated at the North Carolina University and showed that inspiring, positive experiences with STEM subjects during secondary education interacted with demographic variables to moderate students' interest in STEM fields.

Guo *et al.* (2015) explore individual and gender differences in students' entrance into higher education programs and in the educational paths chosen (e.g., in the STEM fields). The study was conducted with a country-level longitudinal sample of 10,370 15-year-old Australian students. One of the results suggests that self-concept and intrinsic value in mathematics interact to define the choice for advanced mathematics in secondary education, entrance into higher education and into STEM fields.

Armoni and Gal-Ezer (2014) studied the relationship between exposure to computer science during secondary education and the choice for this area in higher education, in addition to examining the gender gap in computer science in secondary education in Israel. The authors show that students who took tests in computer science were more likely to choose that field in higher education. Secondary school girls' exposure to science to secondary school had a more relative impact on their choice for that area in higher education.

Buschor *et al.* (2014a) analyzed the career choice processes of students who chose careers that were not traditional for their gender in the transition from secondary to higher education. Based on a longitudinal study, the authors conducted a qualitative survey with 11 female students in STEM programs and 13 male students who chose teacher education programs in order to analyze their perceptions on their own career choice process. The students reported that family and teachers had supported them. The females showed a strong sense of identity as future scientists, without mentioning specific career goals. The males, on the other hand, mentioned the importance of job security, emphasizing the importance of professional role models for their decision. The females emphasized the feeling of being the only women in a male world, while the males underlined the role of masculinity in the classroom.

Koul, Lerdpornkulrat and Chantara (2011) pointed out that the motivational orientation can be a predictor for a number of educational decisions, such as choosing subjects and careers. The researchers conducted a survey with 1,423 students of both sexes at a secondary math and science school in Thailand in order to investigate the relationship between motivation (goals and levels of anxiety in physics and biology classes) and their aspirations to highly paid careers in science and mathematics. Results show the existence of motivational factors that can influence professional choices, as well as the importance of cultural beliefs regarding gender in choosing a career.

Fletcher Jr.'s study (2012) aimed to predict secondary students' professional choices according to demographic variables and student curricular history. The results show that graduates at vocational high schools were 2.7 times more likely to choose careers in the STEM areas, while those who attended

college-preparatory courses were 1.8 times more likely to choose areas related to business administration and commerce.

In their study, Buschor *et al.* (2014b) sought to check whether Swiss young female secondary graduates who intended to study science, technology, engineering and mathematics actually enrolled in higher education programs in those fields two years later, and how these young females perceived this process retrospectively. According to the authors, these young women persevered with their STEM careers. Compared to students who chose the humanities and social science areas, the STEM students had greater competence in mathematics and were interested in careers in research. In a qualitative analysis, the authors say that the key factors for these females' choosing STEM areas were their learning experiences, parent support and role models. The authors also stress that they had begun to develop a scientist identity since childhood.

Leaper, Farkas and Brown (2012) examined social factors (such as family and peer support) and personal factors (such as gender awareness and exposure to feminism) that can affect the motivation of girls aged 13 to 18 years in different racial and ethnical contexts in relation to STEM subjects (in this case, mathematics and science) compared with non-STEM subjects (in this case, English) to conclude that such factors have an influence on the interest of girls in specific knowledge areas.

Based on the finding that family has a great influence on their children's academic motivation and professional choices, Rozek *et al.* (2015) studied the result of an intervention conducted to inform parents of STEM subjects' importance and potentials so they might influence their children's motivation for and interest in these subjects. One of the conclusions was that parents who participated in the intervention were more successful in encouraging interest in STEM areas for female children with a higher academic achievement and for male children with a lower academic achievement. The intervention, however, did not help female children with a lower academic achievement.

Based on the value-expectancy model, Simpkins, Price and Garcia (2015) examined whether some parental behaviors could be predictors of students' ability self-concepts in and the value they placed on biology, chemistry and physics, particularly for Latino students. Caucasian boys reported greater parental influence compared with Latino boys and Latina and Caucasian girls. Latina girls reported a smaller parental influence in that respect. The authors concluded that positive parental influence is decisive for the studied adolescents' abilities in and the importance they attribute to these subjects.

Grossman and Porche (2014) studied the perceptions and experiences of 1,024 urban adolescents about racial/ethnical and gender obstacles to succeeding in STEM areas. The analysis showed that the most ambitious aspirations to science-related careers indicated a greater support perceived by girls and women in this field. In their analysis of the interviews, the authors showed that while there were micro-aggressions related to gender and race/ethnic group, the adolescents'

perceptions of these micro-aggressions varied, and they were generally optimistic about overcoming those barriers.

Using social cognitive theory, Sahin, Gulacar and Stuessy (2015) investigated the perceptions of secondary students on factors that are relevant to their career choices, as well as whether participating in a Science Olympiad had any impact on their interests and skills for the 21st century. The study analyzed questionnaires completed by 172 students from 31 different countries who participated in the Olympiad and showed that the students recognized the influence of their teachers and parents, in addition to their own personal interests. The students also believed that their participation in the Science Olympiad both reinforced their plans to choose STEM subjects in higher education and helped them enhance important skills for the 21st century.

Iskander *et al.* (2013) carried out a longitudinal study to analyze student interest patterns over a 30-year period with a focus on gender discrepancies in STEM areas, using data related to academic achievement, gender, intended college major, career plans, among others. Among results, the authors found a discrepancy between male and female students who were interested in engineering as a major in college or as a career. The emergence of the dot-com era seems to have aroused the interests of both sexes in technology, though according to data, computer games have primarily attracted male students. By crossing data for achievement and interest, the study shows that among the students expressing an interest in engineering as a career, many lacked enough preparation for it. Data show that the female students who expressed an interest in engineering were generally in the category of well-prepared students. The number of students interested in but unprepared for a career in engineering is greater among males than females. In their conclusion, the authors underline the importance for interventions in raising students' interest in STEM areas to start early in the schooling process.

The article published by Zimmerman *et al.* (2011) deals with a school that has been successful in motivating Latino students to choose computer science as their main field of study. Using performance criteria – among several other sources of data – the authors analyzed eleventh to twelfth-grade Latino students to determine the factors affecting their choice for computer science.

Masnack *et al.* (2010) asked secondary and college level students to evaluate the similarities and differences between pairs of occupations. The researchers concluded that participants of different ages and sexes evaluated scientific careers as less attractive and less interpersonal relationship-oriented than other career options. The authors concluded that many students may not feel attracted to those STEM careers due to mistaken perceptions that scientific careers are difficult, not very creative and socially isolating.

Weber and Custer (2005) sought to identify the learning activities, topics and methodologies in technological education that were preferred by boys and girls in secondary and prior education levels so as to provide recommendations for teachers and program coordinators to promote equity from a gender perspective.

Sadler *et al.* (2014) studied the relationship between choosing advanced science and mathematics courses during secondary education and the interest in pursuing a STEM career in higher education. The authors concluded that the number of years youths spend studying advanced science and mathematics in secondary education is associated with an increased interest in STEM careers, particularly in mathematics, chemistry and physics. However, the study found no such relationship for biology and other subjects.

Nwosu, Etiubon and Udofia (2014) sought to identify the obstacles faced by Nigerian girls to follow careers in the fields of science and technology using questionnaires answered by 228 female secondary students for a previous survey. Results show that the main problems they faced were the mathematical concepts, a perception that science and technology-related topics are difficult and that the time dedicated to those topics is insufficient.

Mansfield (2014) underscored the need to include students' voices in research and educational leadership practices in order to increase understanding of their experiences in transformative learning spaces. The study is part of an ethnography that seeks to understand the emerging school culture, as well as the experiences of female secondary school students in a vocational school for girls. Its findings can help understanding why these female youths decided to attend a STEM-dedicated vocational school for girls, as well as what makes their experiences in that school different from those they had in previous education levels.

Thematic area 2: Programs, initiatives, and partnerships aimed to increase female secondary students' interest in STEM subjects and related careers.

All 13 articles classified under this thematic area are based on the importance of attracting girls into STEM areas to mitigate the low female representation in them. A great part of these papers describes and analyzes the impact of experiences of female secondary students who engage in programs and partnerships with universities or companies in order to increase their interest in STEM careers. The analyses seek to examine whether the programs achieved their goal of increasing female youths' interest in those areas, as well as determine which initiatives proved most successful. Among the STEM-oriented programs and initiatives studied are summer camps, extracurricular activities, informal programs, college courses, visits to companies, the joint construction of projects in partnership with universities, among others.

Bamberger's (2014) study discusses an Israeli program designed to encourage secondary school girls to choose professional careers in STEM areas. Sixty girls at a modern orthodox Jewish high school for girls participated in the program. Visits to high-technology companies and meetings with women working in scientific careers were also part of the program. Data were collected

using questionnaires, observation and focus groups with three main topics: the girls' perceptions on female scientists and engineers, their ability to deal with challenges in the STEM areas and their choices for a future professional career.

The article of Carter, Beachner and Daugherty (2015) reflects on the Family and Consumer Science (FCS) course – previously known as *home economics* – as a promising field for increasing the female presence in STEM subjects, due to the high representation of female students in that course (65% of total students enrolled). The authors believe that intersections between STEM subjects and FCS contents should be studied and implemented.

Also with a focus on forms of attracting girls into STEM areas, McCarthy and Slater (2011) describe the changes occurred from 2000 to 2007 in a secondary school in Somers, Connecticut, in order to help young females develop a positive attitude towards STEM subjects and recognize these subjects' importance for occupying positions in engineering fields.

Lou *et al.* (2011) described the impact of a problem solving-based engineering program on the attitude of female eleventh-grade students at a high school for girls in relation to the integrated learning of science, technology, engineering and mathematics in Taiwan, China. Using content analysis and focus groups, the authors concluded, among other things, that the problem solving strategy can help improve the students' attitude to STEM subjects.

Adams, Gupta and Cotumaccio (2014) argue that science programs external to schools – and they cite the Lang Science Program⁹ as an example – can help young students into science areas, particularly youths from groups that are underrepresented in such areas. The authors refer to an exploratory study with a small group of black girls who participated in a science program promoted by a museum during their primary and secondary education years in order to understand the impact of that experience on their identities and interest in science areas, as well as their willingness to follow professional careers in those.

Koenig and Hanson (2008) stress the need to encourage all girls – and not only those interested in STEM subjects – to take advanced courses in science and mathematics in secondary school. The article describes an after-school program known as *Girls in Science* (GIS), which can help increase girls' interest in and develop their positive attitude to sciences, ultimately encouraging them to follow professional careers in those areas.

In their article, Gilbert and Wade (2014) describe an introduction to engineering class according to the *Next Generation Science Standards*¹⁰ (NGSS) engineering program in a urban female secondary school. The program aims to integrate science, technology, engineering and mathematics into daily life.

⁹ Sponsored by the American Museum of Natural History in New York, this program selects fifth-grade students for a seven-year science program focusing on biology (biodiversity, evolution, genetics, etc.) anthropology (culture, human evolution, archaeology and linguistics), and natural sciences (astronomy, geography, geology, astronomy, etc.). See: <http://www.amnh.org/learn-teach/grades-6-8/amnh-lang-science-program/>.

¹⁰ The *Next Generation Science Standards* (NGSS) are content standards for basic education in science which define the science knowledge and skills that students are expected to develop at education level. These standards were developed by U.S. states.

The article of Lawrence and Mancuso (2012) focused on demonstrating how higher education institutions can partner with secondary schools in developing joint programs to promote the engagement of girls in studying engineering. The authors present recommendations for planning, implementing and assessing such programs.

Renner *et al.* (2013) deal, in their article, with an activity developed in a chemistry lab with young female secondary students as part of the *Exciting Discoveries for Girls in Engineering* (EDGE) summer-school program sponsored by the Purdue University's *Women in Engineering Program*. According to the authors, the activity helped expand knowledge of chemical engineering and allowed the girls to form better-informed opinions on their career interests.

Rutz and Shafer (2011) described a case study in electrical engineering conducted with students at an introduction to engineering course in a secondary school for girls. The students visited a power station and carried out individual and group research in order to develop a solution for a problem they were presented with. Later in the program, the group presented and defended their solutions for the problem and prepared a report on their experience. According to the authors, the students showed an improvement in cognitive skills as a result of the activity and reported a positive change in their personal attitude to engineering. The authors believe the activity allowed a realistic vision of engineering, which may help students make informed decisions on higher education programs and professional careers in engineering and technology (RUTZ; SHAFER, 2011).

Mawasha *et al.* (2001) argue in their article that developing a successful training program for women in science, technology, engineering and mathematics depends on a combination of factors. The authors propose a model based on the *Girls Entering Technology, Science, Math and Research Training* (GET SMART) program, which aims to prepare female secondary students for future careers in STEM fields.

The article of Fadigan and Hammrich (2004) presented a longitudinal study describing the trajectories of 152 young females from urban, low income, single-parent, families who participated in the *Women in Natural Science* (WINS) program during secondary school. Results show that 93.1% of the young women eventually enrolled in higher education after high school, with 23.7% following careers in health programs, and 20.7% in STEM areas. The authors believe in the importance of organizing informal science and continuing support programs for women in urban contexts and for socially vulnerable young females.

Sayman (2013) developed a qualitative study to understand the experiences of young Latina females attending state STEM-specialist vocational schools. In addition, the study tried to identify the key factors for enrolling, support and obstacle sources, as well as other factors that contributed for course completion. The author stresses that vocational schools represent good opportunities for students of all socio-economic levels to begin a successful path in STEM-related higher education programs and professional careers.

Thematic area 3: Analyses of STEM-related statistical and history data or standardized assessments, considering gender among other variables

This set of 10 articles is based on the collection and analysis of quantitative educational data – either from standardized tests or representative samples – in order to numerically analyze the underrepresentation of women both in choosing STEM programs and in deciding to follow careers in STEM areas. Some of the studies analyze how the number of women enrolled in STEM programs and careers has evolved over time; others investigate gender gaps in academic achievement and progress in those subjects.

Beekman and Ober (2015) used data from the Indiana Statewide Testing for Educational Progress (ISTEP) math exam (grades 3-10) for a nine-year period in order to investigate gender gaps after the implementation of the *No Child Left Behind* program – which prioritizes reading and mathematics –, as well as differences by school type, socio-cultural factors and socio-economic, gender and ethnic/race related variables. The researchers determined the gender of the students with the highest scores in the math test (grades 3-10) for each of the 292 schools in the state in order to investigate the underrepresentation of females in earning advanced STEM degrees. Results showed that the percentage of boys who took the test was higher, at a 2:1 ratio across all grades. These figures are similar to those on the *Scholastic Aptitude Test (SAT)*¹¹ math exams. According to the authors, the ISTEP math test results, as well as the 2013 SAT math test scores for students who will likely enroll in higher education, support the argument that girls and young women possess the abilities to pursue STEM professional careers that require advanced math skills.

In an initial exploratory study, Gottfried, Estrada and Sublett (2015) investigated whether there are disparities in STEM fields between students from sexual minorities and those from the sexual majority. Using a nationally representative sample from the *National Longitudinal Study of Adolescent Health* database, the authors considered individual factors and academic data and concluded they could not confirm the existence of any relationship between sexual minority status and taking advanced mathematics or science programs.

Starting from the low participation of women in STEM areas in Western countries Van Langen, Bosker and Dekkers (2006) also pointed out the existence of differences between countries. Using multilevel analysis with data from the *Programme for International Student Assessment (PISA)*, their article explores the variation in girls' performance in mathematics, sciences and reading between countries, as well as between schools in different countries. Results show an increase in the female participation in higher education STEM programs and an improvement in girls' performance in secondary school in relation to boys. The

¹¹ A standardized exam that students take in the final stages of secondary education. SAT scores are used for admission into higher education in the U.S.

analysis of countries and schools' characteristics regarding the gender gap shows that integrated educational systems are more favorable to girls than differentiated ones.

Sikora and Pokropek (2012) explored gender segregation in career plans in science among adolescents based on data from the 2006 PISA for 50 countries. The authors discuss whether reducing the self-concept gap in science between men and women could reduce the gender disparities in professional choices. Based on the combination of essentialist theory of gender and biased self-concept theory, the researchers used regression models to interpret the variation in the relationship between self-concept and career plans. Results show that in almost all countries, boys show more confidence in their scientific skills than girls. In almost all countries, girls who identify with science preferred careers in biology, agriculture or health (BAH), while boys who identify with science preferred careers in computer science, engineering and mathematics (SEM). The authors underline that, in developed countries, the science self-concept gap between men and women is greater than in developing nations. The segregation of preference for science careers between men and women is also more pronounced in developed countries. Still, the relationship between gender differences in science self-assessment and gender segregation in the preference for BAH or SEM areas was not confirmed for any country.

According to Reilly, Neumann and Andrews (2015), the gender gap in mathematical and science literacy has important implications for understanding scientific issues; it can also help explain the underrepresentation of women in STEM fields. The authors use data from the *National Assessment of Educational Progress* database in a meta-analysis to study gender differences in academic achievement in mathematics and science in the U.S. in the 1990-2011 period. The authors report slight but stable differences between boys and girls during the period studied, with boys performing better in mathematics and science. The difference becomes greater between students with the highest grades. There is greater representation of boys with higher grades, at a 2:1 ratio, both in mathematics and science.

The study of Adamuti-Trache and Sweet (2014) analyzes secondary students' choices for science courses in schools with culturally diverse students in the Canadian province of British Columbia. The sample comprises 44,000 students born in 1990 – 27% of which are non-native English speakers – who completed secondary education in 2009. The study considers the students' gender, ethnic-linguistic, personal and situational differences as they chose courses during twelfth grade, with an emphasis on the STEM disciplines. The researchers found that the choice for mathematics and science courses is strongly associated with ethnicity and qualified by gender and prior science and math performance, but also by individual performance at school admission and enrolling in English as a Second Language courses. According to the authors, the students who are most likely to choose math and science courses are from Asian ethnic-linguistic

groups, and they enter the provincial educational system in the upper secondary grades.

Stevanovic (2014) used data from the *Institut National de la Statistique et des Études Économiques* to study the evolution of women's enrollment in scientific areas in secondary and post-secondary education in France. The study analyzed a nearly 20-year period, from 1985 to 2008, to study the changes and continuities in girls' choices for science and technology courses during that period. Results show that their choices for courses in both areas went through changes over the period studied, which were positive for secondary education, but more ambiguous for post-secondary education, where female underrepresentation in science and technology persisted despite the changes.

Starting from the finding that few students – particularly few girls – in the United Kingdom currently choose to take their Final School Examination in advanced mathematics, chemistry and physics in the United Kingdom, Korpershoek *et al.* (2011) examined 6,033 students in the upper years of secondary school, including 720 who chose to take their final exam in advanced mathematics, chemistry and physics. One of the findings was that those who took the advanced mathematics, chemistry and physics exams, particularly the girls, had higher grades in mathematics than those who chose to take the exam in other disciplines.

Meng, Idris and Eu (2014) studied the perceptions of over 1,000 secondary students in Malaysia on the assessment of STEM subjects by using a questionnaire. Results indicated positive overall perceptions on the assessment of STEM subjects, in addition to significant differences when comparing schools, but did not indicate statistically significant differences in perceptions regarding gender.

Andersen and Ward (2014) analyzed group differences in the expectancies and values of students with strong science and mathematics skills, as well as their plans to persist in science, technology, engineering and mathematics (STEM). The authors used nationally representative samples of ninth-grade students and the High School Longitudinal Study of 2009. The analytic sample comprised 1,757 students (48% females and 52% males); of these, 13.8% were black, 26.7% were Hispanic, and 59.6% were White. These students corresponded to the 10% with the highest math exam scores in each ethnic-racial group. The authors used hierarchical logistic regression models for each race/ethnic group to analyze the relationships of demographic variables with student persistence in STEM areas. They concluded that science attainment value, science intrinsic value, and STEM utility value were predictors of student persistence in STEM subjects, though in a different way for each ethnic-racial group.

Thematic area 4: Initiatives for increasing interest in STEM subjects and STEM-related careers among secondary education students, with focus on student gender.

The six articles grouped in this thematic area (as with Axis 3) examine programs, partnerships, activities and courses for secondary students. The purpose was to increase their interest in STEM subjects, though for both sexes. Among the articles, two analyze STEM-specialist vocational schools. All articles seek to describe the programs' impact on the interest of boys and girls – sometimes considering also student race/ethnic group – in STEM disciplines and careers.

Sasson and Cohen (2013) investigated the implementation and assessment of a scientific enrichment program in Israel as an example of informal learning environment with an emphasis on physics. Approximately 500 students completed a questionnaire after participating in science activities focusing on biology, chemistry and computer science. Results indicated a high degree of satisfaction among the students, with no gender differences being found except in physics, to which boys showed a more positive personal attitude than girls. In addition, by conducting assessments both before and after a physics activity involving 70 students of both genders, the researchers found that the activity helped improve boys' personal attitude to physics. The girls, however, showed a decreased interest in and lower self-efficacy to that subject.

Forssen *et al.* (2011) examined results of the second year of implementation of the *Surprising Possibilities Imagined and Realized Through Information Technology* (SPIRIT) program, a three-year project dedicated to increasing the interest of male and female secondary students in information technology (IT) careers. According to the authors, all participants, particularly the girls, experienced positive change in their perceptions of gender stereotypes in information technology after participating in the program.

In a study on vocational secondary schools, Erdogan and Stuessy (2015) emphasized that this type of school offers a unique learning environment with advanced curricula, specialist faculty and internship opportunities. The researchers concluded that students who attend STEM-specialist vocational secondary schools perform slightly better on important math and science tests compared to students attending regular secondary schools. In addition, these students are more interested in STEM subjects, more committed in class and more likely pass state and higher education admission exams.

Hamilton, Malin and Hackmann (2015) analyzed enrollment statistics for some secondary Career and Technical Education programs, comparing them with national data when possible. Data were examined by career group, considering students' gender and race/ethnicity, with an emphasis on STEM subjects. According to the authors, enrollment patterns in science, technology, engineering and mathematics showed gender and racial/ethnic group differences, being more equitable in some areas and less in others. In STEM fields, the study found a greater enrollment of males (64.1%) than females (35.9%). In non-STEM areas, particularly in the humanities, the opposite occurs (45% males vs. 55% females). With regard to student race/ethnicity, all sub-groups but White students are underrepresented in the Career and Technical Education programs studied. Among non-White students, Asians have the highest representation.

Christensen, Knezek and Tyler-Wood (2015) analyzed the experience of 364 eleventh and twelfth-grade students in a science and mathematics course conducted in a university. The students completed questionnaires before and after the course, thus, results draw from a comparison between both questionnaires. The researchers found that eleventh-grade students' interest in STEM subjects decreased by the end of the year, while the opposite occurred with twelfth-grade students. The eleventh-grade students showed typical gender differences, with boys being more inclined to engineering and technology than girls. However, twelfth-grade students, being closer to the end of high school, showed no gender difference for any STEM area. Results showed that the young females displayed more interest than the young males in pursuing STEM careers.

Zarske *et al.* (2012) described the longitudinal impacts of a partnership between the University of Colorado and the St. Vrain Valley school district on the teaching of engineering in basic education. In a joint project, the university and school educators developed a replicable pre-college engineering project that serves students traditionally underrepresented in engineering, culminating with a high school STEM academy for students motivated to enter an engineering program in higher education. The authors concluded that the project had a positive impact on the students' perception of engineering, as well as on their preparedness and persistence in this field.

FINAL CONSIDERATIONS

STEM education emerged in the United States as the result of a public educational policy designed to improve the performance and interest of American students in disciplines defined as important to train a workforce in areas that are strategic to the country's growth and competitiveness. The shortage of professionals in these areas and the fact that this shortage is predicted to increase in the next few years drove the U.S. government to develop specific policies and invest in increasing students' performance and interest in these areas. This political strategy is situated at the threshold between an equality-focused education (or one that acknowledges inequalities) and the needs of the labor market.

Acknowledging the underrepresentation of women and ethnic-racial minorities in STEM fields, U.S. federal investments have been also directed to promoting the inclusion of these minorities in order to help occupying positions in these areas. Thus, programs and initiatives for including women in STEM fields have been implemented, as well as investments in teacher education, the expansion of the offer of STEM contents, and the creation of partnerships with companies and universities.

The analysis of the papers selected for our mapping shows, for the most part, an interest in investigating the important factors in education and career decision-making, both for all students and for females in particular. By providing insights into these factors, the studies support interventions that encourage students to choose STEM subjects during secondary education and help them

pursue careers in these fields. Nevertheless, while nearly all quantitative studies (70%) succeeded in mapping facts and trends, they provide little information on the more subjective aspects of female career choices, such as the weight of their social-affective trajectories – including the effects on family finance, the desire to form a family, motherhood, and the impact on the work-family relationship. These trajectories may not yet be very clear to female youths in secondary education, but there is the weight of social expectations on them.

The articles show a significant number of initiatives dedicated to raising the interest of young females in STEM fields. These initiatives occur both in schools – with elective subjects – and in extracurricular activities, summer camps, visits to companies and joint projects with universities. The findings of the studies show a positive impact of these initiatives on girls' interest in STEM disciplines and careers. However, further research is required on education trajectory beyond the mere enthusiasm for the exact sciences, covering also the entrance and permanence in higher education, due to the barriers a career in the making is still faced with, particularly in male-dominated fields.

In the selected articles, the researchers' main concern – at least from reading the abstracts – seems to be the improvement of women's performance in STEM education, as well as seeking alternatives that may lead to gender equality in jobs in those areas. Nevertheless, there seems to be no critical reflection about gender equality, which would entail reflecting on the social trajectories of men and women, including those obstacles that are not limited to the career context – such as family and child care, household tasks, etc. –, but still hinder women's potential to develop their careers in all areas, particularly in STEM ones. STEM-oriented gender equality policies should consider the social place of men and women in the social and sexual division of labor.

The selected studies should be contextualized in the educational policy that caused the analyzed actions to emerge. Since this policy and its efforts aim to attract youths to particular knowledge areas, the resulting actions intend to collaborate to achieving that goal by focusing on understanding the processes in which those choices are made, using other fields, such as cognitive psychology, to that end. The programs' assessments are also intended to improve the initiatives so they can serve more people.

However, overcoming gender inequality in the professional and scientific fields towards equality is not just a matter of access to professional training programs, whether in vocational secondary or higher education. It would imply acting towards equal participation for women in all contexts of social, economic and political life, including the production and development of science and technology. Nancy Fraser (2002), in addressing equal participation as a means to exercise radical democracy for social justice, says that, in order to achieve it – in this case, gender equality –, we need to bring down the institutionalized obstacles that hinder certain groups of people from participating as equals, as *de facto* and *de jure* partners in social interaction.

In the educational field, one path to be sought is complexifying common-sense explanations by understanding of how gender differences have historically developed into inequalities, often reinforced by narratives – “girls don’t like math”; “math is too difficult” – and biased practices and behaviors that increase gender inequality in social relationships.

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