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Artículos científicos

Modelo de ecuaciones estructurales, alternativa para medir el fenómeno de las mujeres STEM en México

Structural Equation Models: An Alternative to Measure the Phenomenon of STEM Women in Mexico

Modelo de equações estruturais, alternativa para medir o fenômeno das mulheres STEM no México

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Resumen

Aunque cada vez hay más mujeres en las universidades en las áreas de ciencia, tecnología, ingeniería y matemáticas (STEM), en términos de representatividad aún están lejos de igualar a los hombres. Los estereotipos de género y la segregación de las carreras STEM son obstáculos para las estudiantes, ya que generan prácticas excluyentes y ambientes hostiles. El objetivo de este artículo fue proponer un modelo de medición del fenómeno de las mujeres STEM que considerara variables latentes relacionadas con las creencias masculinas, las inspiraciones, las estrategias de afrontamiento, el mercado laboral, la escuela y el gusto por las matemáticas. Para ello, se construyó un instrumento que mide la percepción de las mujeres STEM en universitarios. Se aplicaron 1826 cuestionarios a estudiantes de dos escuelas de educación superior del Instituto Politécnico Nacional. Se realizó el análisis factorial exploratorio y confirmatorio, posteriormente se trabajó el modelo de ecuaciones estructurales y por último se establecieron seis hipótesis generadas de las variables latentes. Se encontró que el afrontamiento contribuye a explicar la variable Escuela, además de que las creencias masculinas explican los constructos Escuela y Mercado Laboral. Se concluye que es necesario que las escuelas trabajen para desarrollar ambientes respetuosos y desafiantes para las mujeres, aunado a que el sector laboral tiene que apoyar para cerrar las brechas y eliminar la discriminación por género.

Palabras clave: creencias masculinas, educación superior, modelo de ecuaciones estructurales, mujeres STEM.

Abstract

Although there are more and more women in universities in the areas of science, technology, engineering and mathematics (STEM), in terms of representativeness they are still far from equaling men. Gender stereotypes and segregation of STEM careers are obstacles for female students, as they generate exclusionary practices and hostile environments. The objective of this article was to propose a model for measuring the phenomenon of STEM women that considers latent variables related to male beliefs, inspirations, coping strategies, the labor market, school and a taste for mathematics. For this, an instrument was built that measures the perception of STEM women in university students. 1826 questionnaires were applied to students from two higher education schools of the Instituto Politécnico Nacional. The exploratory and confirmatory factor analysis was carried out, later the structural equations model was worked and finally six hypotheses generated from the latent variables were established. It was found that coping contributes to explain the School variable, in addition to male beliefs explaining the School and Labor Market constructs. It is concluded that it is necessary for schools to work to develop respectful and challenging environments for women, coupled with the fact that the labor sector has to support to close the gaps and eliminate gender discrimination.

Keywords: male beliefs, higher education, structural equation modeling, STEM women.

Resumo

Embora haja cada vez mais mulheres nas universidades das áreas de ciência, tecnologia, engenharia e matemática (STEM), em termos de representatividade ainda estão longe de se igualar aos homens. Os estereótipos de gênero e a segregação das carreiras CTEM são obstáculos para as alunas, pois geram práticas excludentes e ambientes hostis. O objetivo deste artigo foi propor um modelo de mensuração do fenômeno das mulheres STEM que considere variáveis latentes relacionadas às crenças masculinas, inspirações, estratégias de enfrentamento, mercado de trabalho, escola e gosto pela matemática. Para isso, foi construído um instrumento que mede a percepção de mulheres STEM em estudantes universitários. 1826 questionários foram aplicados a alunos de duas escolas de ensino superior do Instituto Politécnico Nacional. Foi realizada a análise fatorial exploratória e confirmatória, posteriormente trabalhado o modelo de equações estruturais e, por fim, estabelecidas seis hipóteses geradas a partir das variáveis latentes. Verificou-se que o coping contribui para explicar a variável Escola, além do fato de que as crenças masculinas explicam os construtos Escola e Mercado de Trabalho. Conclui-se que é necessário que as escolas trabalhem para desenvolver ambientes respeitosos e desafiadores para as mulheres, somado ao fato de que o setor de trabalho tem que se apoiar para fechar as lacunas e eliminar a discriminação de gênero.

Palavras-chave: crenças masculinas, ensino superior, modelo de equações estruturais, mulheres STEM.

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Introduction

It is clear that the presence of women is blurred in the fields of science, technology, engineering and mathematics (STEM). It is a multifactorial problem that has led women to discard from an early age, from childhood, the possibility of developing in these areas of knowledge (United Nations Educational, Scientific and Cultural Organization [Unesco], 2019). Gender discrimination, biases, stereotypes, social norms, low motivation and little recognition of their abilities are some of the reasons why women do not enter, remain or are promoted in the fields of STEM. Although they involve paths that can be difficult to travel and not suitable for everyone, regardless of gender, many young women prematurely discard STEM due to the false belief that they are a better fit for men and that, because they are so professionally demanding, they prevent finding a balance between work and family, both assumptions highly magnetized by gender stereotypes (van Tuijl and van der Molen, 2016). Indeed, adolescent men are more recommended to study engineering than women since they are attributed greater mathematical ability (Pozo et al., 2020).

Despite the lack of engineers in different areas, boys between 10 and 14 years old, although especially girls, do not show interest in entering those careers, since the vast majority think that a superior intelligence is required for this (Poniszewska , Szukalska and Wilczyński, 2021). It is discouraging that gender biases cause gaps in women's participation in STEM fields. And for the same reasons, women project less sense of relevance, which undermines their aspirations in those fields (Moss, Sanzari, Caluori, and Rabasco, 2018).

The literature emphasizes that gender differences in STEM careers are related to low self-esteem of women, in addition to a poor perception of their abilities in the fields of mathematics, low expectations of social relevance and beliefs of low self-efficacy. . Another aspect to consider is that teachers tend to consider that mathematics requires brilliance and, unfortunately, they tend to think that girls lack that brilliance (Copur, Thacker and Quinn, 2020; Rebollo and De la Rica, 2020; Tellhed, Bäckström and Björklund, 2017; van Langen, 2015; Wang and Degol, 2017).

According to Gunderson, Ramirez, Levine and Beilock (2012), there is a proliferation of concern that girls on various occasions have negative attitudes towards mathematics, they even develop more harmful self-concepts and anxieties towards these areas than boys; the above, once again, is related to gender stereotypes. The impact on girls' concept of them is reflected in their performance toward mathematics and pursuit of career paths related to STEM fields. The expectations that parents and teachers have about mathematical competencies are biased and influence the academic performance and attitudes of children.

Equally unfortunate is that there are studies that indicate that women are perceived as lacking the qualities necessary to be successful scientists, which contributes to discrimination. Furthermore, they are thought to be less intelligent and competent (Carli, Alawa, Lee, Zhao, and Kim, 2016; Eaton, Saunders, Jacobson, and West, 2020). The literature emphasizes that young women are less likely to persist in science than men; It also points out that the latter have more family resources than the former, which is why they tend to have more scientific experiences (Hanson, 1996).

According to the Global Gender Gap Report 2020 carried out by the World Economic Forum [WEF, for its acronym in English] (2020), Latin America has a global gender gap index of 0.721. The economic participation of women is 0.642 and that of political empowerment is 0.269. It is noteworthy that only 43% of Mexican women participate in the labor market, of which 26% have a part-time job. Despite having the same academic background, the professional situations of graduates differ according to gender. Women experience greater obstacles to finding a job, they are less likely to find a job according to their education and the worst thing is that in various positions they earn less (Jasko, Pyrkosz, Czarnek, Dukała and Szastok, 2020). López, Grazzi, Guillard and Salazar (2018) emphasize that there are a variety of obstacles for women that hinder their integration in STEM fields.

Although progress has been made that has made it possible to reduce gender gaps, there are still difficulties in reaching leadership positions in various spheres of science, technology and innovation. Regarding occupations in science and technology, Mexico has important differences in those positions of high and middle levels. In comparison with the area of health sciences, where 70% of women are employed and between 40% and 45% are in high and middle positions, in the area of information and communication technologies (ICT), in science and engineering, only 17% of women occupy high positions and 6% middle positions. It should be noted that middle positions do not require tertiary education, but high positions do need this type of education (López et al., 2018).

Although women studying in STEM fields do not openly experience discrimination, they sometimes perceive microaggressions that lead them to feel in threatening environments. These events lead to women becoming psychologically disconnected, which impacts their performance, motivation, and self-esteem. As we know, self-esteem allows us to develop high levels of satisfaction and resistance to exhaustion. (Casad, Petzel e Ingalls, 2019).

The objective of this article is to propose and confirm a model for measuring the phenomenon of women in STEM that considers the following latent variables detected in the literature: male beliefs, inspirations, coping strategies, the labor market, school and the taste for mathematics. The above to determine the causal relationships on non-experimental data by means of a structural equation model.

Theoretical framework of the STEM phenomenon

Women STEM is a multivariable phenomenon. Until now, emphasis has been placed on the beliefs that are generated from the ideologies caused by traditional gender stereotypes. Similarly, work has been done on the discourse that spreads in the school environment, in addition to the coping techniques developed by women, coupled with the early recognition of their math skills, their inspirations and the various obstacles they face. In the labor market. Now, Carli et al. (2016) mention that men are considered leaders, analytical, competitive and independent, while women are kind, understanding, warm and helpful. The foregoing has sparked a variety of academic debates that reaffirm that the low parity of men and women in STEM fields has been generated by gender ideologies that support the idea that one and the other have different abilities and aptitudes. As for women, it is believed that they lack the necessary strengths for STEM fields, coupled with the fact that girls show little interest in it and decide to opt for careers that are better socially fit (Pološki, Obadić and Sinčić, 2019). Without a doubt, gender biases benefit males, as they consider themselves to be much more competent than females (Eaton et al., 2020).

Benevolent sexism manifests itself through condescending behaviors towards women that generate in them low expectations and poor standards of excellence, and causes that, in order to be accepted in these masculinized fields, they act more like men and make extra efforts to be able to feel that they are competitive (Makarova, Aeschlimann and Herzog, 2016).

The study of self-efficacy arises to inquire about the behavior of young people in STEM fields; aspires to predict the time that a student will persist in some activity to solve it. Self-efficacy is defined as confidence in the abilities and capacities to be successful in certain tasks (Paunonen and Hong, 2010). Elements such as self-concept, the value given to tasks, autonomy, affinity and the growth mindset are highly relevant for the development of commitment, performance, subject selection and aspirations that students come to have. STEM (Murphy, MacDonald, Wang & Danaia, 2019). In fact, Tellhed et al. (2017) argue that self-efficacy makes it possible to identify interests in STEM careers.

And along these lines, Zander, Höhne, Harms, Pfost and Hornsey (2020) comment that girls, despite having math scores similar to boys, have lower self-efficacy and show lower self-esteem; in contrast, children have positive feelings. There is evidence that girls have a lower self-concept in STEM and, therefore, they may maintain low interest and attribute any failure in these fields to lack of ability (Murphy et al., 2019). Similarly, the work of Heyder, Weidinger and Steinmayr (2020) points out that women show a lower capacity to develop their self-concept and, therefore, low intrinsic motivation in mathematics, while the opposite is the case with men. Motivation can be affected by the construction of gender roles and stereotypes that are reproduced in society and should be considered as important, since it allows increasing academic performance (Jungert, Hubbard, Dedic and Rosenfield, 2019; Yang and Gao, 2019).

Regarding why women have less confidence in mathematics, Sax, Kanny, Riggers, Whang and Paulson (2015) argue that mathematical self-concept represents a predictor of motivation, emotions and performance of individuals and helps to explain the role of self in school. This intersects with self-perceptions (which are in turn related to achievement behavior), namely, the perceptions that a student has of his / her abilities in mathematics with respect to that of others. In addition, the mathematical self-concept has a strong relationship with academic performance, which is why it is responsible for shaping aspirations in the fields of STEM. Undoubtedly, the mathematical self-concept influences women too much. In order for them to aspire to be in STEM fields more frequently, it is necessary to work on their confidence and, above all, avoid that girls underestimate their mathematical ability. According to Koul, Lerdpornkulrat and Poondej (2017), unlike women, in the case of men, aspirations are independent of mathematical self-concept.

On the other hand, according to Christman and McClellan (2012), resilience is an internal mechanism that causes people to develop positive traits such as patience, self-determination, responsibility and taking risks in order to overcome adversity. It also activates resistance, self-esteem, self-efficacy, intellectual capacity and autonomy, and requires the combination of other elements such as the support of parents and mentors. In this regard, Skolnik (2015) points out that other strategies to reinforce resilience are to work on faith, self-motivation, family support, take extra classes and work hand in hand with teachers. While Thiry (2019) mentions that individual coping skills, in addition to interest in the field, assertiveness and the willingness to accept criticism and lose the fear of being wrong, are elements that support women to persist. Precisely, Deb (2018) emphasizes that women must develop protection mechanisms to face adversity and develop resilient behaviors. And she views self-efficacy as an internal buffer and strong relationships and community support as external. Finally, Grau and Martinez (2017) expressed that the most important element for many women to persist in STEM careers was the family support they received.

The works carried out by the feminist De Beauvoir (1981) are essential to understand the phenomenon of the underrepresentation of women in STEM. This thinker she explains that men and women have never shared the idea of imagining a world based on equality. Despite the efforts, they continue to suffer many disadvantages. In economic matters, women and men are completely different subjects: men have higher salaries, more opportunities to succeed, they are present with greater force in industry, politics, together with having the best positions. Gender gaps in the labor market are the product of family formation, psychological elements, cultural and social norms (Bertocchi and Bozzano, 2020).

The scientific literature developed to date shows that in order to understand gender discrimination in the labor market, it is necessary to understand factors such as income inequality, education levels, occupational distribution and the opportunities that women have in the sectors. and poverty. This is coupled with the fact that certain beliefs about gender roles influence the preferences of employers and increase the gender gap (Miluka, 2013). The economic benefits are related to academic performance and gender. Men earn better than women in STEM fields, despite the fact that they, in several cases, have better academic preparation (Olitsky, 2014). On the other hand, STEM programs geared exclusively to women have had a positive effect on their aspirations (Szelényi and Inkelas, 2011).

According to van Veelen, Derks and Endedijk (2019), on several occasions STEM women face a double problem in the labor market: the first is that they have to work in environments where they are outnumbered by men and the second is that women in these fields are stereotyped in a negative way and that threat to gender identity has a negative influence on the work commitment and professional confidence of women.

Today, an alarming salary disparity persists in STEM fields between women and men with the same academic levels. Gender inequality in labor fields can strongly discourage women who have obtained academic degrees and degrees to enter, advance, and persevere in male-dominated settings (Okahana and Hao, 2019). Research carried out by Castaño, Lubiano and García (2020) and Schlenker (2015) indicates that women who are mothers work longer hours in STEM fields; despite this, they are more likely to be out of the workforce. Labor segregation is a gender equality problem that has serious consequences that can lead women to live in poverty. According to Yamaguchi (2019), the ways in which labor markets are managed are related to the persistent idea of the distribution of domestic activities that exist in the home and that continue to be carried out by women.

Unfortunately, a woman is less likely to be hired for jobs considered male and more likely to be chosen for female-related jobs. This reinforces the gender penalty and accentuates the sexual classification of occupations.

In STEM fields, gender divisions of labor continue to exist. Leadership is still seen as a quality exclusive to the male gender. The erroneous idea that men are the main actors in the processes and that women are only the emotional support has not stopped being replicated. Ultimately, women are at a disadvantage by holding positions of less power. In this type of masculinized organizations, they are sometimes even seen as strange (Acker, 2005). It is known that the generational wage gap in the case of women disappears when individual variables such as maternity and skin color are controlled; In contrast, for men, wage differences are controlled by responding to the characteristics of the market (Manzoni, 2019; Varela, 2019).

Based on the literature review, the following hypotheses are proposed:

- H1the taste for mathematics contributes to the variable School.
- H2: coping techniques contribute to the School construct.
- H3: masculine beliefs contribute to explain the latent variable School.
- H4: masculine beliefs contribute to explain the labor market.
- H5: the inspirations contribute to explain the labor market.
- H6: the school contributes to understanding the labor market.

Materials and methods

It is a quantitative and cross-sectional investigation. The study was carried out in September 2019. An instrument was built that aims to measure the perception of the STEM phenomenon in higher education institutions. We worked with the theoretical framework related to STEM women. The Likert-type scale was used, where 1 is equal to totally disagree and 5 to totally agree; 22 items were worked on. The questionnaires were applied in two schools that belong to the National Polytechnic Institute and that have degrees in the STEM area. 1826 questionnaires were obtained; the participation of 776 women and 1,050 men. For its application, young people from the credit program for extracurricular activities were trained, who were responsible for the withdrawal in the two academic units. The sample was non-probabilistic and for convenience. The exploratory and confirmatory factor analysis were used, both were of maximum likelihood. In the case of exploratory factor analysis, the promax orthogonal rotation was used, since this is more applicable to reflective models that consider the perceptions of variables that work with scales. In the Kaiser Meyer Olkin (KMO) statistical test, 0.823> 0.05 was found, which indicates that the statements have grouping capacity and have internal consistency.

The analysis of the correlations made it possible to remove from the model the statements that did not contribute to the latent variables. The pattern matrix is shown in table 1. In total, six dimensions were obtained.

Tabla 1. Matriz patrón

Variable/indicador	F1. Mercado laboral	F2. Afrontamiento	F 3. Creencias masculinas	F4. Gusto por las matemáticas	F5. Inspiraciones	F6. Escuela
G1. Gusto más por las matemáticas que por otras asignaturas.				0.878		
G2. Creencia sobre las posibles aplicaciones de las matemáticas en la vida real y en los campos de STEM.		0.324				
A3. En la escuela se ha trabajado con problemas prácticos en donde se proponen soluciones haciendo uso de las áreas de STEM.		0.346				
C4. Pienso que los hombres son mejores en las matemáticas que las mujeres.			0.854			
C5. Pienso que los hombres son mejores científicos que las mujeres.			0.956			
M6. Los empleos de STEM en su mayoría están dirigidos a los hombres.	0.591					
M7. Las mujeres deben de trabajar más en aquellos campos en los que se trabaje menos horas, ya que sus actividades como madres les exige tiempo.	0.583					

M8. Las mujeres pocas veces tienen éxito en la ciencia, ya que es un campo de los hombres.	0.590					
M11. Existen trabajos que son adecuados para las mujeres y para los hombres.	0.434					
G15. He tenido logros importantes en el área de matemáticas durante mi trayectoria académica.				0.352		
A16. Cuando obtengo malas calificaciones en matemáticas, me presiono y me pongo a estudiar para resarcir la deficiencia.		0.351				
A17. Considero que soy autodidacta, por lo tanto, soy responsable de mis debilidades académicas.		0.546				
I19. Alguien cercano trabaja en algún campo de STEM, de ahí mi inspiración para estudiar esta carrera.					0.434	
ES20. La escuela cuenta con clubs y cursos de temas avanzados de la carrera que estoy estudiando.						0.403
ES21. En la escuela los profesores se esfuerzan por generar mayor interés por aquellas asignaturas relacionadas con los campos de STEM.						0.747
I26. Creo que mis padres han tenido mucha influencia en mi decisión sobre lo que quiero estudiar.					0.501	
A10. Durante mis estudios he tenido contacto con un científico o científica.		0.321				

M12. Los hombres ganan más que las mujeres en los campos de STEM.	0.685					
A13. Los varones pueden llegar a ser mejores científicos que las mujeres.	0.514					
A18. Conozco el campo laboral de lo que estoy estudiando.		0.632				
C25. A veces pienso que los temas de STEM son para personas solitarias y con alto nivel intelectual.					0.334	
I27. Mis padres benefician a los hijos varones, dotándolos de beneficios y apoyando sus decisiones educativas.					0.447	

Fuente: Elaboración propia

Subsequently, the pattern matrix was worked in the Atlas Ti version 23 software to obtain the initial model shown in figure 1.

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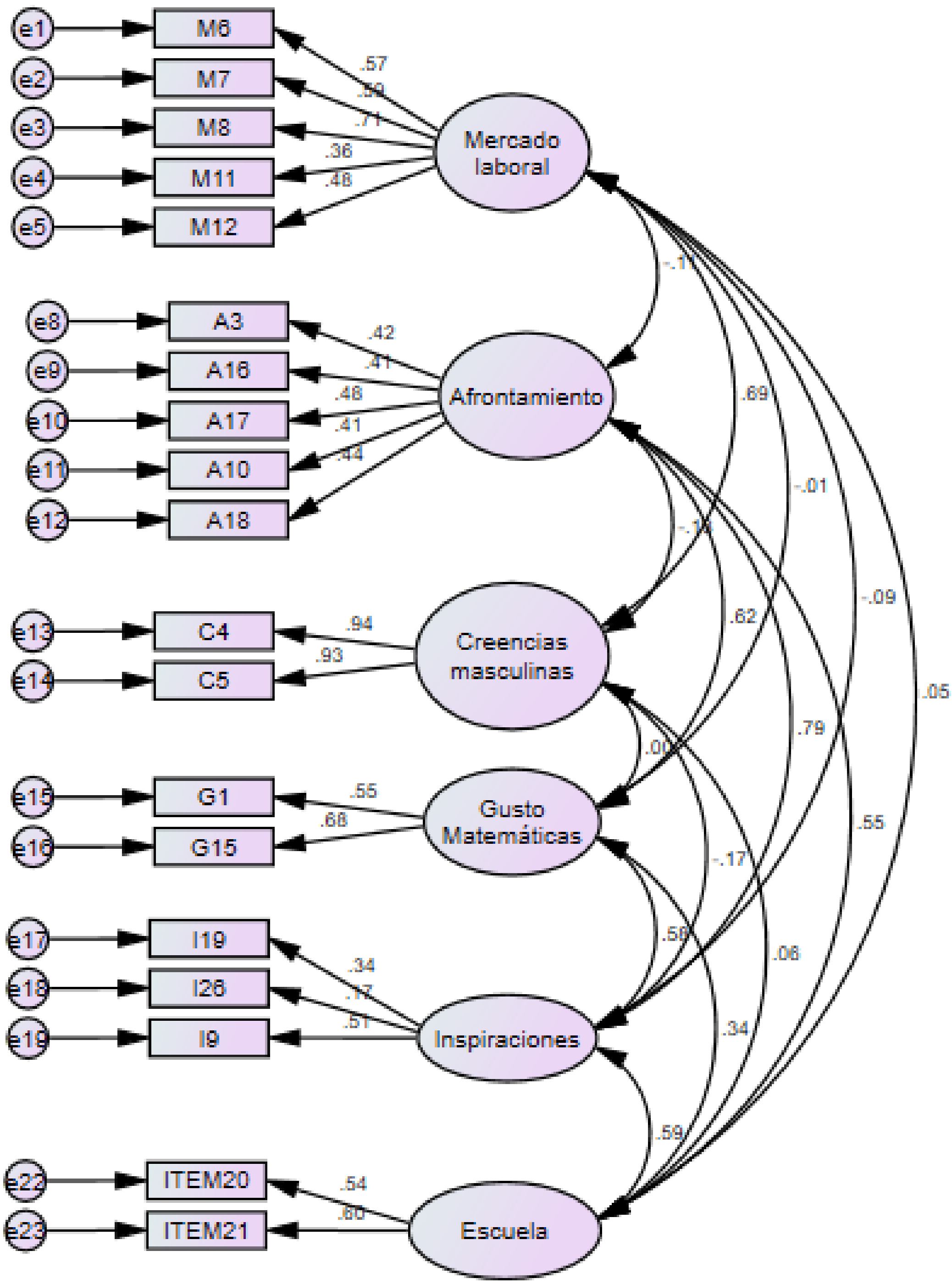
Figura 1. Modelo de medida inicial



Fuente: Elaboración propia

Table 2 shows the measures of adequacy of the model with their thresholds of adequacy.

Tabla 2. Medidas de adecuación del modelo

Medida	Estimación	Umbral de aceptación	Interpretación
CMIN/DF	4.535	Entre 1 y 3	Aceptable
CFI	0.929	>0.95	Aceptable
SRMR	0.047	<0.08	Excelente
RMSEA	0.044	<0.06	Excelente
PClose	0.997	>0.05	Excelente

Fuente: Elaboración propia

Table 2 shows the fit measures that are adequate for the initial model. The structural equation model was used, a type of multivariate statistical model that helps to estimate the effect and possible relationships between various variables. The usefulness of the model is that it allows to establish the shape and direction of the possible relationships to be found and then estimate the parameters that are specified in the relationships that arise from the proposed theoretical framework. A model of this type is made up of two parts: a) the measurement model and b) the structural relationship model. In short, it allows evaluating or testing theoretical models; it is a powerful tool for the analysis of non-causal data (Chahín and Libia, 2018; Ruiz, Pardo and San Martín, 2010). The model that structural equations proposed for the study is presented in Figure 2.

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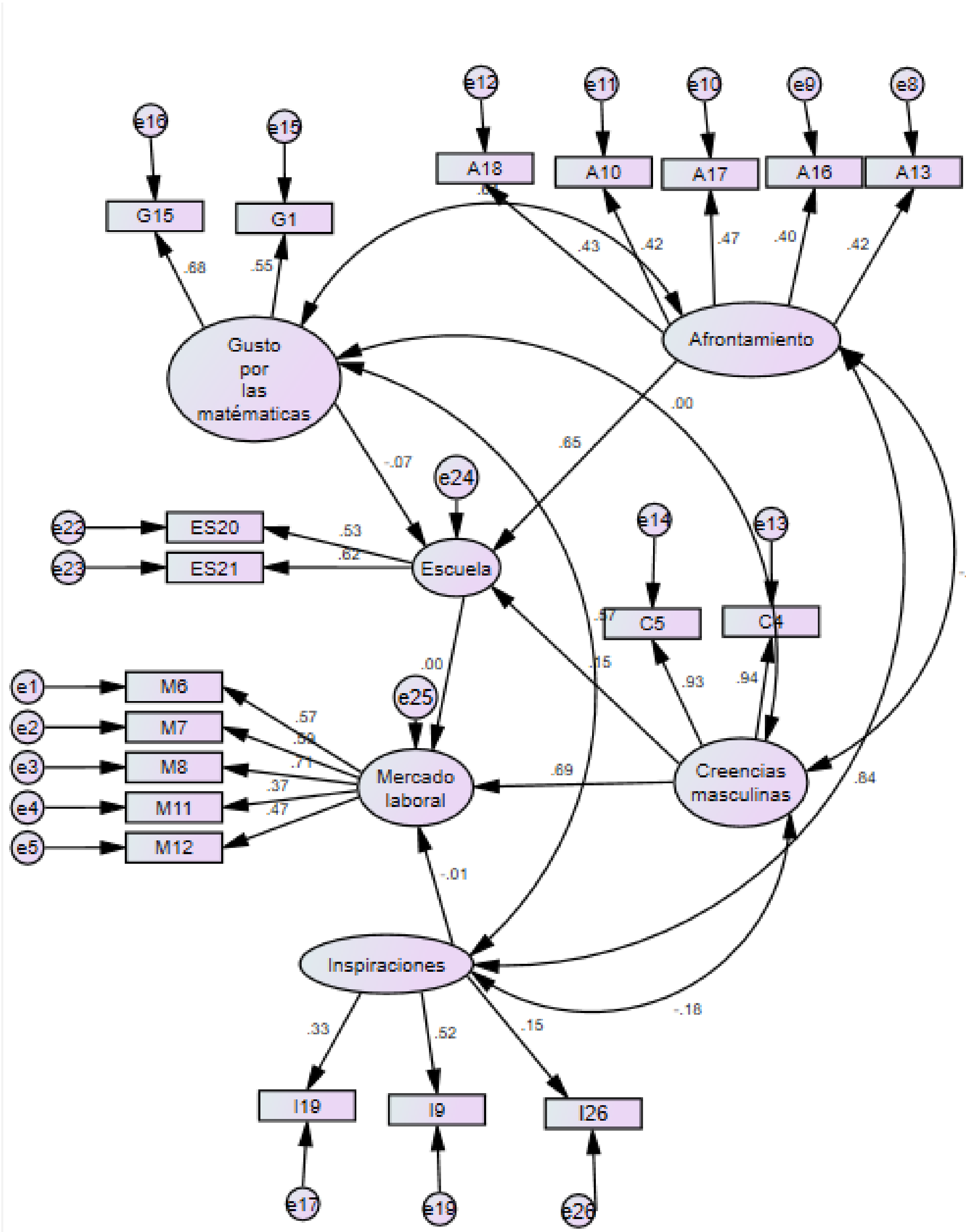
Figura 2. Modelo de ecuaciones estructurales. Estimación por máxima verosimilitud



Fuente: Elaboración propia

Table 3 sets out the hypotheses that were raised for this study.

Tabla 3. Hipótesis planteadas con los estimadores que permiten identificar su aceptación o rechazo

Relaciones causales	Modelo / Estimador	Hipótesis
El gusto por las matemáticas aporta a la variable Escuela.	-0.042 (no significativo)	Se rechaza la hipótesis de que el gusto por las matemáticas aporta a la variable Escuela.
El afrontamiento aporta al constructo Escuela.	0.384**	Se acepta la hipótesis de que el afrontamiento coadyuva a explicar la escuela.
Las creencias masculinas aportan a la variable latente Escuela.	0.086**	Se acepta la hipótesis de que las creencias masculinas aportan positivamente para explicar el constructo Escuela.
Las creencias masculinas aportan a explicar el mercado laboral.	0.453**	Se acepta la hipótesis de que las creencias masculinas aportan para explicar la variable Mercado Laboral.
Las inspiraciones aportan al mercado laboral.	-0.006 (no significativo)	Se rechaza la hipótesis de que las inspiraciones aporten para explicar el mercado laboral.
La escuela aporta al mercado laboral-	0.004 (no significativo)	Se rechaza la hipótesis de que la escuela aporta para estudiar el mercado laboral.

Fuente: Elaboración propia

Discussion

The results found indicate that the variables that make up coping help to explain the variable School. As is known, the STEM environment is complex due to the load of subjects related to mathematics, coupled with the hostile contexts that develop in universities, where sometimes erroneous messages arise and limit the development and advancement of women. Therefore, students are required to develop skills to persist in this field. According to Thiry (2019), the elements that reinforce the persistence of women in STEM fields are: a) study groups, b) opportunities to connect with other women, c) work with female academics and mentors, d) academic assistance programs, e) advisory and guidance practices implemented by universities, f) sustain the will to persist, g) that students believe in themselves, h) develop effective work habits and i) try to find systems of support for. On the other hand, Holland (2019) adds that the great struggles that STEM students face are: 1) the curriculum map, 2) make up for poor grades and face the various laboratory practices, 3) feel that they belong to institutions and 4) develop persistence. Watson (2020) adds that women must identify and assimilate the sacrifices of being in a STEM career, as well as develop leadership and communication skills and learn to make decisions based on data and not on emotions.

In this work, it was also found that male beliefs contribute in a positive way to explain the variable School. The variables that were studied were: a) belief that men are better in mathematics than women and b) men are better scientists than women. Casad et al. (2019) point out that women are aware of their stigmatization in STEM fields, which causes uncertainty in academic environments: when women perceive threats, they form negative judgments about them. Uncertainty develops a chain of psychological events that increase over time. The results found support what was stated by Peila (2017), who mentions that women have to overcome a variety of obstacles, many of which have their origin in gender stereotypes, which are always accompanied by individual and institutional prejudices.

Continuing with the masculine beliefs that explain the School factor, according to Allegrini, Pellegrini and Segafredo (2015), men feel a greater attraction to achieve a status in the field of STEM. This is because institutional models continue to be traditional sociocultural models where the male figure is the most representative. Likewise, there is a perception that science is a masculine environment. Indeed, men benefit more from STEM careers than women (Olitsky, 2014). It is unfortunate that, despite the fact that women have the necessary academic backgrounds in STEM fields, they continue to face innumerable obstacles to pursuing advanced studies, without losing sight of the fact that the lack of female role models, the absence of Peer support, possible maternity career interruptions, caregiving responsibilities, lack of support, poor mentoring from men, everyday sexism, sexual violence, and a culture of misogyny all influence women away from these environments professionals (Cuthbert and Sidelil, 2019).

It is essential that educational institutions develop interventions to increase the representation of academic women (Casad et al., 2019). In addition, they must create environments of gender equality for women to advance in their professional careers (Yang and Gao, 2019). Some strategies that can contribute to gender balance in STEM fields are: a) identifying and promoting female role models, b) implementing programs to develop women leaders, c) generating opportunities for women to increase their presence in the fields scientists, d) development of professional orientation and retention programs, e) establish mentoring as part of the professional training of women, f) work with the change of mentality of young women, g) generate coaching programs so that women discover and improve their potential and h) development of political skills (Barabino et al., 2020).

The activities that can be developed to encourage girls and women to choose STEM fields and thus reduce current masculine beliefs can be: 1) Recognize and work to disprove the gender stereotypes that give men STEM skills , that is, “mathematics is masculine”, 2) encourage girls to interest in mathematics and science, 3) early approach of girls to mathematics, 4) socialize information to girls and women especially the catalog of STEM careers and their fields of work, 5) scientific summer camps for girls and women, 6) developing videos that expose successful female role models in STEM areas and 7) encouraging women and girls to take advanced courses in mathematics and Sciences (Watson, 2020).

Other elements that contribute to persistence are study groups, networking opportunities with other women, and working with female academics and mentors. Retention is supported by academic assistance, counseling and orientation programs implemented by universities (Thiry, 2019). Rosenthal, Levy, London, Lobel and Bazile (2013) add that university women who have contact with successful women generate a greater sense of relevance and show a greater interest in continuing with the career. It is known that girls from sectors with higher income over time increase their scientific affinities, however, girls from low-income families decrease their scientific interests; Hence, it is important that schools pay special attention to women and girls who come from vulnerable sectors (Todd and Zvoch, 2019).

Motherhood continues to be one of the most important obstacles that impede the professional development of women, as well as the unfair distribution of caregiving activities, which leads them to not have time for leisure. And although some companies have developed programs to attend to family responsibilities, women avoid occupying permits because they know that it represents a lethargy in their professional career (Varela, 2019).

Miluka (2013) recognizes that gender discrimination continues to permeate the labor market due to the beliefs that employers continue to have in relation to women, in addition to the division of labor by gender that has developed over time. The foregoing has serious consequences: unequal income, few opportunities, low levels of schooling resulting from school dropouts and increasing levels of poverty in some social sectors. Here it has become clear that gender inequality in the workplace alienates women from STEM fields (Okahana y Hao, 2019).

Conclusions

STEM women is a complex issue due to the number of variables that are present in the various spheres that contextualize the lives of students and professionals in these areas. The findings allow us to conclude that the proposed model measures the phenomenon of STEM women in universities and that it is in accordance with the latent variables that comprise it, the above was verified from the adjustment measures and their acceptance thresholds. Six hypotheses were established, of which three were accepted, the first is related to coping and contributes to explain the variable School. Therefore, schools have to pay special attention to those skills that must be present in the entry profiles of STEM careers, namely: a) being self-taught and b) having the capacity to tolerate frustration and act in situations difficult. In addition, schools have to make an effort to continue working with practical problems and increase the dissemination of information about the labor field of the careers offered.

The findings allowed us to accept the hypothesis that male beliefs contribute to explain the latent variable School. The results obtained reflect that schools have to continue with intervention strategies to reduce stereotypical beliefs that consider males to be more suitable for the areas in question. It is necessary to blur the ideas that men are more competent and stop thinking that women have weak aspirations in these types of careers, stop thinking that they have little capacity and that they have low self-efficacy. It is suggested to work with awareness workshops with a gender perspective, as well as to implement educational strategies aimed at women, to form a mentoring support network that allows them to meet scientists and teachers who can guide and motivate them when difficult times arise in the race. The school has to focus its efforts on those women who come from underprivileged social sectors and in a situation of poverty, so a census must be carried out to be able to send information to the students about scholarships and support programs.

Regarding the masculine beliefs that explain the labor market variable, it is concluded that efforts are needed to help encourage companies to eliminate gender ideologies that impede access to employment for women in STEM areas. And work with policies that promote their inclusion and non-discrimination based on gender. On the other hand, myths related to motherhood have to be eliminated. When this occurs in STEM women, it is an obstacle that prevents them from continuing in jobs, coupled with the few policies that support women to have spaces for the care of their children.

Future lines of research

Future lines of research are aimed at carrying out studies with women graduates from STEM fields to identify the main obstacles they have faced, to know if they are developing professionally in STEM areas, to know how many of them continue with their trajectories academics in national and international postgraduate courses, know the time they have in the labor market and thus count the women who have come to occupy strategic positions in the sectors, as well as study the barriers that have slowed their development.

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