Journal University Management 9 [20]1-16: e5920116
Article

Bridges to STEAM: Effects of a micro-intervention on self-efficacy and gender stereotypes among female students in technical Upper-Secondary Education

Puentes hacia el STEAM: Efectos de una micro intervención en autoeficacia y estereotipos de género en mujeres de Bachillerato Tecnológico

Corral-Verdugo, Alex*[a], Jiménez-López, Eusebio[b], Sepúlveda-Romo, Adrián [c] and Lilia Zulema Gaytán Martínez[d]

[a] ROR Universidad Tecnologica del Sur de Sonora - Universidad La Salle Noroeste • ODI-7910-2025 • 0009-0002-7645-9857 • 072915
[b] ROR Instituto Tecnológico Superior de Cajeme - Universidad La Salle Noroeste • 0000-0001-6893-3550 • 66512
[c] ROR Universidad Tecnologica del Sur de Sonora • OJT-1262-2025 • 0000-0002-7639-3512 • 2072915
[d] ROR Universidad Tecnologica del Sur de Sonora • 0000-0003-4280-6064 • 899737

Classification:

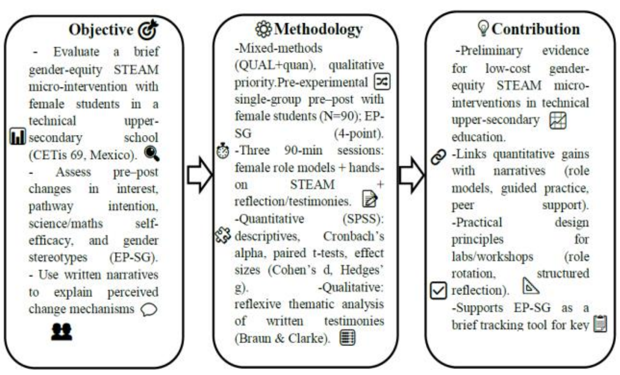
Area: Social Sciences
Field: Education sciences
Discipline: Education
Subdiscipline: Comparative education

https://doi.org/10.35429/JUM.2025.9.20.5.1.16
History of the article:
Received: September 19, 2025
Accepted: December 10, 2025

* ✉ [acorral@uts.edu.mx]

Abstract

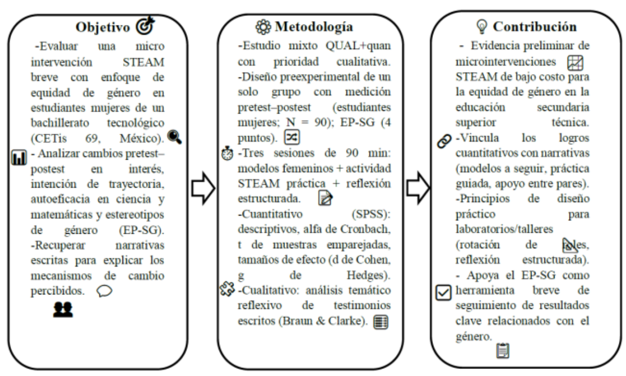
The present study evaluated a gender-equity STEAM micro-intervention with female participants in a technical upper-secondary school in Mexico. It used a mixed-methods design with a qualitative priority (QUAL+quan), as well as a pre-experimental one-group pretest–posttest scheme (N = 90). The EP-SG scale (1–4) was used to measure STEAM interest, pathway intention, science and mathematics self-efficacy, and gender stereotypes, where higher scores indicate lower acceptance of stereotypes. Significant increases were observed across the four subscales, with absolute $t(89)$ values between 4.87 and 5.92, $p < .001$, and moderate effect sizes (d = 0.51–0.62). Reflexive thematic analysis of written testimonies identified four central themes consistent with the quantitative findings. Overall, the results provide preliminary low-cost evidence to support the strengthening of STEAM pathways in technical upper- secondary education.



STEAM education; Gender stereotypes; Self-efficacy

Resumen

En el presente estudio se realizó una evaluación sobre una microintervencion STEAM con perspectiva de género a participantes mujeres de un bachillerato tecnológico en México. Se utilizó un diseño mixto con enfoque orientado a la parte cualitativa (QUAL+quan), además de un esquema preexperimental pretest-postest con un solo grupo con N=90. Se utilizó la escala EP-SG (1-4) para realizar: la medición de interés por STEAM, intención de trayectoria, autoeficacia en ciencia y matemáticas y estereotipos de género donde los puntajes más altos indican una menor aceptación a estereotipos. Se observaron incrementos de manera significativa en las cuatro subescalas con valores absolutos de $t(89)$ entre 4.87 y 5.92, $p < .001$, además de tamaños de efecto moderados (d = 0.51–0.62). Para el análisis temático reflexivo de testimonios escritos se identificaron cuatro temas centrales coherentes con el resultado de los hallazgos cuantitativos. Con todo esto, los resultados aportan una evidencia de forma preliminar de bajo costo que ayuda a fortalecer trayectorias STEAM en educación media superior tecnológica.



Educación STEAM; Estereotipos de género; Autoeficacia

Area: Development of strategic leading-edge technologies and open innovation for social transformation

Citation: Corral-Verdugo, Alex, Jiménez-López, Eusebio, Sepúlveda-Romo, Adrián and Lilia Zulema Gaytán Martínez. [2025]. Bridges to STEAM: Effects of a micro-intervention on self-efficacy and gender stereotypes among female students in technical Upper-Secondary Education. Journal University Management. 9 [20]1-16: e5920116.

Introduction

The incorporation of women into activities related to STEM (science, technology, engineering, and mathematics) and also including the arts (STEAM) continues to be an ongoing challenge, despite international efforts in the area of gender equality. Recent literature confirms that even in modern times, the gender equality gap is a multifactorial phenomenon, which relates to various sociocultural, educational and even organisational dimensions, requiring the incorporation of more empirical evidence from different contexts. (Beroíza-Valenzuela & Salas-Guzmán, 2024; Joyce *et al*., 2024; Altin & Yasan Ak, 2025).

Several authors agree that this disparity in gender equality is not the result of a single cause, but rather the correlation of several psychosocial processes, such as stereotypes related to the ingrained beliefs of those who belong to certain fields, risky academic climates, intrinsic biases in our society and cultural norms, which shape expectations and self-perceptions of competence.

In this regard, there is documentation that biases and the threat of stereotyping act as significant barriers to women's entry and retention in education systems, causing severe effects in fields such as engineering. In this regard, the importance of educational institutions as a fundamental space for peacebuilding and the active promotion of gender equality has been highlighted in recent times (Cheryan *et al*., 2017; Casad *et al*., 2019; Cadaret *et al*., 2017; Zander *et al*., 2020; Cech & Blair-Loy, 2019; Alzate Cardona *et al*., 2025)

In the school environment, evidence confirms that the onset of interest in STEM careers and gender differences are shaped in a critical and important way during secondary school and sixth form. During this period, existing gaps can manifest themselves in specific experiences in classrooms and laboratories, expressed by differences associated with the time devoted to practical activities, perception of participation, and all the elements that can influence early vocational development in young people. (Balta *et al*., 2023; Wang *et al*., 2023; Fernández *et al*., 2023; King & Pringle, 2019).

Based on a cognitive social culture, the most recent literature also suggests that there is a set of relationships associated with aspirations in STEM areas and that these depend largely on the self-efficacy that individuals tend to have in practical activities and on the expectations formed around the results obtained (Küçükaydın & Ulum, 2025; Moss-Racusin et al., 2015; Charlesworth & Banaji, 2021). Moss-Racusin *et al*., 2015; Charlesworth & Banaji, 2021).

In this regard, it has been reported that stereotypes can influence vocational interest in such a way that they can affect self-efficacy. For this reason, interventions that seek to expand boundaries in specific areas tend to be more consistent, as this occurs when mechanisms of representation and perception of ability are strengthened. (Luo et al., 2021; Chan, 2022; Jiang et al., 2024; Martín Carrasquilla et al., 2023).

In response to all this, there has been an increase in interventions in the educational field, which are focused on reducing gaps, especially in school populations. Recent studies indicate that these strategies become more effective with the incorporation of active experiences and proper teacher support, as well as the addition of situations in which existing stereotypes are reinterpreted. Likewise, it has been observed that adding brief interventions, in conjunction with good design, can produce significant changes in adolescents' interest and self-efficacy. For this reason, the current literature emphasises the implementation of teaching strategies that take students beyond traditional teaching and incorporate assessment tools that promote active learning and scientific inquiry. (Prieto-Rodriguez *et al*., 2020; Sáinz *et al*., 2022; Yabaş *et al*., 2022; Ford & dos Santos, 2024; Tulman *et al*., 2025. ; Ruiz & García, 2025)

Despite all this, in Spanish-speaking contexts, particularly in countries such as Mexico, there is still a lack of evidence that considers aspects such as the educational environment and the promotion of professional identity building in the early stages. In educational systems such as technological secondary schools, academic training is developed using workshops, tools, and practices typically associated with men, which makes it especially relevant to understand how participation in these areas, self-efficacy, and the incorporation of women into technical areas are formed.

ISSN: 2523-2495.
RENIECYT: 1702902

Corral-Verdugo, Alex, Jiménez-López, Eusebio, Sepúlveda-Romo, Adrián and Lilia Zulema Gaytán Martínez. [2025]. Bridges to STEAM: Effects of a micro-intervention on self-efficacy and gender stereotypes among female students in technical Upper-Secondary Education. Journal University Management. 9 [20]1-16: e5920116.
https://doi.org/10.35429/JUM.2025.9.20.5.1.16

Therefore, more specific and regional evidence is needed on the training climate for women in technical fields and areas associated with engineering. (Hernández Herrera, 2022; Fernández-Cárdenas & Santillán-Rosas, 2025; Casad *et al*., 2019; Harris, 2025; Master *et al*., 2016).

In this context, this study conducts a retrospective analysis of the micro-intervention of bridges to STEAM with gender equality, implemented at the CETis 69 upper secondary school (located in Ciudad Obregón, Sonora), with the aim of estimating changes in key dimensions in: interest in STEAM, career intentions, self-efficacy in science and mathematics, and gender stereotypes. Therefore, quantitative evidence obtained through the application of the EP-SG instrument is integrated, incorporating written testimonies that allow for an estimation of the mechanisms perceived during the intervention from the participants' perspective.

Finally, this study contributes in three ways: (1) it provides evidence focused on upper secondary technological education, (2) it presents measurable results with narratives of experiences through a mixed-methods design with a qualitative emphasis, strengthening the interpretation of the findings, and (3) it yields practical results on the design of brief and effective strategies focused on strengthening self-efficacy, individual belonging, and intention that women may have in technical and engineering fields.

Methodology

Study design

A mixed study with a predominantly qualitative approach (QUAL+quan) was conducted. The quantitative component adopted a quasi-experimental design that includes the application of a pre-test and post-test with a single group, which is used to describe changes in scores on interest, career intention, self-efficacy, and gender stereotypes towards STEAM-related areas. This type of study is appropriate because it has been widely used in research that seeks to understand in depth both the effects that can be measured and the experiences of participants in STEAM-related activities with a gender perspective (Fredricks *et al*., 2024; Fernández-Cárdenas & Santillán-Rosas, 2025; Sáinz *et al*., 2022).

The qualitative component, which was the main focus of the interpretation, focused primarily on collecting brief narratives and written testimonies from students about their experience in the micro-intervention called 'Bridges to STEAM' with gender equality and their perceptions of women's participation in technical and engineering contexts.

The integration of both components is shown in the diagram in Figure 1, which illustrates the administration of the pre-test tasks, the development of the intervention, and, finally, the process of collecting quantitative and qualitative data.

Box 1

Mixed Methods Study with Qualitative Dominant Status (QUAL + quan)

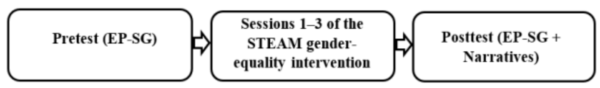


Figure 1
Mixed design with qualitative dominant status (QUAL + quan) from the study "Bridges to STEAM with gender equality"
Source: Own Elaboration

Context and participants

The study was conducted at the institution called "Centre for Industrial and Service Technology Studies No. 69" (CETis 69), which belongs to the technological upper secondary education system, within the framework of subjects related to engineering (mainly Mechatronics and Programming).

The instrument used was based on a non-probabilistic sampling approach for the convenience of this study, focusing on students who identify as women, for which the following criteria were used:

Be enrolled at CETis 69 in the semester in which the instrument was applied.

Be taking at least one technical subject associated with the field of engineering.

Agree to participate voluntarily in the entire intervention.

ISSN: 2523-2495.
RENIECYT: 1702902

Corral-Verdugo, Alex, Jiménez-López, Eusebio, Sepúlveda-Romo, Adrián and Lilia Zulema Gaytán Martínez. [2025]. Bridges to STEAM: Effects of a micro-intervention on self-efficacy and gender stereotypes among female students in technical Upper-Secondary Education. Journal University Management. 9 [20]1-16: e5920116.
https://doi.org/10.35429/JUM.2025.9.20.5.1.16

The final sample consisted of 90 female students, aged between 15 and 17 (M = 16.03, SD = 0.71), distributed by technical specialities, of which 42.2% were studying programming (n = 38) and 37.8% mechatronics (n = 34). In addition, 20.0% were studying other technical specialities (n = 18). Similarly, it is mentioned that, of the sample population, 41.1% were in their third semester (n = 37), 40.0% in their second semester (n = 36), and 18.9% in their fourth semester (n = 17), all of which is represented in Table 1.

Box 2

Table 1
Distribution of the sample by speciality, semester, shift and age.

Variable	Category / statistician	n	%
Age (years)	M = 16.03; DE = 0.71; rango = 15–17	90	100
Technical speciality	Programming	38	42.2
	Mechatronics	34	37.8
	Other technical specialities	18	20
Semester taken	Second semester	36	40
	Third semester	37	41.1
	Fourth semester	17	18.9
Shift	Morning	60	66.7
	Afternoon	30	33.3

Note. N = 90 female students. No missing data were recorded in the characterisation variables. M = mean; SD = standard deviation.

Source: Own Elaboration

Quantitative instrument: EP-SGr

For the quantitative component, the STEAM Bridge Scale with Gender Perspective (EP-SG) questionnaire was used. The instrument includes: A sociodemographic section containing: age, semester, specialisation, and shift.

Four 4-point Likert-type subscales (1 = Strongly disagree; 4 = Strongly agree):

Interest in STEAM (4 items): assesses liking, curiosity, and enjoyment of science, technology, engineering, arts, and mathematics activities and content.

STEAM career intention (4 items): explores future willingness to choose subjects, projects, careers, or jobs related to STEAM areas.

Self-efficacy in science and mathematics (4 items): measures the belief that, with study and effort, students can understand and solve science and mathematics content.

Gender stereotypes in STEAM (6 items): investigates beliefs about supposed male superiority in technical fields and those associated with engineering. Three items written in a stereotypical sense (e.g., engineering is more for men than for women, etc.) were recoded so that higher scores reflect less stereotyping and a greater orientation toward gender equality.

The mean scores for each subscale were calculated from the items. Internal consistency was assessed using Cronbach's alpha coefficient in the pretest data, with values equal to or greater than 0.70 considered acceptable. Table 2 summarises the structure of the assessment instrument, the number of items per subscale, an example of an item, the score range, and the values obtained with Cronbach's alpha.

Box 3

Table 2
Structure of the STEAM Bridge Scale with Gender Perspective (EP-SG) and internal consistency in the pretest (n = 90)

Subscale	N.º of items	Example item	Score range	Cronbach's alpha (pre-test))
Interest in STEAM	4	“I like activities that combine science, technology and creativity.”	4–16	0.899
STEAM trajectory intention	4	I would like to study a degree related to science, technology or engineering.	4–16	0.935
Self-efficacy in science and mathematics	4	"If I study hard, I can understand maths and science topics."	4–16	0.897
Gender stereotypes in technical fields (reversed)	6	Men are better than women at mechanics and programming.	6–24	0.941

Note. The items shown are answered on a 4-point Likert scale (1 = ‘Strongly disagree’, 4 = ‘Strongly agree’) where the subscale scores correspond to the total sum of the items. In the case of the gender stereotypes subscale, previously recoded items were used, such that higher scores show or indicate less agreement with stereotypes and a greater orientation towards gender equality.

Source: Own Elaboration

ISSN: 2523-2495.
RENIECYT: 1702902

Corral-Verdugo, Alex, Jiménez-López, Eusebio, Sepúlveda-Romo, Adrián and Lilia Zulema Gaytán Martínez. [2025]. Bridges to STEAM: Effects of a micro-intervention on self-efficacy and gender stereotypes among female students in technical Upper-Secondary Education. Journal University Management. 9 [20]1-16: e5920116.
https://doi.org/10.35429/JUM.2025.9.20.5.1.16

Qualitative component: narratives and written testimonies

The qualitative component was integrated through a block of open-ended questions and a written reflection activity at the end of the micro-intervention. In addition, students were asked to write short narratives in which they:

- Described significant previous experiences related to science, technology or STEAM-related projects;
- They expressed their perceptions of the presence and role of women in technical and engineering fields;
- They noted perceived changes in their interest, self-efficacy, and intention to continue training in STEAM fields after the intervention;
- They commented on which activities in the module they found most meaningful and why.

Description of the micro-intervention

The micro-intervention, called 'Bridges to STEAM with gender equality', was implemented in the Mechatronics Workshop and in the laboratory at the end of the course and was structured in three sessions of approximately 90 minutes each:

Session 1 - Visualisation and female role models in STEAM activities:

A brief presentation was given on the gaps that exist in technical and higher education, accompanied by brief examples from Mexican and international female engineers and scientists. This activity included thought-provoking questions and a guided discussion on existing gender stereotypes and the personal experiences of the students.

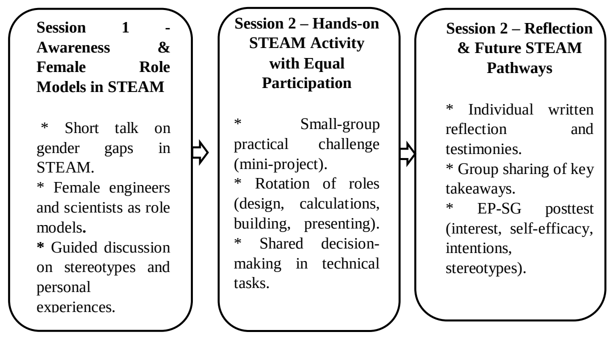
Session 2 - Practical STEAM activity with a focus on equality:

To carry out this activity, a practical exercise was conducted, which consisted of developing a technical idea that would test their creativity and problem-solving skills or, in the case of mechatronics, designing a simple prototype. In addition, equal participation was promoted through the rotation of roles such as design, calculation, execution, presentation, and shared decision-making.

Session 3 – Reflection and future outlook: The experience was concluded with an activity involving both individual and group reflection, in which the students wrote testimonials about the intervention, expressed their interest in continuing with STEAM-related activities, shared their views on the role of women in these fields, and completed the EP-SG post-test questionnaire. The general structure of the micro-intervention is shown in Figure 2.

Box 4

Structure of the Bridges to STEAM with Gender Perspective Scale (EP-SG)



Note: EP-SG = Bridges to STEAM with a Gender Perspective Scale

Figure 2
Structure of the micro-intervention "Bridges to STEAM with a gender perspective."

Source: Own Elaboration

Procedure

The study adhered to the ethical guidelines and regulations of the institution. The procedure was as follows:

1. The management and authorisation of CETis 69 and the corresponding academic coordination were carried out.

2. The objective of the study, the confidentiality of the data, and the importance of participation were communicated to the students. Due to the presence of minors, the data was treated in accordance with institutional procedures for minors, and a report on the activity was provided to the parents.

3. At the beginning of the intervention, a pre-test was administered in Google Forms format, which lasted 10-15 minutes.

ISSN: 2523-2495.
RENIECYT: 1702902

Corral-Verdugo, Alex, Jiménez-López, Eusebio, Sepúlveda-Romo, Adrián and Lilia Zulema Gaytán Martínez. [2025]. Bridges to STEAM: Effects of a micro-intervention on self-efficacy and gender stereotypes among female students in technical Upper-Secondary Education. Journal University Management. 9 [20]1-16: e5920116.
https://doi.org/10.35429/JUM.2025.9.20.5.1.16

4. Subsequently, three micro-intervention sessions were conducted in accordance with the aforementioned plan.

5. After the last session, the post-test of the EP-SG questionnaire was administered, incorporating the block of open-ended questions and the written reflection activity.

6. All the responses obtained were exported to a spreadsheet for subsequent processing using SPSS software version 27. In addition, testimonies and narratives were organised using matrices for qualitative analysis.

Data analysis

Quantitative component

For the statistical processing of the data, subscales such as the mean and standard deviations were calculated during the pre-test and post-test, and Cronbach's alpha was used to measure their reliability. On the other hand, to assess the changes associated with the intervention, ‘t-tests’ were applied to the samples related to the pre- and post-mean scores of the four subscales used, which are: interest, career intention, self-efficacy, and gender stereotypes. Furthermore, the effect size (Cohen's d) was calculated with 95% confidence intervals in order to quantify the practical magnitude of the changes observed.

Qualitative component

The qualitative treatment of the information was carried out following the proposals of: Braun & Clarke, 2006; Braun & Clarke, 2022, which cover aspects such as familiarisation with the data, the generation of initial coding, the search for themes, etc. Themes were identified that relate to:

a. Perceived changes in interest, self-efficacy, and intention to pursue STEAM fields.

b. Reinterpretation of gender stereotypes and perception of female role models in technical contexts.

The quantitative and qualitative results were integrated into the discussion using complementary triangulation, where numerical data was used to contextualise and reinforce the interpretations constructed from the students' narratives.

Results

Sample characteristics

During the study, 90 students participated, all of whom were female upper secondary school students from CETis No. 69. The average age of these women was 16.03 years (SD = 0.71; ranging from 15 to 17 years). The vast majority of the sample under study was enrolled in the Programming and Mechatronics specialisations. However, other technical courses were also represented, accounting for a smaller portion of the sample, mainly from the first and third semesters. Likewise, more than two-thirds of the participants were in the morning shift and the rest in the afternoon shift, with a detailed distribution by specialisation, semester and shift as shown in Table 3.

Box 5

Table 3
Sociodemographic characteristics of participants (N = 90)

Variable	Category	n	%	Media	DE	Range
Age in years	—	90	100	16.03	0.71	15–17
Technical speciality	Mechatronics	34	37.8	—	—	—
	Programming	38	42.2	—	—	—
	Other	18	20	—	—	—
Semester completed	2.º	36	40	—	—	—
	3.º	37	41.1	—	—	—
	4.º	17	18.9	—	—	—
Group turn	Morning	60	66.7	—	—	—
	Afternoon	30	33.3	—	—	—

Source: Own Elaboration

Psychometric properties of the EP-SG

The use of the Bridges to STEAM with a Gender Perspective Scale (EP-SG) consisted of four subscales, which are: 1) interest in STEAM, 2) intention to pursue a STEAM career, 3) self-efficacy in science and mathematics, and 4) gender stereotypes in STEAM (these items were recoded so that higher scores indicate less agreement with stereotypes).

ISSN: 2523-2495.
RENIECYT: 1702902

Corral-Verdugo, Alex, Jiménez-López, Eusebio, Sepúlveda-Romo, Adrián and Lilia Zulema Gaytán Martínez. [2025]. Bridges to STEAM: Effects of a micro-intervention on self-efficacy and gender stereotypes among female students in technical Upper-Secondary Education. Journal University Management. 9 [20]1-16: e5920116.
https://doi.org/10.35429/JUM.2025.9.20.5.1.16

For each subscale, the mean of the corresponding items was calculated, with a typical theoretical range of 1 to 4 points (where 1 = strongly disagree and 4 = strongly agree). For the reliability analyses, Cronbach's alpha coefficients were reported in a high range for all the aforementioned subscales, from the pretest to the posttest. These values are within the expected range for educational studies of this type with Likert scales (see Table 4). The results indicate adequate and correct internal reliability for the use of the EP-SG instrument in this female technological high school student population.

Box 6

Table 4
Structure and internal consistency of the STEAM Bridge Scale with a Gender Perspective (EP-SG)

Subscale	No. of items	Example item	Score range *	Cronbach's alpha (pre-test)
Interest in STEAM	4	“I enjoy participating in activities related to science or technology.”	1–4 (media)	0.899
STEAM trajectory intention	4	"I would like to study a degree related to engineering or technology."	1–4 (media)	0.935
Self-efficacy in science and mathematics	4	"If I study, I can understand maths topics, even if they are difficult."	1–4 (media)	0.897
Gender stereotypes in STEAM (R)**	6	Engineering is just as suitable for women as it is for men.	1–4 (media)	0.941

Source: Own Elaboration

Pre-post changes in the EP-SG subscales

To quantify the impact of the micro-intervention carried out, a comparison was made of the mean scores obtained for each subscale of the EP-SG instrument before and after the intervention using paired t-tests. An increase in the means obtained from the pre-test and post-test of the cases analysed was observed, and statistical significance was obtained in the data obtained and effect sizes in a moderate proportion.

For the STEAM interest subscale, a score was obtained where the mean increased from 2.59 (SD = 1.07) during the pretest to 2.91 (SD = 1.09) for the posttest, $t(89) = -5.92$, $p < .001$, with a Cohen's effect size d of 0.62. For the STEAM career intention subcategory, the mean increased from 2.48 (SD = 1.19) to 2.81 (SD = 1.15), t(89) = -5.73, p < .001, d = 0.60. Based on these data, it is reasonable to suggest that, after completing the micro-intervention, the students not only reported greater interest in STEAM activities, but also showed a greater willingness to consider future studies or career paths related to these areas.

In the case of self-efficacy in science and mathematics, the mean increased from 2.49 (SD = 1.08) in the pretest to 2.79 (SD = 1.10) in the posttest, $t(89) = -4.87$, $p < .001$, $d = 0.51$, This confirms that there was a significant increase of moderate magnitude in the perception of ability to understand and deal with science and mathematics content.

Finally, for the STEAM gender stereotypes subscale (which was recoded so that higher values indicate less agreement with stereotypes), the mean score increased from 2.79 (SD = 1.06) to 3.06 (SD = 0.96), $t(89) = -5.20$, $p < .001$, $d = 0.55$. These data indicate a significant reduction in the acceptance of gender stereotypes linked to STEAM after the micro-intervention (see Table 5). It should be noted that the negative sign of ‘t’ reported is due to the fact that the comparison made was defined as pretest minus posttest, while for effect sizes ‘d’ a positive value is considered for easy interpretation in the study (obtaining favourable increases between the initial and final measurements).

Box 7

Table 5
Pre–post comparison on the EP-SG subscales (means, SD, t, p, and Cohen's d)

Subescala	Pre, M (DE)	Post, M (DE)	*t*(89)	*p*	*Cohen's d*
Interest in STEAM	2.59 (1.07)	2.91 (1.09)	-5.92	< .001	0.62
Intention to pursue a STEAM career	2.48 (1.19)	2.81 (1.15)	-5.73	< .001	0.6
Self-efficacy in science and mathematics	2.49 (1.08)	2.79 (1.10)	-4.87	< .001	0.51
Gender stereotypes in STEAM	2.79 (1.06)	3.06 (0.96)	-5.2	< .001	0.55

Source: Own Elaboration

ISSN: 2523-2495.
RENIECYT: 1702902

Corral-Verdugo, Alex, Jiménez-López, Eusebio, Sepúlveda-Romo, Adrián and Lilia Zulema Gaytán Martínez. [2025]. Bridges to STEAM: Effects of a micro-intervention on self-efficacy and gender stereotypes among female students in technical Upper-Secondary Education. Journal University Management. 9 [20]1-16: e5920116.
https://doi.org/10.35429/JUM.2025.9.20.5.1.16

Qualitative results

For the reflective analysis of the written testimonies in the study, four central themes were identified, which are considered: (1) reframing STEAM as an accessible and achievable option, (2) strengthening self-efficacy in science and mathematics, (3) questioning gender stereotypes in STEAM, and (d) the relevance of female role models and teacher support. These themes emerged inductively from the students' written testimonies, and finally, a relationship was sought with the quantitative subscales for the EP-SG instrument, as shown in Table 6.

Box 8

Table 6
Emerging themes and sub-themes in testimonials about the micro-intervention Bridges to STEAM with gender equality

Subject	Main subtopics	Description of the topic	Illustrative citation example*
Reframing STEAM as an accessible and achievable option	Discovering new STEAM areas: the connection with everyday problems	Students go from perceiving STEAM as something very distant or "only for very intelligent people" to recognising it as diverse fields that are useful and related to real scenarios in their social environment.	I used to see engineering-related courses as something very complicated or unrelated to me, but now I see that they are more relevant to my life and school than I thought. (Student 14, 3rd semester)
Strengthening self-efficacy in science and mathematics.	Perception of ability to resolve difficult content. Confidence to participate and ask questions	There is a noticeable increase in student confidence in relation to learning science and mathematics, taking on more technical challenges and participating in laboratory, classroom and school activities.	I had always struggled with mathematics, but in the projects I was assigned, I felt that I could contribute something valuable. Being able to take things step by step and work as a team with my classmates filled me with confidence in myself and my abilities. (Student 07, 5th semester)
Challenging gender stereotypes in STEAM	Identification of previous sexist messages. Criticism of the idea that technical careers "are solely and exclusively for men".	Students identify phrases and attitudes or situations that they previously saw as just a joke or normal, and now begin to question the idea that STEAM careers are only reserved for men or people who identify with that gender.	In my family, it is said that mechanics is only for men. Previously, I didn't say anything about this, but now I think that as a woman I can also study mechanics or careers such as mechatronics and that I am also capable of doing well. (Student 41, 3rd semester)
Relevance of female role models and teacher support	Visibility of women in STEAM Assessment of the climate of respect and listening towards science and mathematics	Learning about the stories of women involved in STEAM and having a safe and supportive space is seen as a key and essential factor in imagining one's own career paths in these fields.	It was motivating to meet and see examples of women who have already gone through what we are going through and are now working on important things. This makes you think that you can do what you like or what appeals to you. (Student 19, 3rd semester)

Source: Own Elaboration

Reframing STEAM as an accessible and achievable option

The first theme refers to a change in the students' perception and their view of STEAM. The comments show that the students associate highly complex areas of knowledge with highly qualified people or with men only. However, after the three sessions, their thinking changed favourably, with very positive reactions towards STEAM and related fields, which they now perceive as more accessible and associate with their everyday reality.

The practices and activities carried out in the mechatronics and ICT workshops stand out as activities that strengthened their confidence and understanding in the application of science and technology, as well as helping them to understand that STEAM is not limited or restricted to sitting in front of a computer, but that these practices help to solve everyday problems at school or in the community.

Comments such as: *I used to see engineering careers as something very complicated or unrelated to me, but now I see that they are more related to my life and school than I thought. (Student 14, 3rd semester).*

This whole process of reframing is consistent with the increases observed in the scales used to measure interest and intention in STEAM trajectories in EP-SG.

Strengthening self-efficacy in science and mathematics

The second theme is associated with the strengthening of perceived self-efficacy in science and mathematics, where participants describe that, during the micro-intervention, they felt capable of tackling tasks that normally caused them some kind of insecurity. This became more evident when a clearer and more in-depth explanation was provided, complemented by guided examples and the participation of their classmates.

The participants' narratives highlight the collaboration and rotation of roles in the different activities proposed, as well as the conditions that contributed to the active participation of all students during the practical sessions.

ISSN: 2523-2495.
RENIECYT: 1702902

Corral-Verdugo, Alex, Jiménez-López, Eusebio, Sepúlveda-Romo, Adrián and Lilia Zulema Gaytán Martínez. [2025]. Bridges to STEAM: Effects of a micro-intervention on self-efficacy and gender stereotypes among female students in technical Upper-Secondary Education. Journal University Management. 9 [20]1-16: e5920116.
https://doi.org/10.35429/JUM.2025.9.20.5.1.16

Taking on a specific role allowed them to experience a more active contribution to tasks that they had previously avoided, especially in activities associated with calculations or the use of technological tools. The following quote confirms the above:

Quote: *I had always struggled with mathematics, but in the projects I was assigned, I felt that I could contribute something valuable. Being able to go step by step and work as a team with my classmates filled me with confidence in myself and my abilities. (Student 07, 5th semester).*

The pattern observed in the change in narratives indicates that the pedagogical mechanisms that underpin this change, such as scaffolding, guided practices, and peer support in the proposed activities, behave consistently and effectively with the expected results.

Questioning gender stereotypes in STEAM

The third theme considered is the normalisation of questioning gender stereotypes linked to STEAM. In the testimonies collected, the students mention comments associated with all kinds of stereotypes, such as that women are not good at mechatronics, or that careers in mechanics or related fields are only for men. Prior to the intervention, these stereotypes were interpreted as jokes or as unwritten rules that always had to be followed.

Based on the discussions presented in session one and also on the presentation of data related to gender gaps, the participants mentioned that all of the aforementioned stereotypes can cause discouragement among women in remaining in or entering STEAM careers. In addition, some students indicated that these types of stereotypes are still present, however, they now have solid arguments to challenge them effectively.

Textual comment from student 41, 3rd semester: *In my family, they say that mechanics is only for men. I didn't say anything about this before, but now I think that as a woman I can also be in mechanics or careers such as mechatronics and that I am also capable of doing it well.*

Questioning these types of stereotypes is consistent with the increase in scores associated with the EP-SG's STEAM gender stereotypes subscale (where a higher value indicates less agreement with stereotypes), suggesting that during the intervention, it serves as a mechanism for critical reflection on the impact of sexist messages on academic decisions.

Relevance of female role models and teacher support

The fourth topic evaluated discusses the importance of highlighting female role models in STEAM and the type of teacher support used in the intervention. It is possible to observe that the participants greatly valued learning about some success stories of women associated with technical careers, such as scientists or engineers, with a recognised track record and working in relevant areas. This is demonstrated as a role model, which allows them to imagine themselves in possible careers beyond the stereotypes that exist.

The students describe the space provided by the micro-intervention as an environment that promotes their safety, where they were also able to express their doubts and share experiences of insecurity or discrimination. In short, several suggest promoting activities such as those described above, towards a culture and promotion of science and technology in technological secondary schools, as can be seen in the following comment from student 19, 3rd semester: *It was motivating to meet and see examples of women who have already gone through the same thing we are going through and who now work on important things. This makes you think that you can do what you like or what catches your attention.*

This topic associates changes in interest, intention and self-efficacy with relational and contextual components. STEAM trajectories are not only built on individually focused attitudes, but also on having female role models, as well as on the perceived climate in the classroom and the support that teachers can offer.

Integrated synthesis of quantitative and qualitative results

In summary, both the quantitative and qualitative results observed indicate a pattern in relation to the impact of the micro-intervention carried out by STEAM bridges with gender equality on the group of participants under study. The EP-SG instrument scores reveal statistically significant increases of moderate magnitude in the four subscales analysed: interest, intention to pursue a STEAM career, self-efficacy in science and mathematics, as well as, as expected, a lower acceptance of gender stereotypes between the pre-test and post-test. These results suggest a consistent improvement in the participants' attitudes, expectations, and beliefs regarding STEAM areas after the intervention.

On the other hand, the qualitative component contributes by providing detailed explanations for these changes. The participants' narratives reframe STEAM areas as a reliable and safe option, as they show greater confidence when facing scientific or mathematical content, question traditional stereotypes that they previously considered normalised, and greatly value having female role models, as well as the teaching support that can be provided to them. It is also worth mentioning that all these findings reaffirm the trends observed in the scores of the instruments applied and also help to better understand the subjective and relational processes associated with these areas.

In summary, it is possible to mention that carrying out a brief micro-intervention such as the one applied, which combines practice and safe spaces for critical gender reflection, has a very positive effect on bringing women closer to areas related or similar to STEAM. This opens up a wide range of possibilities for the use of long-lasting strategies with a focus on gender equality in technical education.

Conclusions

The objective of this study was to assess the effect of a micro-intervention on the study group from a gender perspective, in aspects such as attitudes and beliefs related to STEAM-related areas in technological high school students, integrating both quantitative and qualitative evidence.

Overall, the findings suggest consistent improvements in the four dimensions assessed by the EP-SG instrument used, with statistically significant pre-post differences and moderate effect sizes (d between 0.51 and 0.62 respectively). In addition, the internal consistency reported for the subscales considered confirms that the changes observed are estimated with acceptable accuracy in this sample.

Changes in interest and career intention, from something distant to a viable option

The increase in interest in STEAM and in STEAM career intention observed after the intervention is consistent with the idea that vocational orientation in STEM depends not only on individual preferences, but also on access conditions, close experiences, and environmental cues about who ‘belongs’ in these fields. Recent literature reports gender differences in interest in STEM career paths in secondary education, and it has been emphasised that such differences are partially explained by psychosocial variables (e.g., beliefs about ability, outcome expectations, and contextual factors). Along the same lines, the weight of the ‘perceived climate’ and available support appears to be a key element in enabling students to translate their interest into a realistic intention to continue.

Qualitative results reinforce this interpretation: the theme of reframing STEAM as a close and achievable option indicates a shift from perceptions of distance to a more everyday, applicable, and ‘possible’ reading of STEAM areas. This correlation between numerical change and giving meaning to the narrative suggests that the micro-intervention used not only increases scores but also refocuses the meaning of STEAM and generates a connection with the daily lives of the participants, which is relevant because it is the mechanism for consolidating vocational decisions at an early stage.

Self-efficacy as a central mechanism: the role of guided experience and collaborative work. The increase in self-efficacy in science and mathematics is a particularly valuable finding because evidence indicates that self-efficacy functions as an explanatory pathway between stereotypes and expectations and interest in STEM trajectories.

ISSN: 2523-2495.
RENIECYT: 1702902

Corral-Verdugo, Alex, Jiménez-López, Eusebio, Sepúlveda-Romo, Adrián and Lilia Zulema Gaytán Martínez. [2025]. Bridges to STEAM: Effects of a micro-intervention on self-efficacy and gender stereotypes among female students in technical Upper-Secondary Education. Journal University Management. 9 [20]1-16: e5920116.
https://doi.org/10.35429/JUM.2025.9.20.5.1.16

For example, it has been documented that STEM stereotypes can predict career interest through self-efficacy and outcome expectations. In your study, the narratives describe very specific pedagogical conditions associated with increased confidence: step-by-step explanation, guided examples, collaboration, role rotation, and active participation.

These descriptions lend plausibility to quantitative changes by suggesting that the increase in self-efficacy was not abstract, but supported by structured experiences that reduce the perceived threat of “difficult” tasks and normalise supported learning.This point matters because self-efficacy is often a robust predictor of engagement and persistence in STEM; therefore, brief interventions that succeed in raising it can be strategic in technical education contexts, where contact with technological and problem-solving activities can become a confirming event (I can do it, I understand, I belong).

Less acceptance of stereotypes and signals from the educational environment. Regarding the STEAM gender stereotypes subscale, the results concerning the increase in scores between the pre-test and post-test suggest that there is a reduction related to the level of acceptance of stereotypes after the end of the intervention.

This evidence is considered relevant because gender stereotypes in STEAM are widely documented in school environments, allowing this problem of attitudes to be addressed at an early age and thus avoiding limitations on aspirations and vocational relevance. Furthermore, when female students perceive signs of exclusion or non-belonging in their environment (e.g., in areas such as computing), their interest tends to decline, not necessarily due to a lack of ability, but rather due to cultural and/or symbolic messages associated with the field of study.

The qualitative component complements this finding by explicitly identifying the questioning of stereotypes as one of the emerging themes, suggesting that the change was not only attitudinal but also discursive, as participants were able to name, discuss or challenge previous assumptions.

From an educational perspective, this is particularly important because evidence shows that exposure to information or evidence causes a change in attitudes and behaviour, although this depends on the context and the way in which it is presented. Female role models and teacher support.

The fourth theme identified is that of female role models and teacher support, which provide a broader view of the relevance of STEAM trajectories, telling us that they are constructed using the relational part with the environment and the contextual part, all of this not only from the individual motivations of the individual but also from that set of attitudinal factors.

This reinforces the idea of the existing need to use school interventions aimed at girls from early school levels as a strategy to generate greater participation and aspirations in STEAM areas. Furthermore, the presence of female role models, together with active teacher support, operates in such a way as to send signals of belonging and validation to these variable models, which in turn reinforce interest and self-efficacy, which in turn favour intentions to continue.

Implications for technical secondary education. The results obtained suggest that the application of brief micro-interventions combined with spaces for critical reflection and guided activities is an effective strategy in technical secondary schools where curriculum time is short and limited.

It should also be mentioned that the combined pattern of improvements in interest, self-efficacy, and lower acceptance of stereotypes supports the relevance of incorporating three components of future actions, which are: (1) properly structured practical experiences that allow for early achievements, (2) visibility of female role models and references, and (3) proper teacher support that fosters a positive classroom environment and everyday language.

Limitations and lines of continuity

The study has limitations that must be considered when interpreting the findings, including the following:

ISSN: 2523-2495.
RENIECYT: 1702902

a) The limitation of the pretest-posttest design prevents the attribution of causality with the same impact as if there were a comparison group design, which is why the idea that factors such as history, maturation, or the measurement effect may influence the results cannot be ruled out. In addition, the qualitative information comes from very brief testimonies, which encourages active participation by individuals but, on the other hand, limits the depth of interpretation compared to other instruments such as interviews or focus groups.
b) It should also be noted that the study was conducted in a very specific institutional context, which is why it is highly advisable to replicate it in other institutions and carry out temporary follow-ups to assess the stability of the change.
c) As a follow-up, it is advisable to implement a design with a comparison group and also follow-up measurements, such as weeks or months after application, to assess permanence.
d) Modelling the variables in greater detail is another aspect that must be considered, for example, whether the reduction in stereotypes and an increase in self-efficacy explain an increase in career intention, given that the literature effectively points to structural links between these dimensions.
e) Another line of inquiry is to model the relationships between variables in greater detail (for example, whether the reduction in stereotypes and the increase in self-efficacy explain the increase in career intention), given that the literature points to structural links between these dimensions.

Final conclusions

In short, with all the evidence gathered, it should be noted that the micro-intervention Bridges to STEAM with gender equality is a promising strategy for promoting attitudes and beliefs in favour of STEAM among technological high school students, especially because it strengthens self-efficacy, redefines the proximity that may exist towards STEAM, and encourages questioning of existing stereotypes.

The results obtained provide valuable evidence for the redesign of brief, replicable interventions adapted to the desired context, which will have the potential to increase female participation in technical and engineering careers.

Annexes

Box 9

Table 7

Operational specification of the STEAM Gender Equality Bridge Scale (EP-SG): subscales, recoding, and scoring rules

Subscale	No. of items	Example item (abbreviated text)	Recoding	Range (average, 1–4)	Rank (amount)	α (pre-test)
Interest in STEAM	4	I like STEAM activities.	Not applicable	1–4	4–16	0.899
Intention towards STEAM	4	I would like to study a degree related to STEAM in the future.	Not applicable	1–4	4–16	0.935
Self-efficacy in STEAM	4	I consider myself to be good at STEAM subjects and activities.	Not applicable	1–4	4–16	0.897
Gender stereotypes	3	Men are better at mechanics and programming.	Yes: new = 5 − original response	1–4	3–12	0.941
Scoring rule	15 (total)	The subscale score was calculated as the mean of its items (1...ions; the sum is equivalent and is reported as a theoretical range.	Apply Recoding only to stereotypes before averaging /summing.	—	—	—

Source: Own Elaboration

ISSN: 2523-2495.
RENIECYT: 1702902

Box 10

Table 8

Guide to open-ended questions (written reflection after intervention) and link to EP-SG dimensions

Dimension of reflection	Open-ended question for reflection (suggested text)	Link to EP-SG
Identification with STEAM	Write a brief experience or story that made you feel connected to STEAM (science, technology, engineering, arts, and mathematics).	Interest in STEAM
Perceived efficacy and interest	Describe a situation in which you felt capable and interested in doing a STEAM activity. What happened and what helped you achieve it?	Self-efficacy in STEAM; Interest in STEAM
Aspirations and career choice	What would you like to study or what would you like to do in the future? Explain why and whether you are interested in it being related to STEAM.	Interest in STEAM
Identification with STEAM	Write a brief experience or story that made you identify with STEAM (science, technology, engineering, arts, and mathematics).	Interest in STEAM
Perceived efficacy and interest	Describe a situation in which you felt capable and interested in doing a STEAM activity. What happened and what helped you achieve it?	Self-efficacy in STEAM; Interest in STEAM

Source: Own Elaboration

Declarations

Conflict of interest

The authors declare that they have no conflicts of interest.

Author contribution

Corral-Verdugo, Alex: Conceptualisation, methodology, research, statistical data processing, formal analysis, visualisation, drafting of the original manuscript, overall project management and administration. Led the mixed design (QUAL+quan) and implementation of the micro intervention, coordinated the application of pre- and post-tests, organised the database for analysis in SPSS v27 software and qualitative matrices, performed quantitative analyses (reliability and pre-post comparisons) and thematic analysis of testimonials, and drafted the first version of the manuscript.

Jiménez-López, Eusebio: Methodology, Resources, Research, Support in data curation, Model validation, Writing: review and final editing of the document. He contributed to the refinement of the EP-SG instrument and application inputs, supported implementation in the school context and the systematisation of responses (quantitative and narrative), collaborated in the curation/organisation of data for analysis, and reviewed the manuscript to ensure pedagogical alignment and internal consistency of the report.

Sepúlveda-Romo, Adrián: Support in methodology, resources, research, validation, writing: review and final editing. Supported operational planning and the development of teaching resources for the micro-intervention sessions, collaborated in the collection of field information (instrument and testimonies), verified the integrity of the records captured before their processing, and contributed substantive revisions to improve the clarity and coherence of the manuscript, and provided the necessary support to the entire team.

Gaytán Martínez, Lilia Zulema: Literature review, article writing, reviewed questionnaires and participated in the development of teaching resources for micro-intervention sessions, contributed substantive revisions to improve the clarity and coherence of the manuscript, and provided necessary support to the entire team.

Luna-Bracamontes, Alberto: Resources, research, supervision, validation of resources, writing, review and editing of materials. He supported the management within the institution for the correct implementation of the intervention (access, logistics, and coordination with the different school actors), in addition to supervising the correct execution of the instrument application protocol, verifying the consistency of the records before analysis, and conducting critical reviews of the manuscript to improve clarity, coherence, and alignment with the educational context.

Availability of data and materials

The data and analysis materials (CSV/Excel, etc.) will be openly available on Zenodo, and the DOI will be provided upon publication of the article.

Funding

This research received no external funding.

Acknowledgements

The authors would like to thank CETis 69 for all the facilities provided for the implementation of the study and data collection. No financial support was received from any institution, university or company.

Abbreviations

CETis	Centre for Industrial and Service Technology Studies
d	Cohen's d (effect size)
SD	Standard deviation
EP-SG	Bridges to STEAM with a Gender Perspective Scale
M	Mean
n	Sample size
p	p-value
QUAL	Qualitative component (mixed design)
quan	Quantitative component (mixed design)
SPSS	Statistical Package for the Social Sciences (IBM SPSS Statistics)
STEAM	Science, Technology, Engineering, Arts, and Mathematics
t	t-statistic (Student's t-test)

References

Antecedents

Alzate Cardona, L. D., Correa Restrepo, M. A., & Osorio Jiménez, Y. (2025). Escuelas Tejedoras de Paz desde la Equidad de Género.

Cadaret, M. C., Hartung, P. J., Subich, L. M., & Weigold, I. K. (2017). *Stereotype threat as a barrier to women entering engineering careers*. Journal of Vocational Behavior, 99, 40–51. https://doi.org/10.1016/j.jvb.2016.12.002

Luo, T., So, W. W. M., Wan, Z. H., & Li, W. C. (2021). STEM stereotypes predict students' STEM career interest via self-efficacy and outcome expectations. International Journal of STEM Education, 8(1), 36. https://doi.org/10.1186/s40594-021-00295-y

Basics

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. Qualitative Research in Psychology, 3(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Braun, V., & Clarke, V. (2022). Thematic analysis: A practical guide. SAGE.

Casad, B. J., Petzel, Z. W., & Ingalls, E. A. (2019). A Model of Threatening Academic Environments Predicts Women STEM Majors' Self-Esteem and Engagement in STEM. *Sex Roles*, *80*, 469–488. https://doi.org/10.1007/s11199-018-0942-4

Chan, R.C.H. A social cognitive perspective on gender disparities in self-efficacy, interest, and aspirations in science, technology, engineering, and mathematics (STEM): the influence of cultural and gender norms. IJ STEM Ed 9, 37 (2022). https://doi.org/10.1186/s40594-022-00352-0

Charlesworth, T. E. S., & Banaji, M. R. (2021). Patterns of implicit and explicit attitudes II. Long-term change and stability, regardless of group membership. American Psychologist, 76(6), 851–869. https://doi.org/10.1037/amp0000810

Cheryan, S., Ziegler, S. A., Montoya, A. K., & Jiang, L. (2017). Why are some STEM fields more gender balanced than others? Psychological Bulletin, 143(1), 1–35. https://doi.org/10.1037/bul0000052

Jiang, H., Zhang, L. & Zhang, W. Influence of career awareness on STEM career interests: examining the roles of self-efficacy, outcome expectations, and gender. IJ STEM Ed 11, 22 (2024). https://doi.org/10.1186/s40594-024-00482-7

Martín Carrasquilla, O., Muñoz San Roque, I., & Santaolalla Pascual, E. (2023). Actitudes hacia la ciencia en la educación STEM: desarrollo de una escala para la detección y fomento de vocaciones tempranas. Revista Española de Orientación y Psicopedagogía, 34(1), 122–140. https://doi.org/10.5944/reop.vol.34.num.1.2023.37421

ISSN: 2523-2495.
RENIECYT: 1702902

Master, A., Cheryan, S., & Meltzoff, A. N. (2016). Computing whether she belongs: Stereotypes undermine girls' interest and sense of belonging in computer science. Journal of educational psychology, 108(3), 424.

Ruiz, M. F. R., & Garcia, D. M. P. (2025). Evaluación formativa con rúbricas digitales en Ciencias Naturales: impacto en aprendizaje por indagación en 7. º–10. º EGB. Horizonte Científico Educativo International Journal, 1(2), 11-28.

Tulman, G. P. M., Guayasamín, P. E. N., Manzano, J. E. E., Soliz, D. C. R., & Naranjo, E. M. (2025). Estrategias Didácticas para la Educación Básica Metodologías, Técnicas y Recursos. Revista Científica Mulfidisciplinar, 8(1), 3207-3227. https://doi.org/10.37811/cli_w1224

Supports:

Balta, N., Japashov, N., Mansurova, A., Tzafilkou, K., Oliveira, A. W., & Lathrop, R. (2023). Middle-and secondary-school students' STEM career interest and its relationship to gender, grades, and family size in Kazakhstan. Science Education, 107(2), 401-426. https://doi.org/10.1002/sce.21776

Cech, E. A., & Blair-Loy, M. (2019). *The changing career trajectories of new parents in STEM*. Proceedings of the National Academy of Sciences, 116(10), 4182–4187. https://doi.org/10.1073/pnas.1810862116

Fernández, D., White, S., Smith, H., Connor, P., & Ryan, M. (2023). *Gender inequality in STEM: Gendered time disparities in perceived and actual time spent in practical laboratory-based activities*. Frontiers in Education, 8, 1194968. https://doi.org/10.3389/feduc.2023.1194968

Fredricks, J. A., Cotter, D. A., & Lafontant, D. (2024). *Paths into and out of STEM fields: A qualitative study of women and students of color at a predominately white institution*. Journal of Research in Science Teaching, 62(5), 1232–1265. https://doi.org/10.1002/tea.22002

Harris, D. (2025). The hidden curriculum: gender, bias and banter in first-year engineering education. European Journal of Engineering Education. (Publicación anticipada en línea). https://doi.org/10.1080/03043797.2025.2586131

Hernández Herrera, C. A. (2022). La opinión de mujeres en STEM sobre lo que impulsa su inclusión. Innovación educativa (México, DF), 22(88), 33-55

Joyce, J. A., Masina, S., Michalik, L., Pot, C., Sempoux, C., & Amati, F. (2024). Closing the scissor-shaped curve: Strategies to promote gender equality in academia. Cell, 187(6), 1335–1342. https://doi.org/10.1016/j.cell.2024.01.050

King, N. S., & Pringle, R. M. (2019). Black girls speak STEM: Counterstories of informal and formal learning experiences. Journal of Research in Science Teaching, 56(5), 539-569. https://doi.org/10.1002/tea.21513

Küçükaydın, M.A., Ulum, H. Understanding STEM Career Interest: STEM Experiences, Stereotypes, Self-efficacy, and Sense of Belonging. Journal for STEM Educ Res 8, 454–476 (2025). https://doi.org/10.1007/s41979-025-00146-3

Moss-Racusin, C. A., Molenda, A. K., & Cramer, C. R. (2015). Can Evidence Impact Attitudes? Public Reactions to Evidence of Gender Bias in STEM Fields. *Psychology of Women Quarterly*, *39*(2), 194-209. https://doi.org/10.1177/0361684314565777 (Original work published 2015)

Wang, N., Tan, A. L., Zhou, X., Liu, K., Zeng, F., & Xiang, J. (2023). Gender differences in high school students' interest in STEM careers: A multi-group comparison based on structural equation model. International Journal of STEM Education, 10(1), 59. https://doi.org/10.1186/s40594-023-00443-6

Zander L, Höhne E, Harms S, Pfost M and Hornsey MJ. (2020) When Grades Are High but Self-Efficacy Is Low: Unpacking the Confidence Gap Between Girls and Boys in Mathematics. Front. Psychol. 11:552355. DOI: https://doi.org/10.3389/fpsyg.2020.552355

Discussions

Altin, R., & Yasan Ak, N. (2025). *Girls in robotics programming: STEAM integration in computer science course*. International Journal of Eurasia Social Sciences, 16(62), Art. 2006. https://doi.org/10.70736/ijoess.2006

ISSN: 2523-2495.
RENIECYT: 1702902

Beroíza-Valenzuela, F., & Salas-Guzmán, N. (2024). *STEM and gender gap: A systematic review in WoS, Scopus, and ERIC databases (2012–2022)*. Frontiers in Education, 9, 1378640. https://doi.org/10.3389/feduc.2024.1378640

Fernández-Cárdenas, J. M., & Santillán-Rosas, I. M. (2025). *Learning critical thinking through dialogic STEAM educational activities: A case of high school students in Northeastern Mexico during pandemic times*. SAGE Open, 15(4). https://doi.org/10.1177/21582440251388756

Ford, S. J., & dos Santos, R. (2024). *Empowering Female High School Students for STEM Futures: Career Exploration and Leadership Development at Scientella*. Education Sciences, 14(9), 955. https://doi.org/10.3390/educsci14090955

Prieto-Rodriguez, E., Sincock, K., & Blackmore, K. (2020). STEM initiatives matter: results from a systematic review of secondary school interventions for girls. *International Journal of Science Education, 42*(7), 1144–1161. https://doi.org/10.1080/09500693.2020.1749909

Sáinz, M., Fàbregues, S., Romano, M. J., & López, B. S. (2022). *Interventions to increase young people's interest in STEM: A scoping review*. Frontiers in Psychology, 13, 954996. https://doi.org/10.3389/fpsyg.2022.954996

Yabaş, D., Kurutaş, B. S., & Corlu, M. S. (2022). *Empowering girls in STEM: Impact of the Girls Meet Science project*. School Science and Mathematics, 122(5), 247–258. https://doi.org/10.1111/ssm.12540

ISSN: 2523-2495.
RENIECYT: 1702902